DIVISION 16

ELECTRICAL

SECTION 16050

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section includes the requirements and methods for furnishing and installing the basic electrical materials, and other associated items as shown on the Plans, and as further specified herein.

1.2 RELATED WORKS SPECIFIED ELSEWHERE

Section	Item
01300	Submittals
01800	Testing, Commissioning, and Training
02300	Site Earthwork
Division 3	Concrete
09900	Painting
11000	Equipment General Provisions
Division 15	Mechanical
Division 16	Electrical

1.3 DEFINITIONS

A. ADJUSTABLE SPEED DRIVE CONTROLLERS

Adjustable speed drives are variable frequency AC drives used to power AC squirrel-cage induction motors at variable frequencies, which relate directly to variable speed. These drives are also commonly known as Variable Frequency Drives (VFDs).

Basic design typically consists of AC to DC conversion followed by AC output wave simulation using pulse-width modulation (PWM). This simulated output power signal will appear to the motor as a representation of an adjustable frequency sine wave. This output may be electrically noisy.

B. ANALOG I/O

Analog I/O are PLC input/output electronic signals that are contiguous over time. Analog signals represent a large number of values within a specific range.

C. ATTICS

Attics shall be considered those closed environments between ceilings and roofing that allow full entry of personnel by use of ladders, pull-down stairs, or other special means.

ATTICS are considered dry crawl spaces (see CRAWL SPACES).

Tight spaces between ceilings and roofs that do not allow full entry of personnel are considered concealed areas (see CONCEALED AREAS).

D. CHEMICAL AREAS

Locations where process chemicals are stored or used within a process in either a confined or open manner. Chemical areas may be exposed to chemical solids, liquids, or gases as a result of normal operation, system maintenance, or spills/leaks.

E. CONCEALED AREAS

Locations that are underground, within walls, or within other areas that do not allow full entry of personnel are considered concealed. Concealed areas are not exposed (see EXPOSED AREAS) or accessible (see ATTICS and CRAWL SPACES).

F. CONTROL PANELS

Control Panels shall be defined as enclosures that contain electrical devices capable of controlling, altering, indicating or displaying the function or conditions of electrical circuits. Unlike junction boxes, Control Panels are not just used for the redirection or reconnection of electrical circuits.

G. CONVENIENCE RECEPTACLES

120 Vac general-purpose receptacles that are not dedicated to a specific function or piece of equipment. Receptacles dedicated to computers, heat tracing, fans, louvers, and etc., are not considered convenience receptacles.

H. CRAWL SPACES

Crawl spaces shall be considered those closed environments that are not normally accessible to personnel, but that allow full entry of personnel by special means.

Crawl spaces are considered exposed areas and may be dry or wet (see ATTICS).

I. DAMP AREAS

Damp areas are considered wet (see WET AREAS).

J. DEDICATED RECEPTACLES

Dedicated receptacles are provided for a specific receptacle load such as computers, heat tracing, fans, louvers, metering pumps, sump pumps, and etc. Dedicated receptacles are not intended for general use.

K. DIGITAL I/O

A digital I/O point consists of a single input or output binary bit at one of two possible states, which may be represented as 1's or 0's, ON or OFF, YES or NO, TRUE or FALSE, etc. Digital I/O may also be called "discrete" I/O. Within these specifications, both terms are synonymous.

L. DRY AREAS

Locations not normally subject to dampness or wetness. A location classified as dry may be temporarily subjected to dampness or wetness, as in the case of a building under construction (see FINISHED AREAS).

Rooms containing process water, chemical piping, or related equipment are not considered DRY. Areas that are not considered DRY are considered WET.

M. EXPOSED AREAS

Locations that are visible, outdoors, or exposed to a process or room environment. Exposed areas are not concealed (see CONCEALED AREAS).

N. FINISHED AREAS

Indoor confined areas that are not directly exposed to a process or process chemicals. They typically include closed offices, bathrooms, laboratories, lunch/break rooms, etc. Finished areas are considered DRY.

O. HAZARDOUS AREAS

Class I, Divisions 1, and 2; Class II, Divisions 1 and 2; Class III, Divisions 1 and 2 locations where fire or explosion hazards may exist due to flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers or flyings (reference National Electrical Code, Article 500).

P. HIM

Human Interface Module – A programmable operator interface directly associated with, or integral to, an electrical control device (such as a VFD or Soft Start drive). This interface displays device setpoints and status with a keypad for data entry.

Q. HMI

Human Machine Interface – The way a person interacts with a computer or electronic device. It comprises the screen menus and icons, keyboard shortcuts, command language, and help functions. Peripheral support devices, such as a mouse, keyboard, touch screen, and remote controls are also included. The HMI system is typically PC based, located in an office or lab environment.

R. HOT SPARE

A "Hot Spare" is a PLC analog or digital channel in a PLC card that is powered but the channel is unassigned. Hot spares are connected to fused field I/O terminal block groups per Specification 16940.

S. INDOOR AREAS

Confined locations where the equipment is normally protected from wind, dust, rain, snow, and other natural elements. INDOOR areas are not the same as DRY areas.

T. I/O

Inputs/Outputs – Input and output signals into and out of a PLC or RTU.

U. OIU

Operator Interface Unit – A graphical display of industrial plant system variables and status. It may also allow for process control adjustments. Navigation of its programming may be via keypad, touch screen, or a

combination of both. An OIU is typically located on a field control panel or control panel in an electrical equipment room.

An Operator Interface Unit is considered a possible extension of a PLC, like an I/O or network card. PLC installations may or may not not include an OIU.

V. OUTDOOR AREAS

Locations where the equipment is normally exposed, or partially exposed, to weather in the form of wind, dust, rain, snow, and other natural elements.

W. PROCESS AREAS

Process areas are those areas that are directly exposed to process moisture, or that may be subjected to moisture in the event of a process leak or failure. They typically include pump rooms, chemical rooms, and direct process-exposure areas such as clearwells, open filters, and reservoirs. Process areas are considered WET.

X. PLC

Programmable Logic Controller – A device used to monitor and control system process. It can be used stand-alone or in conjunction with other systems such as SCADA. It may provide telemetric functions or interface with telemetric equipment.

Y. RTU

Remote Telemetry Unit/Remote Terminal Unit – A device that reads the status of process devices and transmits them to another telemetric unit. RTUs may transmit a command from another source but will not alter or interpret the command. RTUs differ from PLCs in that they do not control a process.

Z. SCADA

Supervisory Control and Data Acquisition (SCADA) systems are data monitoring and control stations that allow operators to visualize and adjust live process conditions at a centralized HMI. These systems often include process historical data tracking and alarming capabilities. SCADA systems can be used for data monitoring locally, remotely, or both.

AA. SHOP FABRICATED

Manufactured or assembled equipment for which a UL test procedure has not been established.

BB. SOFT START MOTOR CONTROLLERS

See SOLID STATE MOTOR CONTROLLERS in this Section.

CC. SOLID STATE MOTOR CONTROLLERS

Solid State motor controllers provide an electronically controlled acceleration and deceleration of AC squirrel-cage induction motors. Once the motor has reached full speed, the electronics are switched off and replaced with a motor drive contactor that connects the motor directly to line power, thus assuring continuous full voltage to the motor. Solid State motor controllers are also referred to Soft Start motor controllers.

Unlike VFD drives, Solid State motor controllers do not alter the sine wave *frequency* to the motor; instead they alter the portion of the sine wave that reaches the motor. This controls the amount of power sent to the motor and affects the motor's ability to create torque. The electronic Solid State control is only used during acceleration and deceleration. During acceleration the controller switches the waveform from 0 up to 100 percent (full voltage) and during deceleration switches the waveform from 100 down to 0 percent (no voltage).

DD. TELEMETRY

Telemetry is the transfer of data between remote sites. Typical methods of data transfer are utility phone lines, radio transmission, and fiber optics.

EE. VARIABLE FREQUENCY DRIVES (VFDs)

See ADJUSTABLE SPEED CONTROLLERS in this Section.

FF. VIBRATING EQUIPMENT

Equipment that is subject to vibration under normal operating conditions, such as motors, transformers, electrically operated valves, etc.

GG. WET AREAS

Locations outdoors, underground, directly or indirectly exposed to the process, in concrete slabs or masonry in direct contact with the earth, or in any other way subject to saturation with water or other liquids.

1.4 REFERENCES

Unless otherwise noted, the requirements of the following code-making authorities and standard organizations apply:

References	**Title**
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society of North America
ISA	Instrument Society of America
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NRTL	National Recognized Testing Laboratory
OSHA	Occupational, Health, and Safety Administration
UL	Underwriters Laboratories, Inc.
UL 508	Safety Industrial Control Equipment
UL 698	Industrial Control Equipment for Use in Hazardous Locations
WAC 296-46B	Washington Administrative Code, Electrical Safety Standards, Administration, and Installation

In case of conflict or disagreement between codes, standards, laws, ordinances, rules, regulations, plans, and specifications, the more stringent condition shall govern.

1.5 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Prior to submittal of shop plans, coordinate all electrical equipment, particularly motor control equipment, process and control panels, and instrumentation, with related manufacturers and with other applicable equipment and systems specified in other divisions of the Specifications.

C. Provide submittals in the following manner:

1. Organize the submittals by CSI code type.

2. Clearly show the Tag Number associated with each submittal within each CSI grouping.

3. Include non-tagged devices such as grounding systems, conduits, wireway, ductbank details, wire, cable, boxes, fittings, switches and receptacles.

4. Clearly show the specific part, part number, order code, etc. associated with the device. Use pointers, highlights, circles, etc. to clearly identify the specific part.

5. Submit on distribution equipment, including but not limited to: Unit substations, Medium voltage switching equipment, motor control centers and control equipment, low voltage switchboards, safety switches, dry-type (specialty) transformers, panelboards, and grounding.

6. Submit on generators and automatic transfer switches.

7. Submit on lamps, lighting, site lighting, and wiring devices.

D. Provide manufacturer's product technical data including, but not limited to:

1. Manufacturer's name, address, and contact number.

2. Manufacturer's product descriptive bulletin.

3. Nameplate data, current, voltage, load, impedance, and other electrical data pertinent to the Project and necessary to assure compliance with the Specifications and Plans.

E. Provide elementary wiring diagrams for the electrical control systems showing the wiring of electrical control items, such as starters, control systems, interlocks, switches, and relays as they apply to this Contract.

F. Provide schematic interconnection diagrams and/or PID diagrams for each control system and each control panel. Each control diagram shall show a schematic representation of the process equipment and the locations of the switches, meters, automatic valves, indicators, controllers, and recorders. Show correct operating settings and ranges for each control instrument on the diagrams.

G. Use diagrams and symbols in shop plans, which conform to JIC Electrical Standards for Industrial Equipment and/or NEMA, ICS, ANSI, and IEEE standards, latest revisions. Prepare plans on 22" x 34", or ANSI size A, B, or D in a format similar to the Contract Documents or other nationally recognized drawing standard.

H. Clearly, indicate on submittals that the equipment or material is NRTL listed or is constructed of listed or recognized components. Where a NRTL standard has not been established, clearly identify that no NRTL standard exists for that equipment.

I. OPERATION AND MAINTENANCE MANUALS

Reference base requirements in specification 01300.

Manuals for the electrical system shall also include:

1. Manuals for Motor Control Centers. MCC wiring diagrams shall include updated title block showing the date redline field changes were incorporated into the documentation.

2. Manuals for fabricated control panels. Wiring diagrams shall include updated title block showing the date redline field changes were incorporated into the documentation.

3. In each section, compile a spare parts list and supplier index.

4. Assemble records of all tests, measurements, and calibration settings made for each device.

1.6 SYSTEM DESCRIPTION

A. Provide the labor, materials, and equipment necessary to furnish, install, and place into operation complete power, lighting, control, alarm, communications, and instrumentation electrical system of this Contract as shown on the Plans or Specifications herein.

B. Provide a functioning system(s) in compliance with manufacturer's instructions, performance requirements as specified or indicated, and modifications resulting from reviewed shop plans and field coordinated plans.

C. Provide complete wiring and controls for all equipment specified under other divisions and that comply with Division 16.

1. Connect motors, controls, meters, and any other electrical device installed or provided as part of the project.

D. Pay and make arrangements for necessary permits, licenses, and inspections.

1.7 QUALITY ASSURANCE

A. TESTING AGENCY QUALIFICATIONS

A "Nationally Recognized Testing Laboratory" (NRTL) recognized and approved by the State of Washington.

1. Testing Agency Field Supervision: Use persons currently certified by NETA or the National Institute for Certification in Engineering Technologies, or equal, to supervise onsite testing specified in Part 3.

B. Comply with NFPA 70 (NEC) for components and installation.

C. LISTING AND LABELING

Provide products specified in this Section that are listed and labeled.

1. The Terms "Listed and Labeled:" As defined in the National Electrical Code, Article 100.

2. Listing and Labeling Agency Qualifications

a. A NRTL recognized and approved by the State of Washington.

1.8 DELIVERY, STORAGE AND HANDLING

Ensure that equipment is not used as steps, ladders, scaffolds, platforms, or for storage – either inside or on top of enclosures. Protect nameplates on electrical equipment from being defaced. Repair or replace damaged, corroded, and rejected items at no additional cost to the Owner.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Refer to individual Division 16 sections.

1. Similar equipment shall be provided by only one manufacturer throughout the project unless otherwise noted in the Specifications.

B. Submit requests for substitution in accordance with Section 01300.

C. Trade names and catalog numbers may be used in the Plans or Specifications to establish quality standards and basis of design:

1. Other listed manufacturers in the applicable specification sections with equal equipment may be acceptable.

2.2 GENERAL PRODUCT REQUIREMENTS

A. Except as otherwise indicated, provide new materials and equipment, which are standard products of manufacturers, regularly engaged in production of such equipment. Provide material or equipment approved and labeled for the purpose for which it is to be used by NRTL or other organizations acceptable to the State of Washington Department of Labor and Industries.

B. Where voltage, current, power, temperature or other ratings are specified that do not correspond to standard ratings of the manufacturer selected by the Contractor, furnish the next rating level which is more conservative or increases the capacity of the device or material in question.

C. Furnish materials, devices, and equipment that are non-corrosive or coat them in a manner that renders them non-corrosive and acceptable to the Engineer. Do not provide materials, which contain polychlorinated biphenyls, asbestos, or other hazardous or detrimental materials. Do not install materials in a location or construction manner that produces galvanic action or do not install material combinations with corroding or eroding action.

D. Where changes in the work, or substitutions in material are proposed, ensure that sizes, weights, openings, etc., are provided that do not require changes in the work outside this Division.

E. All terminals shall be suitable for 75 degrees C rated copper conductors.

2.3 FABRICATION

A. When equipment is shop fabricated specifically for this Project, use electrical devices and enclosures, which are NRTL, listed and labeled or recognized.

B. SHOP OR FACTORY FINISHES

1. See Division 11 and Section 09900.

2. Interiors of other painted electrical equipment shall be either white or light gray.

C. Fabricate equipment or devices in the field equivalent in every respect to manufactured items used for the same purpose. Where cutting, drilling, grinding, etc., is done to galvanize or painted metal, regalvanize, or paint to match original finish.

2.4 SUPPORTING DEVICES

A. Channel and angle support systems, hangers, anchors, sleeves, brackets, fabricated items, and fasteners are designed to provide secure support from the building structure for electrical components.

1. Material

Steel, except as otherwise indicated, protected from corrosion with zinc coating, or with treatment of equivalent corrosion resistance using approved alternative finish or inherent material characteristics.

2. Metal Items for Use Outdoors or in Damp Locations

Hot-dip galvanized steel, or stainless steel, except as otherwise indicated.

B. ANCHORS

Galvanized steel in dry areas; stainless steel or hot dipped galvanized steel in wet areas.

1. Lag screws or Type A tapping screws for wood.

2. Rockwell “well-nut” for light loads in masonry.

3. Thru-bolt with fender washers for heavy loads in masonry.

4. Toggle bolts with springhead for hollow partitions.

5. Self-drilling anchors with threaded studs for concrete.

6. Clamps or U-bolts for structural steel.

7. Self-drilling anchors with extension rods for hollow tile over concrete.

C. SHEET-METAL SLEEVES

0.0276 of an inch or heavier galvanized sheet steel, round tube, closed with welded longitudinal joint.

D. PIPE SLEEVES

ASTM A53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.

2.5 ELECTRICAL IDENTIFICATION

A. MANUFACTURER'S STANDARD PRODUCTS

Where more than one type is listed for a specified application, selection is Installer's option but provide single type for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, and Specifications.

B. COLORED ADHESIVE MARKING TAPE FOR RACEWAYS, WIRES, AND CABLES

Self-adhesive vinyl tape, not less than 3 mils thick by 1 inch wide.

C. UNDERGROUND LINE WARNING TAPE

Provide bright-colored, vinyl or polyethylene tape not less than 3-mils thick by 6-inches wide compounded for direct-burial service with permanent and continuous print.

D. TAPE MARKERS

Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.

E. COLOR-CODING CABLE TIES

Type 6/6 nylon, self-locking type. Colors to suit coding scheme.

F. FASTENERS FOR PLASTIC-LAMINATED AND METAL SIGNS

Self-tapping stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.

G. FLASH PROTECTION WARNING

Provide Arc Flash Warning Label on all equipment as required by 110.16 NEC (2020). The label is to contain the following text:

WARNING or DANGER
Arc Flash Hazard!
Follow requirements in NFPA 70E
for safe work practices and
appropriate PPE. Failure to comply
can result in death or injury.

2.6 TOUCHUP PAINT

Use touchup paint on equipment provided by equipment manufacturer and select color to match existing equipment finish.

A. FOR NON-EQUIPMENT SURFACES

Matching type and color of undamaged, existing adjacent finish.

B. FOR GALVANIZED SURFACES

Zinc-rich paint recommended by equipment manufacturer.

PART 3 EXECUTION

3.1 ELECTRICAL SUPPORTING METHODS

A. WET AREAS

1. For pullboxes and equipment vaults, reference Specification Section 16130.

2. For wet areas which are not pullboxes or equipment vaults, hot-dip galvanized materials, stainless steel materials, or nonmetallic,

U-channel system components unless otherwise noted on the Plans.

B. DRY AREAS

Hot-dip galvanized materials unless otherwise noted on the Plans.

C. METHODS

Support raceway, equipment, and devices from framing members or building structure with sufficient clearance for maintaining and servicing. Provide backing plates, and/or framing material to support equipment, devices, and materials, which are located between the building or facility structure-framing members.

3.2 RECORDS

A. Maintain and annotate on the job at all times a separate set of Record Drawings in accordance with the General Conditions. Show changes from the Contract Documents, routing of hidden raceways, actual fixture and equipment locations, equipment sizes and dimensions and building outline changes. At the end of the Project, provide the Engineer a complete set of Plans marked in red pencil in a manner consistent with the Contract Plans, indicating the changes made on the job.

B. Record voltage, current, and megohmeter and ground ohmic resistance test measurements made on the electrical work, the trip units, fuses, and overload relay elements installed in the equipment and the setting of all pressure, flow, level, etc., control devices. When the Project is completed and operating, turn over these records to the Owner.

C. Equipment and raceways installed under this contract for future work shall be dimensioned on the Record Drawings.

3.3 COORDINATION

A. Arrange for chases, slots, and openings in building structure during progress of construction to allow for electrical installations. Obtain approval from structural Engineer for penetration of structural components prior to penetrating the component.

B. Coordinate installation of supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the work. Coordinate installation of large equipment requiring positioning prior to closing in the building.

D. Coordinate the location of motors, switches, panel connections, and other points of connection with the equipment manufacturers or vendors prior to conduit installation. Route circuits to the actual connection point. Even if removal and reinstallation of building materials is necessary, remove and reinstall conduit, outlet boxes, and other electrical connections, if initial electrical connections are not made to the appropriate equipment location.

E. Coordinate and schedule connecting electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

F. Coordinate and verify work under Division 16 with work under other Divisions, cooperate in locating equipment to avoid interference with work of others, and plan work to harmonize with the work of other trades so that all work may proceed as expeditiously as possible. Coordinate the installing of built-in work, attaching items to buildings, and cutting and patching. Coordinate connecting electrical circuits to components furnished under other Divisions. (Portions of the electrical design are based upon the equipment specified in other Divisions.) No extras are allowed because of moving work required to avoid interference with work of other Contractors.

G. Coordinate the interruption of electrical systems to any part of the facility in use by the Owner at least 2 working days before interruption of the system.

H. Coordinate installing electrical identification after completion of finishing work where identification is applied to field-finished surfaces.

I. Where changes in the work, or substitutions in material are proposed, ensure that sizes, weights, openings, etc., are provided that do not require changes in the work outside this Division.

3.4 INSTALLATION

A. ENCLOSURES FOR USE WITH ELECTRICAL EQUIPMENT

Unless specifically called out otherwise on the Plans, electrical enclosures shall meet the following specification:

1. Dry Areas

   NEMA 1.

2. Wet Areas

   a. Indoors

      NEMA 3R with HVAC equipment.

      NEMA 12 where the enclosure will not be subjected to splashing water or hose-directed water.

   b. Outdoors

      NEMA 3R where the enclosure will not be subjected to splashing water, hose-directed water, or windblown dust.

3. Corrosive Locations

   NEMA 4X.

4. Exceptions to 1-3 above

   a. As otherwise indicated on the Plans.

   b. As modified in other Division 16 sections.

5. Standards

   a. NEMA ICS-6, Enclosures for Industrial Controls and Systems.

   b. UL 508A, Standard for Industrial Control Panels.

   c. UL 698, Industrial Control Equipment for use in Hazardous Locations.

B. WORKMANSHIP

Install the equipment and materials in accordance with the manufacturer's instructions, the National Electric Code, National Electric Safety Code, applicable local regulations, ordinances, and industry standards. A person in charge at the site shall maintain adequate supervision of the work under this division when necessary for coordination with other work.

C. SELF-SUPPORTED EQUIPMENT

Install self-supporting equipment in a level and plumb manner, shimming with full width stainless steel shims, as necessary. Bolt units to the floor with stainless steel expansion anchors and bolts, or weld units to embedded steel channels. Floor or pad shall be level within plus or minus 1/8 of an inch in a square yard before installing equipment. Grout or caulk enclosure to floor or pad. Provide bushings on conduits entering from above or at the side. For conduits entering from below, install grounded insulating bushings bonded to the ground bus or pad.

Install concrete pads and bases according to requirements of Section 03300.

Provide concrete foundations or pads required for electrical equipment as indicated or specified:

1. Floor-mounted equipment shall be mounted on a 4-inch-high concrete housekeeping pad. Pad shall be poured on top of the finished floor or slab.

D. MOUNTING HEIGHT

Install components and equipment to provide the maximum possible headroom where mounting heights or other location criteria are not indicated. Mount enclosures for individual units at 54 inches above floors to centerline of controls unless otherwise indicated in the Plans.

E. ACCESSIBILITY

Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, while minimizing interference with other installations.

F. EQUIPMENT ORIENTATION

Install items parallel and/or perpendicular to other building systems and components, except where otherwise indicated.

G. EQUIPMENT MOUNTED ENCLOSURES

Attach enclosures mounted on equipment with machine screws or clamps as required. Do not drill equipment frames or sheets without permission of supplier/manufacturer or the Engineer.

Do not mount safety switches and external equipment to other equipment enclosures, unless enclosure mounting surface is properly braced to accept mounting of external equipment.

H. COORDINATION

Give right of way to raceways and piping systems installed at a required slope.

I. WALL MOUNTED ENCLOSURES

Stand equipment off wall surfaces a minimum of 1/4 of an inch where enclosures are mounted on walls in WET AREAS with neoprene or plastic shim washers.

J. MISCELLANEOUS SUPPORTS

Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices, except where components are mounted directly to a structural member of adequate strength.

K. SLEEVES

Install for cable and raceway penetrations of concrete slabs and walls, except where core-drilled holes are used. Install for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.

L. FASTENING

Unless otherwise indicated, securely fasten electrical items and their supporting hardware to the building structure.

1. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or any other items.

2. Select fasteners so the load applied to any fastener does not exceed 25 percent of the proof-test load.

M. FIREPROOFING

1. Do not remove or damage fireproofing materials.

2. Install hangers, inserts, supports, and anchors prior to installation of fireproofing.

3. Repair or replace fireproofing removed or damaged.

N. PENETRATIONS

Make all penetrations of electrical work through walls and roofs water and weather-tight.

O. MISCELLANEOUS REQUIREMENTS

1. Screen or seal all openings into outdoor equipment to prevent the entrance of rodents and insects.

2. Equipment fabricated from aluminum shall not be placed in direct contact with earth or concrete.

3. Do not exceed the dimensions indicated for equipment except as approved in writing by the Engineer.

4. Do not use equipment or arrangements for equipment that reduce the required clearance or exceed the space allocations.

P. DIMENSIONS

Dimensions indicated for electrical equipment and dimensions indicated for the installation of electrical equipment are restrictive dimensions.

1. Field measurements take precedence over dimensioned plans.

3.5 IDENTIFICATION

A. LABELS

Install labels where indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment. Conduit labeling is further described in section 16130. The labeling of conductors is further described in section 16120.

B. NOMENCLATURE

Coordinate names, abbreviations, colors, and other designations used for electrical identification with corresponding designations indicated on the Contract Documents or required by codes and standards. Use consistent designations throughout the Project.

C. SELF-ADHESIVE IDENTIFICATION PRODUCTS

Clean surfaces of dust, loose material, and oily films before applying.

D. IDENTIFY PATHS OF UNDERGROUND ELECTRICAL LINES

During trench backfilling, for exterior underground power, control, signal, and communication lines, install continuous underground plastic line marker located directly above power and communication lines. Where multiple lines installed in a common trench or concrete envelope, do not exceed an overall width of 16 inches, use a single line marker.

E. ENGRAVED, PLASTIC-LAMINATED LABELS, SIGNS, AND INSTRUCTION PLATES

Engraving stock shall be melamine plastic laminate punched for mechanical fasteners with a minimum thickness of 1/16 of an inch for signs up to 20 square inches, and 1/8 of an inch thick for larger sizes. Engraved legend in white letters on black face. Provide nameplates on equipment enclosures giving the name and circuit identification of the enclosed device/equipment in 1/4 of an inch lettering.

F. PANELBOARD SCHEDULES

For panelboards, provide framed, typed circuit schedules with explicit description and identification of items controlled by each individual breaker.

G. ARC FLASH HAZARD

Provide and install warning labels for arc flash hazard on all switchboards, panelboards, control panels, motor control centers, and other equipment per the requirements of the NEC and Washington State Administrative Code (WAC).

3.6 DEMOLITION

A. EQUIPMENT TO BE DEMOLISHED

Demolish all existing electrical devices and circuits, which are noted for demolition. Demolition includes, but is not limited to:

1. Removing all conduit, conductors, fittings, device boxes, hangers, panels, devices, etc., which are not concealed in the building structure or below grade/slab.

B. TEMPORARY POWER

Provide temporary power to existing branch circuit panels, branch circuits, and/or directly to electrical devices as required to keep all portions of the existing facility, which are occupied by the Owner, or required for operation, in operation at all times. Obtain approval by all appropriate code authorities, including the Department of Labor & Industries Electrical Inspection Department, or the local jurisdiction having authority, for any temporary connections required.

C. DAMAGED ELECTRICAL EQUIPMENT

Where remaining electrical work is damaged or disturbed in the course of the work, remove damaged portions, and install new products of equal capacity, quality, and functionality.

D. ABANDONED WORK

Remove existing conductors from conduits, unless otherwise indicated. Cut and cap buried raceway indicated to be abandoned in place 2 inches below the surface. Cap and patch surface to match existing surface finish.

E. REMOVAL

See section 01900.

F. TEMPORARY DISCONNECTION

Remove, disconnect, store, clean, reinstall, reconnect, and make operational those components that are indicated for relocation and/or reconnection. Coordinate the process, mechanical, HVAC, and other equipment scheduled to be relocated and/or reused with other Divisions.

3.7 CUTTING AND PATCHING

Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for electrical installations. Perform cutting by skilled mechanics of the trades involved.

Repair disturbed surfaces to match adjacent undisturbed surfaces.

3.8 TOUCHUP PAINTING

Thoroughly clean damaged areas and provide primer, intermediate, and finish coats to suit the degree of damage at each location.

Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.

3.9 EXTRA MATERIALS

Extra materials in this Section cover all spare parts for electrical devices under this contract and are centrally listed here for clarification and completeness. Spares shall match products installed, and shall be packaged with protective covering for storage and identified with labels describing the contents within.

A. GENERATOR ASSEMBLIES (ASSOCIATED CSI SECTION – 16230)

1. Power Fuses (line power)

   Provide 3 spare power fuses of each type and rating.

2. Control Fuses

   Provide 10 percent (minimum of two) spare control fuses of each type and rating to cover all motor starters (not per starter).

   Provide 1 control fuse puller.

3. Filters

Provide two sets each of lubricating oil, fuel, and combustion air filters.

4. V-Belts

Provide one complete replacement set of all V-belts.

5. Touchup Paint

Provide 1 quart (minimum) of touchup paint matching each color utilized on generator set.

6. Provide spare parts in suitable boxed watertight container marked "GENERATOR SPARE PARTS" and deliver to the Owner. Label with supplier's/manufacturer's name, the model number of the generator set, and the 24-hour service telephone number.

B. MOTOR CONTROLLERS (ASSOCIATED CSI SECTION – 16420)

The following quantities cover all motor starters under this contract (quantities are not per starter).

1. Power Fuses (line power)

Provide three spare power fuses of each type and rating.

2. Control Transformer Fuses (primary and secondary)

Provide 10 percent (minimum of two) spare control transformer fuses of each type and rating.

Provide one control fuse puller.

3. Control Fuses

Provide 10 percent (minimum of two) spare control fuses of each type and rating.

Provide one control fuse puller.

4. Control Relays

   Provide 10 percent (minimum of two) spare control relays of each type and rating.

5. Control Timing Relays

   Provide 10 percent (minimum of two) spare control timer relays of each type and rating.

6. Provide a single latching plastic container with a printed label adhered to the lid stating “MOTOR STARTER SPARE PARTS.”

C. PANELBOARDS (ASSOCIATED CSI SECTION – 16440)

1. Cabinet Keys

   Provide three spares of each type of key for panelboard cabinet locks.

2. Provide a latching plastic container with a printed label adhered to the lid stating “PANELBOARD SPARE KEYS.”

D. CONTROL PANELS (ASSOCIATED CSI SECTION – 16940)

The following quantities cover all control panels fabricated by the fabrication shop (quantities are not per panel).

1. DIN-rail Fused Terminals

   Provide five spare DIN-rail fused terminals of each type and rating.

2. DIN-rail Feed-Through Terminals

   Provide five spare DIN-rail feed-through terminals of each type, color, and rating.

3. Power Fuses (line power)

   Provide three spare power fuses of each type and rating.

4. Control Power Fuses

   Provide 10 percent (minimum of two) spare control power fuses of each type and rating.

   Provide one control fuse puller.

5. PLC I/O Fuses

   Provide 10 percent (minimum of two packets of five fuses each) spare control fuses of each type, voltage, and rating. Fuse ampacity should be clearly shown or marked.

6. PLC Buffer Relays

   Provide 10 percent (minimum of four) spare PLC buffer relays of each type, style, and rating.

7. Control and Timing Relays

   Provide 10 percent (minimum of four) spare control and timing relays of each type, style, and rating.

8. Control and Timing Relay Sockets

   Provide two spare control and timing relay sockets of each type, style, and rating.

9. Intrinsically Safe Barriers

   Provide one spare intrinsically safe barrier each type, style, and rating.

10. Relay/Solenoid Surge Protective Devices

    Provide two spare Metal Oxide Varistors (MOVs) for AC relays and solenoids and two spare diodes for DC relays and solenoids.

11. Provide a single latching plastic container with a printed label adhered to the lid stating “CONTROL PANEL SPARE PARTS.”

E. PLC PROCUREMENT (ASSOCIATED CSI SECTION – 16910)

1. Provide 10 percent (minimum of one) boxed spares of each PLC I/O module, communications module, power supply, and CPU module used in this contract.

2. Provide a single latching plastic container with a printed label adhered to the lid stating "PLC SPARE PARTS."

3.10 REQUEST FOR INFORMATION

Contractor shall locate all relevant information pertaining to the question prior to submission to the Engineer for review.

The Electrical Contractor shall review and approve all RFIs concerning electrical topics before submission.

3.11 TESTING, THIRD PARTY

Test electrical equipment before energization and placing into service. Report all test results in writing. Where tests disclose a defect in the work, rework, or repair the work at no additional expense to the Owner and retest to confirm the rework or repair until testing confirms that the defect has been corrected. Test in accordance with the manufacturer's installation and testing instructions and the applicable electrical standards (i.e., NEMA, NFPA, IEEE, ISA, ANSI) for the class of equipment

A. THIRD-PARTY CIRCUIT BREAKER TEST

Prior to energization engage an independent electrical testing organization to perform the test below.

1. For molded case circuit breakers with trip settings 100 A or greater, and in frames that are 125 A or greater, i.e., >= 100AT/125AF, provide an independent testing agency to perform switch tests as stated in NETA ATS, Section 7.5 and circuit breaker tests as stated in NETA ATS, Section 7.6. Certify compliance with test parameters.

2. Provide third party breaker test documents signed by the independent testing agency and the contractor and issued and approved by the Engineer prior to energizing the breaker(s).

These documents shall clearly show and describe the methods and equipment used in the test and all relevant readings and findings and shall include, as a minimum, the following:

a. All breakers tested shall use the breaker tag numbers as assigned on the Plans.

b. Each parameter measured shall include the dimension in the measured column (Amps, mΩ, seconds, etc.).

c. Each parameter measured shall include an associated minimum and maximum acceptable value (acceptable range).

d. Each breaker shall include a "passed" or "failed" status.

e. Failed breakers shall a include short statement describing the failed parameter.

f. Each breaker shall include the manufacturer's associated circuit breaker curve.

3. A copy of these signed test results shall be included in the O&M Manual.

4. Breakers that fail third party testing shall be replaced with new and retested by the same third-party testing agency. This process shall be repeated until all breakers subjected to this requirement have successfully passed testing and have been documented.

   Upon failure of a third-party breaker test, the cost of a new breaker and additional third party testing shall be borne by the device/equipment manufacturer.

5. These specifications apply to the following Sections if they are included in this contract: 16230, 16410, 16440, 16442.

B. THIRD-PARTY ENGINEERING COORDINATION STUDY

Engage an independent engineering company to perform the study below.

1. Provide a third-party engineering coordination study of all new and existing overcurrent devices. Panelboards shall be excluded from this study. Contractor shall adjust devices as necessary to meet the recommendations of the coordination study. A copy of these

signed test results shall be submitted to the Engineer for approval prior to startup and shall be included in the O&M Manual.

C. THIRD-PARTY ENGINEERING ARC FAULT AND SHOCK HAZARD STUDY

Engage an independent engineering company to perform the study below.

1. Provide a third-party engineering study to determine the arc flash levels, shock hazard, and required PPE, at each key piece of electrical equipment including:

    a. All Motor Control Centers (MCCs)

    b. All panelboards and/or switchboards

    c. All process control panels listed under UL 508/ UL 508A or similar WA state approved agency.

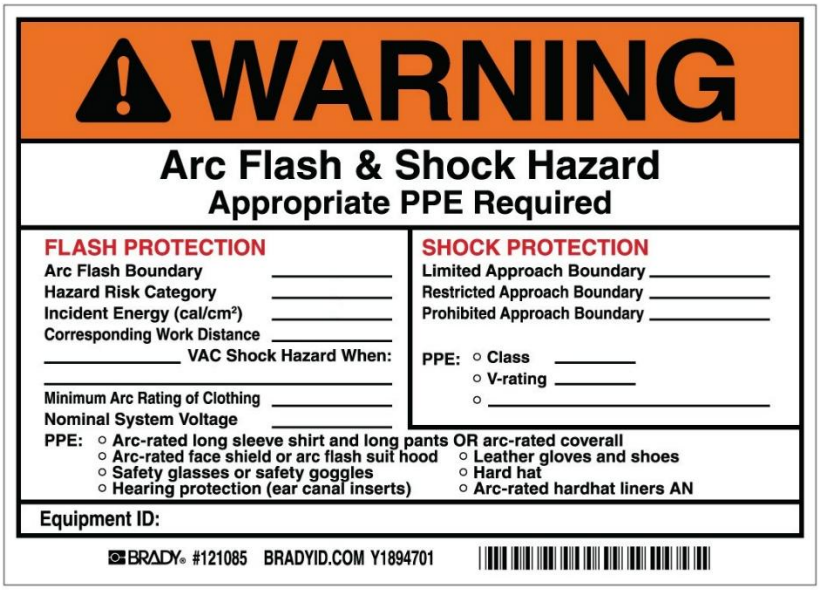
    d. All field control panels listed under UL 508/ UL 508A or similar WA state approved agency.

    e. All manual or automatic transfer switches

    f. All service entrance devices (SUSE rated) with bonded neutral connections.

2. A copy of these signed test results shall be submitted to the Engineer prior to project completion and shall be included in the O&M Manual.

3. Provide and install OSHA and NEC compliant labels with the information provided by the study. Labels shall contain the following information as a minimum.



3.12 TESTING NOT REQUIRING THIRD PARTY

Test electrical equipment before energization and placing into service. Report all test results in writing. Where tests disclose a defect in the work, rework, or repair the work at no additional expense to the Owner and retest to confirm the rework or repair until testing confirms that the defect has been corrected. Test in accordance with the manufacturer's installation and testing instructions and the applicable electrical standards (i.e., NEMA, NFPA, IEEE, ISA, ANSI) for the class of equipment

A. CONDUCTOR MEGGER TEST

1. Power Conductor Testing

After pulling and prior to connection perform a Megger test between all power conductors (including the equipment ground) and between each power conductor and earth ground in the following manner:

a. Perform megger tests at 600 V.

b. Record ambient temperature and humidity during testing.

c. Cables or conductors with a steady-state value less than 100 megohms shall be considered "failed".

d. Failed cables and conductors shall be removed and replaced with new and retested per these specifications.

e. Provide a Power Conductor Megger Testing Report. A blank copy of this report, specifically associated with this contract, is available from Engineering on request. A copy of these signed test results shall be submitted to the Engineer for approval prior to startup and shall be included in the O&M Manual.

2. Control Conductor Testing

a. Control conductor insulation testing is not required.

3. Instrumentation Conductor Testing

b. Instrumentation conductor insulation testing is not required.

B. CONDUCTOR INSPECTION

On installation of wires and cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures

a. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.3.2. Certify compliance with test parameters.

b. Remove and replace conductors with visible insulation damage on conductor ends due to installation in an incomplete or damaged conduit system such as, but not limited to, missing bushings or burrs on conduit ends.

C. MOTOR COMMISSIONING TEST

1. Provide a Motor Commissioning Test Report for each new or refurbished motor. A blank copy of this report, specifically associated with this contract, is available from Engineering on request. Motor Commissioning Test Reports shall be signed by the Contractor and approved by the Engineer prior to energizing the motors. A copy of these signed test results shall be included in the O&M Manual.

D. GROUND TEST

1. Subject the completed GROUNDING ELECTRODE SYSTEM to a 3-point fail-of-potential ground test according to IEEE 81. Perform the test not less than 2 full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage, and without chemical treatment or other artificial means of reducing natural ground resistance.

   Maximum grounding resistance values shall be as listed below:

   a. Equipment Grounding System: 25 ohms.

   b. Main Service, Grounding Electrode System: 5 ohms.

2. Provide ground test documents signed by the tester and the contractor and issued and approved by the Engineer prior to energizing the power distribution system.

   These documents shall clearly show and describe the methods and equipment used in the test and all relevant readings and findings including ground resistance at each test location and observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

   These documents shall clearly state whether the system has passed or not passed and show the point(s) where failure occurred. A copy of these signed test results shall be included in the O&M Manual.

3. Where resistance to ground exceeds specified values, check connections of affected equipment and conductors and repair or replace and defects. If replacement and repair of contractor provided connections does not bring the test to meet specifications, the contractor shall provide and install an additional ground rod, ground rod box, make connections, and perform one more retest without additional cost to Owner. Where resistance to ground continues to exceed specified values submit an RFI.

3.13 GENERAL TESTING AND INSPECTION

A. PRIOR TO ENERGIZATION

1. After installing disconnect switches and circuit breakers, perform visual and mechanical inspection of enclosures and devices.

2. Test the equipment and electrical circuits for proper connection, tightness, and absence of undesirable shorts and grounds.

3. Check for continuity, visual damage, marking, and proper phase sequence.

4. Remove any burrs, filings, or other foreign materials from all enclosures; completely wipe down and vacuum.

5. Run a magnet around the bottom of each enclosure and around surfaces that may have collected metal shavings during manufacturing or construction.

B. AFTER ENERGIZATION

1. After electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

2. Correct malfunctioning units on site where possible and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

3. Test operation, calibration, and settings of the meters, relays, and indicating devices.

4. Test all operating controls for proper operation.

5. Test all auxiliary equipment, i.e., heaters, thermostats, lights, all illuminated indicating devices and lamps, and all audible alarm devices which are an integral part of transformers and panels to verify that they function properly.

6. Take load readings on each panelboard after all loads are connected. Record these measurements to give the maximum reading for each phase and neutral obtained with lighting, appliances, motors, and other loads connect to, and operating from, the panels in service.

7. Check fuses with an ohmmeter. Ring out wiring and busing. Check operation of control and safety interlocks. Check grounding of potential transformers, current transformers, and surge protective devices. Check control connections and tightness at terminal blocks, relays, meters, switches, etc. Tug on each connection to verify a tight connection.

8. Check field connections to field devices, PLCs, and motor starters.

9. Verify proper communication reliability and data transfer speed on local networks.

10. Rework or repair equipment, which performs unsatisfactorily during, or as a result of, testing at no additional expense to the Owner.

11. Additional testing requirements specific to other sections are specified in those sections.

C. INSPECTIONS BY THE AHJ

For any situations concerning the AHJ and/or inspections, the Electrical Contractor shall provide a written description of the issue encountered during inspection, documentation of any field conversation with the AHJ/inspector, and recommendations to rectify the situation.

3.14 TEST DOCUMENTS

Test documents, as described above, shall be signed and submitted to Engineering for review prior to energizing associated electrical circuits.

3.15 DEMONSTRATION

Demonstrate to the Owner that the electrical installation is working by operating all electrical systems and equipment. Simulate control and emergency conditions, artificially where necessary, for complete system tests. Demonstrate equipment in accordance with each section in Division 16.

3.16 CLEANING

Clean dirt and debris from all internal and external surfaces. Vacuum out the interior of electrical panels.

Apply touchup paint as required to repair scratches, etc.

Replace nameplates damaged during installation. Thoroughly vacuum the interior of all enclosures to remove dirt and debris.

***** END OF SECTION *****

SECTION 16060

GROUNDING AND BONDING

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section includes grounding of electrical systems, equipment, and basic requirements for grounding, and protection of life, equipment, circuits, and systems. Grounding requirements specified in this Section may be supplemented in other Sections of these Specifications.

1.2 RELATED WORKS SPECIFIED ELSEWHERE

Sections	Items
01300	Submittals
16050	Basic Electrical Materials and Methods
16120	Conductors and Cables
16130	Raceway and Boxes
WAC 296-46B-250	Grounding and Bonding

1.3 DEFINITIONS

A. BONDING JUMPER (from NEC 2017, Article 100 - Definitions, Bonding Jumper, Main)

The connection between the GROUNDED CIRCUIT CONDUCTOR and the EQUIPMENT GROUNDING CONDUCTOR at the service.

B. EQUIPMENT GROUNDING CONDUCTOR (from NEC 2017, Article 100 - Definitions)

The conductive path installed to connect normally non-current-carrying metal parts of equipment together and to the SYSTEM GROUNDED CONDUCTOR or to the GROUNDING ELECTRODE CONDUCTOR, or both. Code requirements associated with equipment grounding is referenced to NEC 250, Section VI – Equipment Grounding and Equipment Grounding Conductors.

C. GROUNDED SERVICE CONDUCTOR

Also called “utility neutral.” A conductor used to connect the neutral point of the utility transformer to the neutral point of the service entrance.

See SUSE, SYSTEM GROUNDING.

D. GROUNDING ELECTRODE (from NEC 2017, Article 100 - Definitions)

A conducting object through which a direct connection to earth is established.

E. GROUNDING ELECTRODE CONDUCTOR (from NEC 2017, Article 100 - Definitions)

A conductor used to connect the SYSTEM GROUNDED CONDUCTOR or the equipment to a GROUNDING ELECTRODE or to a point on the grounding electrode system.

F. GROUNDING ELECTRODE SYSTEM

See SYSTEM GROUNDING.

G. SUSE

The term SUSE is an acronym for "SUITABLE FOR USE AS SERVICE EQUIPMENT." It is the point in the electrical grounding system where the SYSTEM GROUNDING CONDUCTORS connect to the EQUIPMENT GROUNDING CONDUCTORS, or the GROUNDED SERVICE CONDUCTOR, or both. For each separately-derived source, this shall occur at the SUSE point. These two points are connected by a BONDING JUMPER.

H. SYSTEM GROUND GRID

The SYSTEM GROUND GRID refers to all portions of SYSTEM GROUNDING. It may be as simple as a pair of ground rods and their associated GROUNDING ELECTRODE CONDUCTORS or a complex ground system with multiple types of GROUNDING ELECTRODES.

I. SYSTEM GROUNDED CONDUCTOR

See GROUNDING ELECTRODE CONDUCTOR.

J. SYSTEM GROUNDING

System Grounding (also referred to as a GROUNDING ELECTRODE SYSTEM) consists of all GROUNDING ELECTRODES, GROUNDING ELECTRODE CONDUCTORS, and associated connecting devices. The GROUNDED SERVICE CONDUCTOR, typically referred to as the

"utility neutral", is also associated with the system ground. Code requirements associated with system grounding is referenced to NEC 250.50 – Grounding Electrode System.

1.4 SUBMITTALS

Submit under provisions of Section 01300, and Section 16050.

1.5 QUALITY ASSURANCE

See Section 16050.

PART 2 PRODUCTS

2.1 GROUNDING AND BONDING PRODUCTS

Where types, sizes, ratings, and quantities indicated are in excess of National Electrical Code (NEC) requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.

2.2 WIRE AND CABLE GROUNDING CONDUCTORS

Comply with Section 16120.

A. EQUIPMENT GROUNDING CONDUCTORS

1. Insulated Conductors

   Color coded green, per section 16120.

2. Sized in compliance with NEC Table 250.122 or as shown on the Plans, whichever is larger.

B. GROUNDING-ELECTRODE CONDUCTORS

1. Bare Conductors

   Soft drawn stranded copper meeting ASTM B8.

2. Sized in compliance with NEC Table 250.66 or as shown on the Plans, whichever is larger.

C. GROUNDING BRAIDS

1. Copper, manufactured, sized at 26,240 circular mils minimum (#6 AWG equivalent).

2. Certified C22.2, No. 41, Grounding and Bonding Equipment.

3. UL Listings: UL-467 and UL486A.

2.3 GROUND RODS

A. SIZE AND TYPE

1. Ground rods shall be 3/4-inch diameter by 10-feet long unless otherwise stated on the Plans.

2. Ground rods shall be copperclad steel rods as follows:

a. Heavy uniform coating of electrolytic copper molecularly bonded to a rigid steel core.

b. Corrosion resistant bonding between the copper and steel.

c. Hard drawn for a scar-resistant surface.

2.4 GROUND ROD BOX

A. GROUND ROD BOXES

1. Ground rod boxes shall be “Fogtite Ground Rod Box” or equal.

B. GROUND ROD BOX LIDS

1. Ground rods associated with vaults, pullboxes, or handholes that may be subjected to road traffic or heavy loads shall have their ground box lids match the road rating load value of the associated vaults, pullboxes, or handholes.

2. The minimum ground rod box lid shall be rated H20.

2.5 CONNECTOR PRODUCTS

A. COMPRESSION CONNECTORS

1. Compression type for interior locations:

a. Standards: UL 467.

b. High copper alloy content.

c. Non-reversible.

d. Terminals for connections to bus bars shall have two bolt holes.

2. Compression type suitable for direct burial in earth or concrete:

a. Standards: UL 467, IEEE 837.

b. High copper alloy content.

c. Non-reversible.

B. BOLTED CLAMPS

1. Standards: UL 467.

2. High copper alloy content.

3. Heavy-duty type.

PART 3 APPLICATION

There are two types of grounding systems covered in this specification; (1) Grounding Electrode Systems and (2) Equipment Grounding Circuits.

1. Grounding Electrode Systems shall comply, as a minimum, to the requirements of NEC Sections 250.50 through 250.104, including Table 250.66, “Grounding Electrode Conductor for Alternating-Current Systems.”

2. Equipment Grounding Circuits shall comply, as a minimum, to the requirements of NEC Sections 250.110 through 250.148, including Table 250.122, “Minimum Size Equipment Grounding Conductors for Grounding Raceway and Equipment.”

3.1 GROUND ROD BOX

The connection of Grounding Electrode Conductors to each ground rod shall be accessible through a ground rod box as described herein.

A. Each ground rod shall be provided with a separate ground rod box which shall provide access to the ground rod, its Grounding Electrode Conductor, and its associated ground clamp.

Exceptions:

- *Unless specifically stated or detailed otherwise on the Plans.*
- *Ground rod boxes shall not be required if the ground rod is exposed in a manhole, handhole, or seal-off vault as described in this specification.*

B. Each ground rod box shall be mounted flush to grade.

Exceptions:

- *Unless specifically stated or detailed otherwise on the Plans.*

3.2 GROUNDING ELECTRODE SYSTEMS

Comply with NEC Article 250, Section III for types, sizes, and quantities of Grounding Electrode Conductors, except where specific types, larger sizes, or more conductors than required by NEC are shown on the Plans.

Provide grounding system as shown on the Grounding One Line Diagram of the Plans if provided.

A. GROUNDING ELECTRODE SYSTEM

A GROUNDING ELECTRODE SYSTEM shall have a minimum of two ground rods spaced a minimum of 6 feet apart and connected with Grounding Electrode Conductors as described in this Section.

B. SYSTEM GROUND GRIDS AROUND STRUCTURES WITH CONCRETE FLOORS OR STEM WALLS

A ground grid shall consist of a ring of Grounding Electrode Conductors around a building or structure placed a maximum of 3 feet away from the structure at a minimum depth of 30 inches below grade with its ground

connection established in one of the three following ways: (1) with ground rods; (2) with "concrete-encased electrodes;" or (3) with a combination of both (1) and (2).

When the Plans specifically show, state, or define the method of establishing the SYSTEM GROUND GRID and show the distribution and sizes of the Grounding Electrode Conductors, then these methods shall be followed unless required to be larger by NEC Table 250.66.

C. VAULT AND PULLBOX GROUNDING

1. Provide a SYSTEM GROUND GRID at Pullboxes and Equipment Vaults in compliance with ground conductors sized per NEC Table 250.66 unless shown larger on the Plans. The minimum grounding electrode conductor size shall be #6 AWG.

2. Install grounding around and inside the vaults as described in INSTALLATION; VAULT AND PULLBOX SYSTEM GROUNDING in Part 4 herein.

D. MANHOLE, HANDHOLE, AND SEAL-OFF VAULT GROUNDING

1. Provide a ground rod inside each manhole that contains metal parts.

2. Install grounding around and inside Manholes, Handholes, and Seal-Off Vaults as described in INSTALLATION; MANHOLE, HANDHOLE, AND SEAL-OFF VAULT SYSTEM, GROUNDING in Part 4 herein.

E. OTHER GROUNDING ELECTRODE DEVICES AND METHODS

1. Hydraulic Piping Systems

a. Provide and connect a Grounding Electrode Conductor pigtail to metal hydraulic piping on each major riser. Connect the conductors to the pipe using NEC-approved hardware and methods.

b. Provide a ground jumper across both sides of a hydraulic piping electrical insulator to continue ground continuity past the insulator.

c. Ground shall be derived from:

i. SYSTEM GROUND GRID

ii. System SUSE connection point.

2. Magnetic Flow Meters

a. Provide and connect a Grounding Electrode Conductor to the flow meter manufacturer's ground rings as per the manufacturer's recommendations. Provide a #6 AWG ground conductor unless shown otherwise on the Plans.

Exceptions:

- *Unless manufacturer provides documentation verifying that ground rings are not required.*

3. Generators

a. In addition to the equipment ground provided with the generator feeder, provide a grounding electrode conductor to the generator's neutral terminal sized per the Plans or per NEC Table 250.66, whichever is larger. Treat this conductor as a neutral wire.

b. Grounding Methods

i. The Grounding Electrode Conductor shall be connected to the neutral terminal of the generator as a neutral. This conductor shall be connected to the grounding system at the SUSE bonding connection.

If required to run through a transfer switch, then this neutral wire shall terminate at the transfer switch's isolated neutral bus before continuing to the SUSE bonding point.

ii. The Equipment Grounding Conductor shall be connected to the metal frame of the generator in compliance with NEC.250.110.

4. Separately Derived Sources

a. Ground step-down power transformer secondary neutral "XO" terminals to Grounding Electrode Conductors.

i. System Ground Grid

b. Ground step-down power transformer secondary neutral "XO" terminals to Grounding Electrode Conductors.

3.3 EQUIPMENT GROUNDING

Comply with NEC Article 250, Section VI for sizes of Equipment Grounding Conductors, except where specific larger sizes are shown on the Cable and Conduit Schedule in the Plans.

A. EQUIPMENT GROUNDING CIRCUITS

Install insulated Equipment Grounding Conductors with circuit conductors in the manner listed below and in compliance with Code.

1. Service and Feeders.

Bond the Equipment Grounding Conductor to the equipment to which the circuit connects and to the raceway if it is metallic.

2. Single-phase motor or appliance branch circuits.

3. Three-phase motor or appliance branch circuits.

4. Flexible raceway runs.

B. EQUIPMENT GROUNDING CONDUCTORS

Equipment Grounding Conductors shall be insulated and color-coded green.

C. ISOLATED GROUNDING-RECEPTACLE CIRCUITS

Install a separate insulated Equipment Grounding Conductor connected to the receptacle grounding terminal. Isolate grounding conductor from raceway and from panelboard grounding terminals. Terminate at the Equipment Grounding Conductor terminal of the applicable derived system or service, except as otherwise indicated.

D. NONMETALLIC RACEWAYS

Install an Equipment Grounding Conductor in nonmetallic raceways unless they are designated for telephone or data cables. Bond the conductor at each end to grounded metallic raceway or equipment.

E. METALLIC RACEWAYS

Install grounding bushings at the end of each conduit and connect to the equipment ground or GROUNDING ELECTRODE SYSTEM.

F. WATER HEATER, HEAT-TRACING, AND ANTIFROST HEATER CIRCUITS

Install a separate Equipment Grounding Conductor to each electric water heater, heat-tracing assembly, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment, and components.

G. CONTROL PANELS WITH A PLC

Provide an insulated Equipment Grounding Conductor from the panelboard ground bus directly to a block of isolated ground terminals in the control panel. These terminals shall not be connected to the control panel's chassis ground. This ground shall considered "Clean Ground" and shall be dedicated to the termination of instrument cable shields. This "clean" ground shall be #10 AWG minimum.

3.4 FREE-STANDING ELECTRICAL SUPPORT STRUCTURES

Metal support structures used to support electrical equipment, devices, cabinets, panels, or enclosures shall be connected to the GROUNDING ELECTRODE SYSTEM by Grounding Electrode Conductors sized as shown on the Plans or per NEC Table 250.66, whichever is larger. Provide a ground conductor to each vertical support member within 6 inches after rising out of the concrete pad.

3.5 METAL FRAME BUILDING AND SIMILAR STRUCTURES

The metal frame of a building, metal roofs, and other large metal surfaces on buildings shall be bonded to the grounding electrode conductor sized in accordance with NEC Table 250-66. Use a heavy-duty clamp or lug bolted to the metal. Welded metal frame members will be considered to be bonded together. Bolted metal frame members will be considered bonded together under all of the following conditions:

A. Members are cleaned and a conductive corrosion inhibitor is applied between the mating surfaces.

B. Bolts are fully torque.

C. It is proved that from no point on the framework there is more than 5-ohms measured from it to the attachment point of the grounding electrode.

PART 4 EXECUTION

4.1 INSTALLATION

A. GROUNDING ELECTRODE CONDUCTORS IN RACEWAYS

1. GROUNDING ELECTRODE CONDUCTORS shall not be installed in metallic raceway. Where required to be in raceway, use PVC-Schedule 80 unless shown otherwise on the Plans. Reference Specification Section 16130.

Ground electrical systems and equipment according to NEC requirements, except where Plans or Specifications exceed NEC requirements.

Coordinate grounding connections made to the water system with the mechanical work and install bonding jumpers wherever deemed necessary.

B. VAULT AND PULLBOX SYSTEM GROUNDING

1. Grounding Outside the Structure

a. Provide a minimum of one ground rod on the outside of the structure.

b. Provide a ground rod box over each ground rod with the same road rating of the pullbox/vault lid.

c. Space the SYSTEM GROUND GRID a minimum of 12 inches from the edge of the vault.

d. Connect the vault/pullbox SYSTEM GROUND GRID to the main SYSTEM GROUND GRID with Grounding Electrode Conductor sized per NEC Table 250.66 unless shown larger on the Plans. The minimum conductor size shall be #6 AWG.

2. Grounding Inside the Structure

Reference Figure 4.1.B. In this section, the term “vault” shall apply to both pullboxes and equipment vaults.

a. Provide a Grounding Electrode Conductor into the vault at one of the four corners. Seal the penetration with non-shrink grout.

b. Continue the Grounding Electrode Conductor up one corner to 3 - 6 inches below the vault ceiling. Loop the Grounding Electrode Conductor around the vault at this height, on all walls containing a junction box, cable tray, ladder, or other metallic equipment, securing to the vault walls each 24 inches with 316L stainless steel clamps, lag bolts, and fasteners.

c. Extend a Grounding Electrode Conductor to one of the top mounting bolts of each junction box, cable tray, permanent ladder, or other metallic equipment.

d. For vaults with metallic hatch lids, provide a grounding braid from the Grounding Electrode Conductor to the hatch lid, sized per NEC Table 250.122 minimum. Provide the braid on the hinged side, sufficiently long to allow a complete 180 degree opening of the hatch lid without tension on the braid. For vaults with dual lids, connect grounding braids to both hinged sides.

e. Ground hydraulic piping near its points of entry into, and exit out of, the vault.

f. Ground manufacturer’s instrumentation devices inside the vault per the manufacturer’s recommendations.

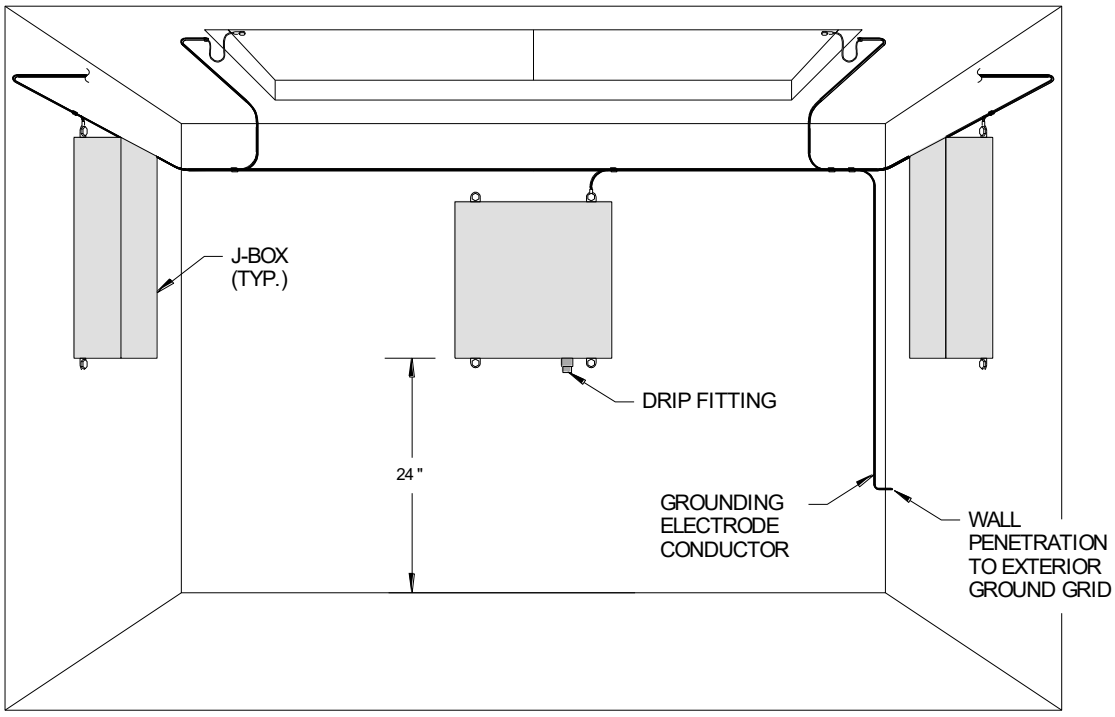


Figure 4.1.B

Vault and Pullbox Internal Grounding

C. MANHOLE, HANDHOLE, AND SEAL-OFF VAULT SYSTEM GROUNDING

1. Provide a ground rod inside each handhole that contains metal parts.

2. Expose a minimum of 4 inches of the ground rod above the floor for field inspection and connections to the rod.

3. Connect the manhole/handhole/seal-off vault SYSTEM GROUND GRID to the main SYSTEM GROUND GRID with Grounding Electrode Conductors sized per NEC Table 250.66 unless shown larger on the Plans. The minimum conductor size shall be #6 AWG.

4. Connect the Grounding Electrode Conductor to each metal lid with braided ground conductors of equivalent size and ampacity of the ground ring. Connect braid to metal lids as per manufacturer's recommendations.

5. Connect the Grounding Electrode Conductor to each metal device (conduits, cable tray, j-boxes, support structures, etc.).

4.2 CONNECTIONS

A. GENERAL

Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to assure high conductivity and to make contact points closer in order of galvanic series.

2. Make connections with clean, bare metal at points of contact.

3. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to the contact surfaces.

B. EQUIPMENT GROUNDING-WIRE TERMINATIONS

Make the grounding conductor connections to motors or equipment 10 hp and above or 20 amperes and above, with conductor termination and a 5/16 of an inch minimum bolt tapped to the motor frame or equipment housing. Ground connection to smaller motors and equipment may be made by fastening the conductor termination to a connection box.

C. METAL RACEWAY TERMINATIONS

Where metallic raceways terminate at metallic or non-metallic enclosures, panels, or housings, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at both entrances and exits with grounding bushings and bare grounding conductors, except as otherwise indicated.

D. CONNECTION TORQUE

Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. Where these requirements are not available, use those specified in UL 486A and UL 486B.

E. COMPRESSION-TYPE CONNECTIONS

Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by manufacturer of connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

4.3 QUALITY CONTROL

A. TESTS

1. Provide ground testing per Specification 16050, Section 3.

***** END OF SECTION *****

SECTION 16120

CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section includes building wires, cables, and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

1.2 RELATED WORKS SPECIFIED ELSEWHERE

Section	Item
01300	Submittals
16050	Basic Electrical Materials and Methods
RCW 19.28.261	Revised Code of Washington, Exemptions from RCW 19.28.161 through RCW 19.28.271
16940	Control Panels

1.3 SUBMITTALS

See Section 01300.

Indicate Field Test Reports and interpret their results for compliance with performance requirements.

1.4 QUALITY ASSURANCE

See Section 16050.

PART 2 PRODUCTS

2.1 BUILDING WIRES AND CABLES

A. STRANDING

1. All power, control, and instrumentation conductors larger than #20 AWG shall be stranded.

2. All equipment ground conductors larger than #16 AWG shall be stranded.

3. All grounding electrode conductors larger than #10 AWG shall be stranded.

B. POWER AND CONTROL WIRE

All power and control wire and conductors in raceways shall be rated 600 VAC.

1. XHHW, XHHW-2

a. Conductor

Class B, stranded, annealed, uncoated copper. Conductors shall comply with:

i. UL Standard 44.

ii. ASTM-B3 and ASTM-B8.

b. Insulation

Cross-Linked Polyethylene (XLP) High Heat Water Resistant. Insulation shall comply with:

i. UL-83 Thermoplastic-Insulated Wires and Cables.

ii. UL-1063 Machine-Tool Wires and Cables.

c. The cable shall meet the following Standards and Agency approvals:

i. NEMA WC70/ICEA S-95-658.

ii. ASTM Stranding Class B3 and B8.

iii. Federal Specification A-A-59544.

2. THHN, THWN, THHN/THWN-2

a. Conductor

Copper, annealed, uncoated. Conductors shall comply with:

i. ASTM-B3, ASTM-B8, and ASTM-B7B8.

b. Insulation

Polyvinyl Chloride (PVC), Nylon jacket. Insulation shall comply with:

i. UL-83 Thermoplastic-Insulated Wires and Cables.

ii. UL-1063 Machine-Tool Wires and Cables.

c. The cable shall meet the following Standards and Agency approvals:

i. NEMA WC70/ICEA S-95-658.

3. MTW (Machine Tool Wiring)

a. Conductor

Copper, annealed, uncoated. Conductors shall comply with:

i. ASTM-B3, ASTM-B8, and ASTM-B7B8.

b. Insulation

Polyvinyl Chloride (PVC). Insulation shall comply with:

i. UL-83 Thermoplastic-Insulated Wires and Cables.

ii. UL-1063 Machine-Tool Wires and Cables.

c. The cable shall meet the following Standards and Agency approvals:

i. NEMA WC70/ICEA S-95-658.

ii. UL Standard UL 83, UL 1063, UL 758 cUL file: E156879 and E123744

iii. AWM Specification 1316, 1317, 1318, 1319, 1320, 1321

iv. ASTM Stranding Class B3, B8, B7B8

v. Federal Specification A-A-59544

vi. CSA 22.2 No. 75, UL E156879 and E123744

4. VFD CABLES

The VFD cables shall be 3-conductor with 3 bare copper symmetrical ground wires in XLPE insulation, dual 100 percent copper tape shielding, UL rated at 1,000 V, direct burial, 90C, wet/dry rated, in a sunlight- and oil-resistant PVC jacket (Beldon Series 295xx, or equivalent).

a. Conductor: Copper, tinned.

b. Insulation: XHHW-2 or RHW-2 rated.

c. The cable shall meet the following certifications:

i. Mine Safety & Health Administration (MSHA) standards.

ii. Suitable for use in Class I & II; Division 2 hazardous locations.

d. The cable shall meet the following Standards and Agency approvals:

i. 1000 V UL 1277, Type TC-ER

ii. 1000 V CSA AWM I/II, A/B FT4

C. INSTRUMENTATION, COMMUNICATION, AND NETWORKING CABLES

All instrumentation, communication, and networking cables and conductors in raceway shall be rated 600 VAC.

Exceptions:

- *Telephone cables.*
- *Antenna cables.*
- *Fiber optic cables.*

1. Analog Instrument Cables

Paired and triad analog instrument cables shall be #18 AWG stranded tinned copper 600 V tray cable, rated for wet applications at 75 degrees C in a sunlight resistant PVC jacket. Cables shall be plenum and direct burial rated, and shall be provided with individual pair/triad isolated 100 percent foil shields with independent drain wires and an overall isolated shield with drain wire.

These cables shall also be used for totalizing pulse signals from flow meters.

The following cables shall be used for multiple conductor applications:

a. 2-Conductor, 1 twisted pair, 100 percent overall shield. Belden #9341 or #1120A or equivalent.

b. 3-Conductor, 1 twisted triad, 100 percent overall shield. Belden #1121A or equivalent.

c. 4-Conductor, 2 twisted pairs, 100 percent individual shields plus 100 percent overall shield. Belden #1048A or equivalent.

2. Ethernet Copper Cables

Ethernet cables shall be 600 V, bonded pair, shielded.

a. Enhanced Category 6 (6e).

i. 600 V, polypropylene insulation, with inner PVC jacket and Industrial Grade, Sunlight and Oil Resistant, Black, PVC outer jacket.

ii. 8-Conductor, 4 twisted bonded pairs, #23 AWG, solid bare copper, 100 percent overall foil shield.

iii. 19.8 dB attenuation per 100 meters at 100 MHz.

iv. Beldon #7953A or equivalent.

3. Enhanced Category 5 (5e) and 6 (6e) RJ45 cable plugs

RJ45 cable plug connectors shall be 8-wire, 10 – 10000 Mbit/sec with metal housing and FC connection technology.



Siemens P/N 6GK1901-1BB12-2AA0 or equal.

D. CONTROL AND POWER CABLE/CORDS

1. HVAC Cables

HVAC cables shall only be used as control cables between HVAC equipment and thermostats or other controlling devices.

a. 4-Conductor, #16 AWG, stranded, 600V, tinned copper, cabled, PVC insulation, and PVC jacket. Beldon #8620 or equivalent.

b. 5-Conductor, #16 AWG, stranded, 600V, tinned copper, cabled, PVC insulation, and PVC jacket. Beldon #9620 or equivalent.

c. 9-Conductor, #16 AWG, stranded, 600V, tinned copper, cabled, PVC insulation, and PVC jacket. Beldon #9621 or equivalent.

d. 12-Conductor, #16 AWG, stranded, 600V, tinned copper, cabled, PVC insulation, and PVC jacket. Beldon #8622 or equivalent.

2. Power Cords

a. Type SO, 600 Vac, size #14 or larger.

3. Specialty Wire

As shown specifically on the Plans.

E. CONTROL AND INSTRUMENTATION CABLE CONNECTORS

1. Open Cable to Enclosure Connectors

Open cable to enclosure connectors for interior and exterior applications shall be 316 stainless steel control receptacle cord connector sets: Panel Receptacle = Turck #P-RKV series; field cable termination plug = Turck #P-RSV series. Provide separate pins for each cable shield.

2.2 SPLICES, TAPS AND TERMINAL BLOCKS

Splices are only allowed under the conditions of Section 4.2.E.

A. SPLICES TO POWER CONDUCTORS

1. Splices in Outdoor Areas, Handholes, Vaults, or Direct Buried

a. For inline butt splices, use inline resin splice kits for non-shielded cables, 600 V; 3M Scotchcast 82-A series or equal. UL listed 486D.

b. For odd-shaped and odd sized splices, use multi-mold resin splice kits for non-shielded cables, 600 V; 3M Scotchcast 85-14CP or equal. UL listed 486D

2. Indoor Splices and Taps for Receptacles and Lighting

a. Use quick spin, wing torque Electrical Spring and Grounding Connectors; 3M 312, 412, 512, and 512G or equal.

3. Motor Lead Connectors

a. Motor terminal connectors shall be insulated multiple tap connectors rated for 600 Vac; N.S.I. Polaris or equal.

4. Power Terminal Blocks

a. All power terminals shall be 600 Vac, suitable for 75 degrees C rated copper conductor.

b. Power terminal blocks may be copper or aluminum and shall have a short circuit current withstand rating following the guidelines described in UL 1059 and shall meet or exceed the available bolted fault current at the point of application.

B. SPLICES TO CONTROL CONDUCTORS

1. In Junction Boxes and Handholes

Splices to control conductors in junction boxes and handholes shall be made with 600 V, UL486D certified, water-proof direct bury connectors with strain relief, pre-filled with waterproof and corrosion-proof, non-hardening, silicone dielectric sealant; DRYCONN DBSR Series or equal.

2. In Pull Boxes

a. For inline butt splices, use inline resin splice kits for non-shielded cables, 600 V; 3M Scotchcast 82-A series or equal. UL listed 486D.

b. For odd-shaped and odd sized splices, use multi-mold resin splice kits for non-shielded cables, 600 V; 3M Scotchcast 85-14CP or equal. UL listed 486D.

3. Terminal Blocks in Panels

Reference Specification 16940 for terminations in Control Panels.

C. SPLICES TO INSTRUMENTATION CABLES AND CONDUCTORS

1. In Junction Boxes

Strip back the cable outer sheath exposing cable conductors and shield lengths to 1-inch or less. Twist the wires together and solder. Insert and engage into 600 V, UL486D certified, water-proof connectors, pre-filled with waterproof and corrosion-proof, non-hardening, silicone dielectric sealant; DRYCONN Aqua Series or equal.

2. In Pull Boxes and Handholes

Instrument cables and conductors are always passed through a junction box inside pull boxes and handholes. Reference "In Junction Boxes" (above) and Specification 16130, Section 4.

3. Terminal Blocks in Panels

Reference Specification 16940 for terminations in Control Panels.

2.3 INSULATING MATERIALS

A. ELECTRICAL INSULATION PUTTY

Scotchfill, or equal.

B. INSULATING ELECTRICAL TAPE

7 Mil/0.18 mm Plasticized PVC, rubber-based adhesive, 200 percent elongation, 26 N/cm tensile strength, 8 kV breakdown voltage, meeting CE, CSA, UL certifications.

C. CONDUCTOR COLOR-MARKING TAPE

7 Mil/0.18 mm Plasticized PVC, rubber-based adhesive, 200 percent elongation, 26 N/cm tensile strength, 8 kV breakdown voltage, meeting CE, CSA, UL certifications, in required color.

D. ELECTRICAL HEAT SHRINK TUBING

Heat shrink tubing shall be dual-wall polyolefin, 3-1 shrink ratio, 600 Vac, -55 to 110 degrees C operating range meeting UL 224 600V, 125 degrees C.

PART 3 APPLICATIONS

3.1 WIRE APPLICATIONS

A. CABLE AND CONDUIT SCHEDULE

The Cable and Conduit Schedule shall be considered absolute. No changes to wire sizes, wire count, insulation type, or circuit type shall be allowed without approval from the Engineer.

B. WIRES IN RACEWAYS

Wires installed in raceways shall be considered "FIELD" wiring and shall be installed and terminated by qualified and licensed electrical contractors.

Exceptions:

- *Installation and termination may be by the owner under the provisions of "RCW 19.28.261, Exemptions from RCW 19.28.161 through RCW 19.28.271."*

- *If the raceway is installed inside a control panel fabricated by a certified UL 508 shop, then these wires may be installed and terminated per the provisions of WIRES IN CONTROL PANELS as listed below.*

1. Power Wire

    a. Insulation

        All service, feeder, and branch circuit conductors shall be XHHW-2.

        Exceptions:

        - *Unless called out otherwise in the Cable and Conduit Schedule.*

        - *Unless approved in writing by the Electrical Engineer.*

        - *Unless both ends of wire are installed in the same control panel.*

2. Class 1 and 2 Control Wire

    a. Insulation

        All control circuits in raceways shall be XHHW-2.

        Exceptions:

        - *Unless called out otherwise in the Cable and Conduit Schedule.*

- *Unless approved in writing by the Electrical Engineer.*

b. Minimum control wire size in conduits and raceways

The minimum control wire size in conduits and raceways shall be #14 AWG.

C. WIRES IN CONTROL PANELS

Wires in control panels are those that are terminated within a control panel, and do not extend beyond the control panel enclosure. Wires that extend beyond the control panel enclosure shall be installed and terminated per the provisions of "WIRES IN RACEWAYS," above.

1. Control Panel Power and Control Wire

a. Insulation

Power and control conductors in control panels shall be MTW or THHN/THHN-2.

b. Wires shall have the following minimum sizes and colors:

Circuit Type	Wire Size[(1)]	Wire Color
120 VAC Power Circuits		
120 VAC, Line	#14 AWG	Black
120 VAC, Neutral	#14 AWG	White
120 VAC, Equipment Ground	#14 AWG	Green
120 VAC Control Circuits		
120 VAC, Line	#18 AWG	Black
120 VAC, Neutral	#18 AWG	White
Low-Voltage AC Control Circuits		
Low-Voltage, Line	#18 AWG	Red
Low-Voltage, Neutral	#18 AWG	White
24 VDC Power Circuits		
+24 VDC Power	#14 AWG	Blue
24 VDC Common	#14 AWG	White with Blue stripe
24 VDC Equipment Ground	#14 AWG	Green
Isolated (Shield) Ground	#12 AWG	Yellow with Green stripe[(2)]

Circuit Type	Wire Size[1]	Wire Color
24 VDC Control Circuits		
+24 VDC Control	#18 AWG	Blue
24 VDC Common	#18 AWG	White with Blue stripe
PLC I/O Circuits		
DC I/O	#18 AWG[3]	Purple
DC I/O Common	#18 AWG	White with Purple stripe
Analog Inputs	#18 AWG	Analog Instrument Cable[4]
Analog Outputs	#18 AWG	Analog Instrument Cable

Notes:

(1) Wire sizes are minimums; size wires to comply with NEC and UL 508.

(2) Isolated (Shield) ground wires shall be of a color scheme that is approved for ground wires but distinct from equipment grounds.

(3) For PLC digital outputs, conductors may be #18 AWG between the PLC output terminal and the buffer relay coil when fused at not more than 5A. Wiring from the buffer relay output contacts to field terminals shall be #14 AWG minimum. For retrofit panels without buffer relays, digital output wiring shall be #14 AWG.

(4) Contractor shall provide one of the Analog Instrument Cables described in the "PRODUCTS" section of this specification.

2. Where panels are required to be manufactured and certified to a particular standard (such as UL 508A), the contractor shall substitute wire colors where required to meet the standard.

D. CONDUCTORS DIRECT BURIED

Refer to the Plans for specifications regarding directly buried conductors and cables.

E. POWER CORDS

SO power cords shall be allowed in control panels for circuits not greater than 120 Vac or 48 Vdc. Such applications require installation by a UL 508 shop.

F. SPECIALTY WIRE

Refer to the Plans for specifications regarding "Specialty Wire".

PART 4 EXECUTION

4.1 EXAMINATION

Examine raceways and surfaces receiving wires and cables for compliance with requirements for installation tolerances and other conditions affecting performance of wires and cables. Do not proceed with installation until unsatisfactory conditions have been corrected.

4.2 INSTALLATION

A. GENERAL INSTALLATION METHODS

1. Install wires and cables in raceway system, according to manufacturer's written instructions and NECA's "Standard of Installation," after raceway system is complete.

2. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3. Install cables and conductors neatly in all enclosures. Bend or form wires in neat runs from conduits to terminals. Arrange wires so that they may be grouped by conduit or function in the enclosure. Install cable ties and straps to support and bundle wires in enclosures. Arrange wires to allow wire tags and numbers to be easily read without bending or flexing wiring.

4. Leave 6 inches or more of free conductor at each connected device or equipment terminal and 9 inches of free conductor at each unconnected outlet. Tape free ends of conductors at unconnected outlets and coil neatly in outlet box.

5. Install wiring to equipment neutral and grounding blocks on the bottom or furthest back row first. Leave unconnected blocks accessible for future neutral or grounding connections.

6. Provide individual neutral conductors for each associated circuit. Common neutral conductors for multi branch circuits are not permitted.

7. All power distribution raceways shall contain at least one continuous copper grounding conductor with a minimum size as

per NEC 250.122. Larger sizes shall be used if identified in the Cable and Conduit Schedule on the Plans.

B. CONDUCTORS SHARING RACEWAYS

1. Power conductors shall not be run in the same raceway with control conductors.

Exception:

- *Unless specifically shown otherwise in the Cable and Conduit Schedule.*

2. Power conductors shall not be run in the same conduit or raceway with instrumentation cables/conductors.

3. Control conductors shall not be run in the same conduit or raceway with instrumentation cables/conductors.

Exception:

- *Unless specifically shown otherwise in the Cable and Conduit Schedule.*

C. CONDUCTORS IN CONTROL PANELS

1. Control Panel Instrumentation (Signal) Wiring

a. Signal cables between analog input and output field terminals and a PLC shall be connected to the field terminals as shown in Specification 16940.

b. All cables shields shall be terminated at the field terminal end. Connections to the PLC analog input and output terminals shall not land the shield.

c. Signal cable conductors and their shields/drains shall not be separated greater than as described below.

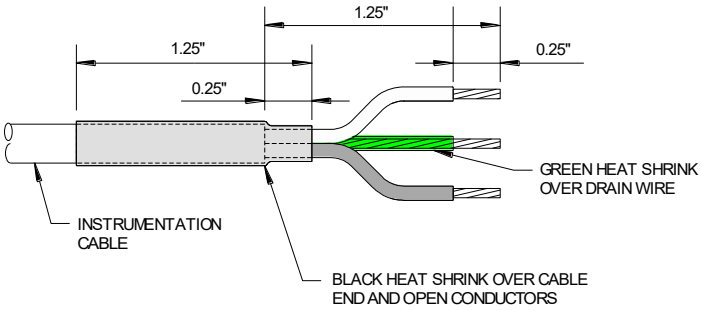
2. Control Panel Communication and Networking Wiring

a. All communication and networking cables inside control panels shall have their ends made up with terminal connectors. No cables shall be left open-ended.

b. Cables shall be routed inside Panduit™ or neatly tied to other conductor bundles.

D. INSTRUMENTATION (SIGNAL) CABLES

1. Preparing the Shielded End



a. Neatly trim the end of the cable.

b. Strip back 1.25 inch of the outer jacket taking care not to cut into the conductor insulation.

c. Neatly trim the foil back to the edge of the outer jacket taking care not to damage the drain wire.

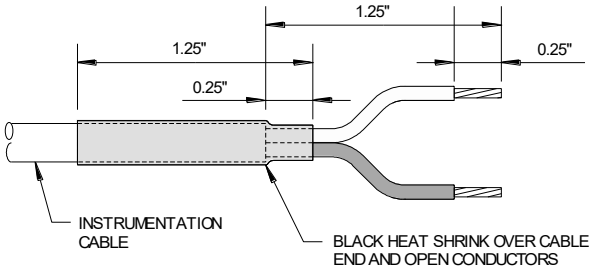
d. For signal cables with a braided shield over a foil shield, carefully cut the braid back to the edge of the outer jacket.

e. Provide a green heat shrink tube over the drain wire, leaving 0.25 inch of exposed conductor.

f. Provide a 1.25-inch black heat shrink over the jacket, covering 0.25 inch of the exposed conductors. This properly insulates and protects the ends of the shields and the outer jacket.

g. Strip the signal conductors exposing 0.25 inch of conductor.

2. Preparing the Unshielded End



a. Neatly trim the end of the cable.

b. Strip back 1.25 inch of the outer jacket taking care not to cut into the signal conductor insulation.

c. Neatly trim the foil back to the edge of the outer jacket.

d. Cut the drain wire at the edge of the outer jacket taking care not to damage the signal conductor insulation.

e. For signal cables with a braided shield over a foil shield, carefully cut the braid back to the edge of the outer jacket.

f. Provide a 1.25-inch black heat shrink over the jacket, covering 0.25 inch of the exposed conductors. This properly insulates and protects the ends of the shields and the outer jacket.

g. Strip the signal conductors exposing 0.25 inch of conductor.

E. SPLICING CONDUCTORS

1. Install service, feeder, and motor circuits continuous without splices from equipment terminal to equipment terminal or motor lead.

Exceptions:

- *Service entry feeders at weatherheads.*
- *Branch circuits at taps for convenience receptacles and lighting.*

- *As specifically called out.*

- *With written permission from the Engineer.*

2. Install instrumentation and control circuits continuous without splices or terminations from source equipment terminal to destination equipment terminal.

   Exceptions:

   - *On terminal strips in control panels.*

   - *On terminal strips in termination panels.*

   - *As specifically called out.*

   - *With written permission from the Engineer.*

3. Where splicing is allowed, or specifically called out, install in the following manner:

   a. Splicing Inside Vaults, Handholes, Outdoor J-Boxes, or J-Boxes in Wet Areas

      Power and control conductors shall be spliced per Section 2.2.A. Provide a minimum of 24 inches of length on both wires for future resplicing.

   b. Splicing Inside Motor J-Boxes

      Power connections inside motor j-boxes shall be made using insulated multiple tap connectors rated for 600 Vac; N.I.S. Polaris or equal. Cover the splice with a minimum of three layers of black insulating electrical tape. Provide a single band with a minimum of two wraps of the appropriate phase color tape to the entry T-lead. Bend the connections away from the sides of the j-box and motor frame to prevent abrasion from motor vibration.

      Control connections inside motor j-boxes shall be made with crimped butt-splices with heat shrink covers. The heat shrink shall overlap the butt barrel ends by a minimum of 1/2 inch on each side. Cover the splice with a minimum of three layers of black insulating electrical tape.

c. Splicing in J-Boxes and Control Panels Mounted Indoors in Dry Rooms

i. Conductors size #12 AWG through #6 AWG:

For conductors less than #6 AWG, provide crimped butt-splice with heat shrink cover. The heat shrink shall overlap the butt barrel ends by a minimum of 1/2 inch. Cover the splice with a minimum of three layers of black electrical tape. Provide a 2-wrap (minimum) single band of the appropriate phase color tape.

Exception:

- *For receptacles and lighting, reference Section 2.2.B.*

ii. Conductors size #4 AWG and larger:

(1) Terminal Connectors

For conductors larger than #6 AWG, connections shall be made using insulated multiple tap connectors rated for 600 Vac; N.S.I. Polaris or equal.

Cover the splice with a minimum of three layers of black electrical tape. Provide a 2-wrap (minimum) single band of the appropriate conductor color tape.

(2) Terminal Blocks

All power terminals shall be 600 Vac, suitable for 75 degrees C rated copper conductor.

Connect using properly sized terminal blocks.

Exception:

- *If splices are allowed by the Engineer, then use plated copper alloy compression splicing sleeves installed by high-pressure compression tools and insulated with heat shrink Raychem sleeves.*

F. REPLACING FAULTY CONDUCTORS

When replacing a faulty conductor or cable that shares a raceway with other conductors or cables, all conductors and cables must be removed and replaced with new.

Exceptions:

- *If the raceway is straight and without bends or offsets and its length is less than 30 feet, and the conductors are not bound together in the raceway, then only the faulty cable must be pulled and replaced with new. A manufacturer-approved pulling compound or lubricant must be used to minimize degradation to the remaining conductors. The contractor is responsible for the integrity of the remaining conductors.*

- *With specific approval by the Engineer.*

G. CONDUCTOR COLORS

1. For conductor colors inside control panels, reference Section 3.1.C.1.

2. Do not use white, gray, green, or green with yellow stripes color for any power, lighting, or control conductor not intended for neutral or equipment grounding purposes.

   Exception:

   - *Instrumentation and control multi-conductor cables may use white, gray, or green singly or as part of a trace color in addition to the base color.*

3. Equipment grounding conductors: Green or green with yellow stripes.

4. 480/277 volt, 3-phase systems:

Phase A	Phase B	Phase C	Neutral
Brown	Orange	Yellow	Gray

5. 208/120 or 240/120 volt, 3-phase systems:

Phase A	Phase B	Phase C	Neutral
Black	Red	Blue	White

6. 240/120 volt, single phase systems:

Phase A	Phase B	Neutral
Black	Red	White

7. Use wire with insulation of required color for conductors of #6 AWG and smaller. For wire larger than #6 AWG, where not available in specified colors, use conductor color marking tape per Section 2.3.C. When conductors are marked in this manner, mark each conductor at all accessible locations such as panelboards, junction boxes, pullboxes, auxiliary gutters, outlets, switches, and control centers.

8. Connect power conductors of the same color to the same phase throughout the installation. Viewing all equipment from the front, make connections so phase color sequence is in the same order as that for panelboards, switchboards, motor control centers, etc.

H. PULLING CONDUCTORS

1. Instrumentation, Communication, Networking, and Fiber Cables

   Make all cable pulls by hand using a manufacturer-approved pulling compound or lubricant where necessary.

2. Power and Control Conductors

   a. Make all cable pulls by hand where possible. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, or wrapping extra conductor into an eye, that will not damage cables or raceway.

   b. On mechanically-assisted pulls use a manufacturer-approved pulling compound or lubricant where necessary. The compound used must not deteriorate the conductors or

insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values. Install pullboxes where necessary to prevent exceeding manufacturer's recommendations.

3. Cut cable or conductor ends off after pulling and clean all pulling compound from exposed conductors before terminating.

I. CABLE SUPPORTS

Support cables according to Section 16050.

Provide vertical conductor support per NEC Table 300.19(A).

J. WIRING AT OUTLETS

1. Install conductor at each outlet, with at least 6 inches of slack. Connect only to receptacle screw terminals using insulated spade-type lugs.

2. Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer, and in compliance with other Sections of Division 16.

4.3 FIELD QUALITY CONTROL

A. TESTING

1. Provide conductor megger testing per Specification 16050, Section 3.

***** END OF SECTION *****

SECTION 16130

RACEWAY AND BOXES

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.2 RELATED SECTIONS SPECIFIED ELSEWHERE

Sections	Items
01300	Submittals
02530	Utility Structures
16050	Basic Electrical Materials and Methods
16060	Grounding and Bonding
16120	Conductors and Cables
16140	Wiring Devices

1.3 DEFINITIONS

A. 100 PERCENT CONTINUOUS

100 percent continuous means that electrical continuity shall be maintained over a conduit's entire length and that such conduits shall consist of only RGS (whether PVC-coated or not), LFMC, or combinations of these types. There can be no break in the electrical continuity by non-metallic components.

EMT conduits are not considered 100 percent continuous.

B. CONDUIT BODIES

A separate portion of a conduit system that provides access through a removable cover to the interior of the system at a junction of two or more sections of the system.

C. CONTROL CONDUITS

Control conduits typically contain cables or conductors in the range of 12 Vdc to 120 Vac. These cables/conductors are used to provide discreet field inputs and outputs to motor drives, PLC controllers, operator stations, etc. They typically connect to discreet I/O field devices like local

panel pushbuttons, indicating lights, selector switches, field limit switches, relay circuits, etc.

D. CONTROL PANELS

Control panels are enclosures in which one or more circuits are changed, unlike junction boxes where circuits are simply routed through the panel. Control panels may be as simple as an enclosure with a pilot light or they may be very complicated with hundreds of I/O terminations. For Control Panel considerations, reference Specification 16940.

E. CONVENIENCE RECEPTACLES

Reference Section 16140, Definitions.

F. DEVICE BOXES

Device boxes are electrical boxes used for receptacles, light switches, dimmers, and other similar devices. Selector switches, indicating lights, displays, etc., are mounted in control panels and equipment enclosures, not in device boxes.

G. DRIP FITTINGS

Drip fittings are used to drain water from conduit entry points, junction boxes, or other enclosures where accumulation of moisture must be removed. They are also intended to disable the entry of foreign materials, including tools and fingers, through the drain.

H. DRY LOCATIONS

Reference Section 16050, Definitions.

I. EMT

Electrical Metallic Tubing (a type of RMC).

J. EQUIPMENT VAULT

An Equipment Vault is a VAULT that contains one or more electrical devices that are terminated within the vault; such as flow meters, control valves, control or power panels, lighting, and etc.

SEE VAULTS

K. FINISHED AREAS

Reference Section 16050, Definitions.

L. FMC

Flexible Metal Conduit (a type of RMC).

M. FRP

Fiberglass Reinforced Plastic (a type of RNC).

N. HANDHOLES

A handhole is a pullbox that is not sufficiently sized for entrance of personnel (reference PULLBOXES).

O. INSTRUMENTATION CONDUITS

Instrumentation conduits contain cables and conductors that carry low-power modulated or communication signals. They may include 4-20 mA current loops, 0–10 volt analog signals, 5 to 12 Vdc digital (TLL) data, analog or digital communications signals, etc. They may also include low-voltage compliance power to instruments such as 5 Vdc, ±15 Vdc, or 24 Vdc.

P. INTRINSICALLY SAFE CIRCUIT

A circuit in which any spark or thermal effect, produced either normally or in specified fault conditions, is incapable of releasing sufficient electrical or thermal energy to cause ignition of a specific hazardous atmospheric mixture in its most easily ignitable concentration.

Q. JUNCTION BOXES

Junction boxes are electrical enclosures used for combining, splitting, pulling, or redirecting electrical circuits. Junction boxes may terminate one conduit or join multiple conduits. Circuits are not *altered* inside a junction box. Enclosures where circuits are altered are called CONTROL PANELS. With the exception of terminal strips, junction boxes do not contain electrical devices.

1. Junction Boxes, Type J1

   Junction boxes identified as TYPE J1 can contain only non-linear power circuits.

2. Junction Boxes, Type J2

   Junction boxes identified as TYPE J2 can contain only intrinsically safe circuits.

3. Junction Boxes, Type J3

   Junction boxes identified as TYPE J3 can contain only instrumentation circuits that are not intrinsically safe.

Junction boxes not containing circuits of the types identified for TYPE J1, TYPE J2, or TYPE J3 are simply called "junction boxes" (without a TYPE identifier).

R. LFMC

Liquidtight Flexible Metal Conduit (a type of RMC).

S. LINEAR POWER LOADS

Linear power loads are those that are not VFD circuits (both line or load), and are not UV ballast circuits. Although actually non-linear, fluorescent lighting circuits shall be considered linear power loads.

T. NON-LINEAR POWER LOADS

Non-linear power loads shall include all VFD circuits (both line or load) and all UV ballast circuits. Although actually non-linear, fluorescent lighting circuits shall be considered linear.

U. POWER CONDUITS

Power conduits contain branch and feeder conductors with voltages 120 Vac and above. These conductors provide operating power to MCCs, panels, motors, lighting, receptacles, HVAC, etc. Conductors can be of #12 AWG wire gauge and larger, either separate or in power cables.

V. PROCESS AREAS

Reference Section 16050, Definitions.

W. PULLBOXES

Pullboxes are underground electrical enclosures, sufficiently sized to allow the entrance of personnel, used for combining, splitting, pulling, or redirecting electrical circuits. Pullboxes may terminate one conduit or join multiple conduits. A pullbox can be considered an underground junction box.

Circuits are not altered or terminated inside a pullbox. Pullboxes do not contain electrical equipment or devices.

Exception:

- *Pull boxes may include a sump pump.*

Handholes are types of pull boxes but are not sufficiently sized to allow the entrance of personnel (reference HANDHOLES).

X. PVC

Polyvinyl Chloride Conduit (a type of RNC).

Y. PVC-RGS

Polyvinyl chloride, externally coated RGS (a type of RMC).

Alias: May be called or shown on Plans and elsewhere in specifications as PVC-Coated RGS or PVC-RMC.

Z. PVC-RMC

Reference PVC-RGS.

AA. RGS

Rigid Galvanized Steel (a type of RMC).

BB. RMC

Rigid Metal Conduit (General NEC Category).

CC. RNC

Rigid Nonmetallic Conduit (General NEC Category).

DD. SURFACE RACEWAYS

A metallic raceway that is intended to be mounted to the surface of a structure, with associated couplings, connectors, boxes, and fittings for the installation of electrical conductors.

EE. VAULTS

A vault is an underground structure, serviceable or accessible only from the top. Handholes, Equipment Vaults, and Pullboxes are considered vaults.

FF. WET LOCATIONS

Reference Section 16050, Definitions.

GG. WIREWAYS

Sheet metal troughs with hinged or removable covers for housing and protecting electric wires and cable in which conductors are laid in place after the wireway has been installed as a complete system.

1.4 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Provide data for surface raceways, wireways and fittings, hinged-cover enclosures, and cabinets.

1.5 QUALITY ASSURANCE

See Section 16050.

1.6 COORDINATION

Coordinate layout and installation of raceways and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

Coordinate electrical work with outside utilities associated with the project.

Non electrical piping and structural has priority over underground conduit routing.

Exception:

- *Unless specifically coordinated otherwise with the General Contractor.*

PART 2 PRODUCTS

2.1 METALLIC CONDUIT TYPES

A. EMT

1. Conduit

   Galvanized steel tubing meeting ANSI C80.3.

2. Conduit bodies shall be galvanized, or epoxy coated cast iron or aluminum one piece with galvanized, or epoxy coated cast cover, gasket, and threaded hubs. Use stainless steel screws or other approved non-corroding screws to hold cover in place.

3. EMT connectors shall be compression type only. Set screw connectors shall not be allowed.

4. Conduit clamps for EMT shall be stamped galvanized steel.

B. FMC

1. Conduit

   Flexible, galvanized steel convolutions forming a continuous raceway.

2. Connectors

   Galvanized steel, screw in, approved for grounding.

C. LFMC

1. Conduit

   Flexible, galvanized steel convolutions forming a continuous raceway, covered by a liquid tight PVC layer. Electri-Flex Type LA or American Sealtite, Type UA

2. Connectors

Galvanized steel, screw in, grounding type with a ferrule, which covers the end of the inside and outside of the conduit.

D. RGS

1. Conduit

Hot dipped galvanized with threaded ends meeting ANSI C80.1.

2. Couplings

Steel, cast iron, or malleable iron compression type employing a split, corrugated ring and tightening nut, with integral bushings and locknuts. No indent or set screw type.

a. Couplings

Unsplit, NPT threaded steel cylinders with galvanizing equal to the conduit.

b. Nipples

Factory made through 8 inches, no running threads.

c. Conduit bodies shall be galvanized, or epoxy coated cast iron or aluminum one piece with galvanized, or epoxy coated cast cover, gasket, and threaded hubs. Use stainless steel screws or other approved non-corroding screws to hold cover in place.

3. Conduit Clamps

Conduit clamps for RGS shall be cast iron.

E. PVC-COATED RGS, PVC-RMC

1. General

a. Coated steel shall be hot dipped galvanized inside and out with hot dipped galvanized threads. The interior galvanizing shall be listed per UL 6. The exterior shall be listed per UL 6 as primary corrosion protection. Thread protectors shall be used on the exposed threads. PVC

coated ERMC-steel conduit shall comply with UL 6, ANSI c80.1, and NEMA RN-1.

b. The PVC exterior and urethane interior coatings applied to the conduit shall afford sufficient flexibility to permit field bending without cracking or flaking at temperatures above 30 degrees F (-1 degrees C). PVC coating shall be a nominal 40 mils in thickness over the entire length of the conduit except at the threads, and be free from defects. Internal coating shall be a nominal 2-mil thickness.

c. Installation of the PVC coated conduit system shall be performed in accordance with the manufacturer's installation manual.

d. Conduits and fittings shall meet the following standards:

i. ASTM A239

ii. UL 6

iii. UL 514B

iv. NEMA RN1

2. Conduit

a. Ferrous fittings for general service locations must be UL listed with PVC as the primary corrosion protection. Hazardous location fittings, prior to plastic coating must be UL listed. All conduit and fittings must be new, unused material. Applicable UL standards may include: UL 6 Standard for Safety, Rigid Metal Conduit, UL 514B Standard for Safety, Fittings for Conduit and Outlet Boxes.

3. Fittings and Accessories

a. The PVC coating on the outside of conduit couplings shall be a nominal 40mils in thickness.

b. Conduit clamps and fittings for PVC-Coated RGS conduits shall be 316L stainless steel.

4. Approved Material

a. Plasti-Bond REDH2OT or Perma-Cote manufactured by Robroy Industries.

b. Ocal-Blue Steel conduit and fittings as manufactured by Thomas & Betts (ABB)

c. Any deviation from the above approved materials must be approved by the Engineer.

2.2 NONMETALLIC CONDUIT TYPES

A. PVC

1. Conduits

NEMA TC 2, Schedule 40 or 80 PVC.

2. Fittings and Accessories

NEMA TC 3; match to conduit type and material, but elbows shall be RMC.

3. Conduit bodies

Where allowed, shall match type, material, and gauge of conduit.

2.3 OUTLET AND DEVICE BOXES

A. STANDARD METAL BOXES

Assembled from stamped steel hot dipped zinc galvanized coated flat pieces, welded or mechanical assembled into a device box, with knockouts for conduit or connector entrance, meeting NEMA OS 1, with plaster or extension rings and necessary mounting appurtenances to suite construction and application.

B. CAST BOXES

1. Cast Aluminum

Epoxy coated cast aluminum box, one piece, with mounting lugs, with threaded holes or hubs, with internal green ground screw and with neoprene gaskets.

2. Cast Iron

Cast iron with electro-galvanized and aluminum acrylic paint finish, one piece, with mounting lugs, with threaded holes or hubs, with internal green ground screw and with neoprene gaskets.

C. DEVICE COVERS

1. Plastic: Thermoplastic nylon, device-mount, ivory.

2. Aluminum: Sheet Aluminum.

3. Cast Iron: Iron alloy.

D. SWITCH ACTUATORS

1. Aluminum: Lever-arm type, raintight, cast aluminum matching the metallurgy of the device box.

2. Cast Iron: Lever-arm type, raintight, cast iron alloy matching the metallurgy of the device box.

E. WEATHERPROOF COVERS AND PLATES

Weather proof, self-closing, die-cast aluminum, UL listed.

F. IN-SERVICE COVERS

Shall be weather proof and hinged from top with removable cord slots.

2.4 JUNCTION BOXES, HANDHOLES, AND VAULTS

A. JUNCTION BOXES

1. Standard

Stamped steel, deep drawn one piece (without welds or tab connections), galvanized, with knockouts for conduit or connector entrance, meeting NEMA OS 1. Boxes 6" x 6" x 4" or larger may be code gauge fabricated steel continuously welded at seams and painted after fabrication.

2. Cast

Cast iron with electrogalvanized and aluminum acrylic paint finish, one piece, with threaded cover of the same metallurgy and finish, with mounting lugs, with threaded holes or hubs, with internal green ground screw and with neoprene gaskets; explosion-proof, dust-ignition-proof, raintight, rated for Class I, Division 1 and 2, Groups C, D.

3. Stainless Steel

NEMA 4X 316L stainless steel with gasketed screw down cover.

4. Explosion Proof for Internal Wire Termination

Explosion proof junction boxes shall be 18"H x 12"W x 6"D (minimum inside dimension) cast aluminum; explosion-proof, dust-ignition-proof, raintight, rated for Class I, Division 1 and 2, Groups C, D; Killark #EXB-12186-N34 or equal.

Exception:

- *Unless specifically stated otherwise on the Plans.*

5. Explosion Proof, No Terminations

Cast iron with electrogalvanized and aluminum acrylic paint finish, one piece, with threaded cover of the same metallurgy and finish, with mounting lugs, with threaded holes or hubs, with internal green ground screw and with neoprene gaskets; explosion-proof, dust-ignition-proof, raintight, rated for Class I, Division 1 and 2, Groups C, D.

Exception:

- *Unless specifically stated otherwise on the Plans.*

B. HANDHOLES

1. Material and Strength

Handholes shall be made from Concrete or Polymer Concrete. The boxes and covers are required to conform to all test provisions of ANSI/SCTE 77 2002 “Specification for Underground Enclosure Integrity” for Tier 15 applications (Design Load Vertical

22,500 lbs. and Lateral 800 lbs/sq. ft.) and to be Listed and Labeled. The boxes must physically accommodate and structurally support compatible covers, which possess the Tier rating. In no assembly can the cover design load exceed the design load of the box. All components in an assembly (box and cover) are to be manufactured by the same manufacturer. All covers are required to have a minimum coefficient of friction of 0.50 in accordance with ASTM C1028. Independent third-party verification or test reports stamped by a registered Professional Engineer certifying that all test provisions of this specification have been met are required with each submittal. The cover is to have an identifying function descriptor imprinted on it. The Descriptor shall be ELECTRICAL, CONTROL, SIGNAL, TELEPHONE, STREET LIGHT, or similar approved by the Engineer.

Handholes with metallic lids shall be grounded per Specification Section 16060.

Handhole lid assemblies comprised of steel shall have a factory-applied galvanized finish.

Exception:

- *Unless the assembly is fabricated from stainless steel.*

2. Manufacturers

Quazite (Strongwell Corp.)
Carson Industries

C. PULLBOXES AND VAULTS

Precast concrete structures with preformed knockout holes for conduit entrance. Reference Section 02530, Utility Structures.

Pullboxes and vaults with metallic lids shall be grounded per Specification Section 16060.

Pullbox lid assemblies comprised of steel shall have a factory-applied galvanized finish.

Exception:

- *Unless the assembly is fabricated from stainless steel.*

PART 3 APPLICATION

3.1 CONDUIT BODIES

This section describes the types of raceways, junction boxes, and device boxes that can used for different circuits and different environments. Reference Section 4.1 for methods and practices required for installation.

A. CABLE AND CONDUIT SCHEDULE

The Cable and Conduit Schedule shall be considered absolute. No changes to wire sizes, wire count, insulation type, circuit type, or conduit size shall be allowed without approval from the engineer.

The Cable and Conduit Schedule does not indicate conduit type (PVC, EMT, RGS, etc.) since, in many cases, a conduit's type may change between its source and destination. The rules stated in this specification define the necessary and allowed conduit type(s) for various applications and routes.

B. RACEWAY REQUIREMENTS

The term "RGS conduits" refers to a type of conduit body and does not imply whether the conduit is PVC-coated or not. Certain applications require RGS conduits with PVC coating, others do not. Reference Section 3.2, "RGS RACEWAY PROTECTIVE COATINGS" for these requirements.

1. Circuit Types and Categories

a. Circuit Types

Conduits are broken into three general circuit types; 1) Power, 2) Control, and 3) Instrumentation (see Definitions).

On the Cable and Conduit Schedule, Power conduits are those starting with the letter "P," Control conduits are those starting with the letter "C," and Instrumentation conduits are those starting with the letter "S."

b. Circuit Categories

Power circuits are broken into two categories, those that contain linear loads and those that contain non-linear loads (see Definitions).

Control and Instrumentation circuits are broken into two categories, those that contain intrinsically safe circuits and those that do not (see Definitions).

These types and categories are listed below in Table 3.1.B.1 below.

a. Relationships Between Circuit Categories and Conduit Types

Many electrical circuit types do not require special conduit routing considerations. However, Table 3.1.B.1 shows the circuit types where the conduit route must be 100 PERCENT CONTINUOUS (reference Definitions).

Table 3.1.B.1

Circuit		
Type	**Category**	**100% Continuous?**
Power	Linear	No
Power	Non-linear	Yes
Control	Non-intrinsic	No
Control	Intrinsic	Yes
Instrumentation	Non-intrinsic	Yes
Instrumentation	Intrinsic	Yes

2. Conduit Shape

Wiring shall be routed in pipe or tubular conduits, NOT in fabricated wireways or gutters.

Exception:

- *Unless specifically called out otherwise in the Plans.*

C. PVC SCHEDULE 40 RACEWAY APPLICATIONS

1. All straight portions of conduits completely concealed in walls, attics, concrete, or below ground (not exposed) shall be PVC Schedule 40.

Exceptions:

- *Power conduits containing non-linear loads shall be 100 percent continuous over their entire length.*
- *Control conduits containing intrinsically safe circuits shall be 100 percent continuous over their entire length.*
- *All Instrumentation conduits shall be 100 percent continuous over their entire length.*
- *All conduits containing grounding electrode conductors shall be PVC Schedule 80 over their entire length.*
- *PVC conduit areas under roads or heavy traffic areas shall be Schedule 80.*
- *Where specifically called out otherwise in the Cable and Conduit Schedule.*

2. All portions of power and control conduits completely concealed inside a reservoir shall be PVC Schedule 40.

D. PVC SCHEDULE 80 RACEWAY APPLICATIONS

1. All portions of conduits which contain grounding electrode conductors shall be PVC Schedule 80 and shall contain no metal fittings, connectors, or devices. Such conduits containing grounding electrode conductors shall contain no other types of conductors.

2. PVC conduit areas under roads or heavy traffic areas.

3. As stated in the Cable and Conduit Schedule.

E. RGS RACEWAY APPLICATIONS

1. All conduits requiring 100 percent continuity per Section 3.1.B.1 shall be RGS over their entire length. For coating requirements, reference Section 3.2.

Exception:

- *LFMC conduit shall be allowed per the "LFMC Raceway Applications" section herein.*

2. Underground factory or bent elbows and offsets greater than or equal to 30 degrees shall be RGS.

   Exceptions:

   - *Where the radius of a conduit bend is greater than or equal to 15 feet per inch of trade size.*

   - *Raceways used for the containment and protection of bare grounding electrode conductors shall be PVC Schedule 80. Reference PVC Schedule 80 raceway applications.*

3. All portions of conduits exposed outdoors shall be RGS.

   Exception:

   - *All conduits containing grounding electrode conductors shall be PVC Schedule 80 over their entire length.*

4. All portions of conduits under covered structures open on any side shall be RGS.

   Exception:

   - *All conduits containing grounding electrode conductors shall be PVC Schedule 80 over their entire length.*

   - *LFMC conduit shall be allowed per the "LFMC Raceway Applications" section herein.*

5. All portions of conduits exposed on the inside of below-ground pullboxes, equipment vaults, wet wells, and dry wells (vaults) shall be RGS.

   Exceptions:

   - *All conduits immediately terminating after penetrating a vault wall, that are allowed to be PVC Schedule 40 underground, shall terminate as a PVC conduit bell-end.*

     If the conduit is connected inside the vault to any device, conduit body, junction box, control panel, or any other conduit, then all portions of the conduit inside the vault,

through the wall penetration, and 24 inches outside the vault shall be RGS and shall be grounded.

- *All conduits containing grounding electrode conductors shall be PVC Schedule 80 over their entire length.*

6. All portions of conduits penetrating concrete floors, walls, or ceilings shall be RGS.

   Exception:

   - *In below ground vaults as described above.*

7. All conduit penetrations from grade shall be RGS.

   Exception:

   - *All conduits containing grounding electrode conductors shall be PVC Schedule 80 over their entire length.*

8. All portions of exposed conduits inside closed buildings shall be RGS.

   Exceptions:

   - *EMT conduit shall be allowed per the "EMT Raceway Applications" section herein.*

   - *LFMC conduit shall be allowed per the "LFMC Raceway Applications" section herein.*

   - *All conduits containing grounding electrode conductors shall be PVC Schedule 80 over their entire length.*

   - *Unless otherwise specifically called out on a separate plan or detail.*

F. LFMC RACEWAY APPLICATIONS (REFERENCE DEFINITIONS)

1. LFMC conduit shall be used for the last 18 inches of connection to motors, transformers and other vibrating equipment.

2. LFMC conduit shall be used for the last 18 inches of connection to field instruments such as flow meters in vaults and ultrasonic level transducers.

3. LFMC conduit shall be used for the last 18 inches of connection to any device that may require minor movement during maintenance or repair or that may require physical adjustment.

4. LFMC conduit may be used in pull vaults for connections between conduit penetrations and junction boxes inside the vault where space is limited.

G. EMT RACEWAY APPLICATIONS (REFERENCE DEFINITIONS)

1. Exposed conduits may be EMT in completely enclosed dry (see Definitions) rooms.

2. EMT conduits may be used in attics and where concealed in walls.

Exception to the use of EMT:

- *Where conduit is required to 100 percent continuous.*

3.2 RGS RACEWAY PROTECTIVE COATINGS

Protected RGS conduits are used to minimize conduit degradation from moisture and chemicals.

Where called in the Plans or Specifications as “Protected RGS,” “PVC-Coated RGS,” “PVC-Coated,” “PVC-RGS,” or “PVC-RMC,” all such conduits, elbows, and fittings shall be factory coated PVC as defined in Section 2.1.

A. PVC-COATED RGS CONDUIT APPLICATIONS

1. All portions of RGS elbows, bends, straight pipes, couplings, and fittings buried underground shall be PVC-Coated.

2. All portions of RGS elbows, bends, straight pipes, couplings, and fittings encased in concrete shall be PVC-Coated.

3. All portions of RGS elbows, bends, straight pipes, couplings, and fittings exposed outdoors shall be PVC-Coated.

4. All portions of RGS elbows, bends, straight pipes, couplings, and fittings inside underground vaults, pullboxes, wet wells, and dry wells shall be PVC-Coated.

5. All portions of RGS elbows, bends, straight pipes, couplings, and fittings exposed in Chemical Rooms (reference Definitions) shall be PVC-Coated.

6. All portions of RGS conduits penetrating concrete floors and below-ground walls and ceilings shall be PVC-Coated at least 12 inches into the exposed area and extending at least 24-inches underground.

Exceptions:

- *Where specifically noted to be otherwise in the Plans.*
- *Non-metallic conduits that terminate at the wall of a pullbox.*

3.3 JUNCTION AND DEVICE BOX APPLICATIONS

A. JUNCTION BOXES

1. Junction boxes for Instrumentation, Intrinsically Safe, and Non-Linear Power circuits (see Definitions) shall be hinged steel, 6" x 6" x 4" minimum.

2. Dry Areas (see Definitions).

   a. Flush-mounted junction boxes may be the standard type.

   b. Wall-mounted junction boxes shall be the NEMA 1 gasketed.

3. Wet Areas (see Definitions).

   a. NEMA 4X 316L stainless steel.

   Exceptions:

   - *Except in pullboxes, cast junction boxes shall be allowed for applications where three conduits or less approach from three different directions and no terminations are made inside the junction box.*
   - *Unless called out otherwise on the Plans*

4. Hazardous Areas (see Definitions).

a. Junction boxes shall be explosion-proof, dust and ignition-proof, raintight, rated for Class I, Division 1 & 2, Group C, d environments and shall conform to NEC Articles 500 through 517 (reference Section 2.5.A).

B. DEVICE BOXES, ACTUATORS, AND COVERS

All exposed boxes shall be of cast construction.

All aluminum and cast iron covers shall be provided with a weatherproof gasket.

1. Outdoors, In Pullboxes, In Equipment Vaults

a. Receptacles

Cast iron device box body with cast aluminum gasketed cover and top-opening "in-service" cover.

Exception:

- *Cast aluminum device box bodies may be used if specifically called out on the Plans or approved by the Engineer.*

b. Light Switches

Cast iron device box body with cast iron gasketed cover and lever-arm actuator.

Exception:

- *Cast aluminum device box bodies with gasketed die cast aluminum covers and lever arm actuators may be used if specifically called out on the Plans or approved by the Engineer.*

2. Indoor, Wet Areas (see Definitions).

Flush-mounted (recessed) junction boxes may be the standard metal type.

These boxes will usually be mounted in wood or steel stud framed walls with gypsum plasterboard or similar surfacing cover. Boxes mounted in Concrete Masonry Unit (Block) walls shall be Masonry type boxes.

a. Receptacles

i. Recessed (flush-mount) – standard device box body with gasketed die cast aluminum, snap-action, weatherproof cover.

ii. Surface-mounted – cast aluminum device box body with gasketed die cast aluminum, snap-action, weatherproof cover.

b. Light Switches

i. Recessed (flush-mount) – standard device box body with gasketed cast aluminum switch cover.

ii. Surface-mounted – die cast aluminum device box body with gasketed cast aluminum switch cover.

3. Indoor, Dry Areas (See Definitions)

a. Receptacles

i. Recessed (flush-mount) – standard device box body with plastic cover.

ii. Surface-mounted – cast aluminum device box body with plastic cover.

b. Light Switches

i. Recessed (flush-mount) – standard device box body with plastic switch cover.

ii. Surface-mounted – cast aluminum device box body with plastic switch cover.

4. Hazardous Areas (see Definitions).

a. Explosion proof.

3.4 PULLBOX AND HANDHOLE APPLICATIONS

A. PULLBOXES

Pullboxes shall be provided as shown on the Plans and as required by the Utility Companies.

1. Pullboxes shall be 6' x 6' x 4' deep minimum.

   Exceptions:

   - *Pullboxes with less than 2 TYPE J1, TYPE J2,or TYPE J3 junction boxes (reference Definitions) shall be allowed to be 4' x 4' x 4' minimum.*
   - *Unless specifically called out otherwise on the Plans.*
   - *Unless called out otherwise by a Utility Company.*

2. Pullboxes shall be provided with metal H30 hatch lids.

   Exceptions:

   - *If pullboxes are located where only light load vehicular traffic is present, then the hatch lids shall be rated at H25.*
   - *If pullboxes are located where no vehicular load traffic is present, then the hatch lids shall be rated at H20.*

3. Pullbox lids shall be cast, engraved, or otherwise permanently marked with the legend “ELECTRICAL.”

B. HANDHOLES

Handholes are used as pull and splice points in underground installations and are typically installed in driveways, parking lots, and off-roadway applications subject to occasional non-deliberate heavy vehicular traffic.

1. Handholes shall be set adjacent to each pole light pedestal.

   Exception:

   - *Unless specifically shown or called out otherwise on the Plans.*

PART 4 EXECUTION

4.1 EXAMINATION

Examine surfaces and spaces to receive raceways, boxes, for compliance with installation tolerances and other conditions affecting performance of raceway installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

4.2 INSTALLATION, GENERAL

A. COORDINATION WITH OTHER WORK

Wherever practical, route conduit with adjacent ductwork or piping.

1. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes or other heat sources operating at temperatures above 100 degrees F.

2. When installing utility conduits, comply with the spacing and depth requirements of the utilities.

3. Non-electrical buried piping has routing priority over electrical burials.

B. MOUNTING PRACTICES

1. All conduits in process areas shall be surface mounted unless specifically called out otherwise on the Plans.

2. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions.

3. Where several conduits follow a common route, stagger pull boxes, junction boxes, pulling sleeves, and fittings.

C. DEVICE BOX INSTALLATION

1. Coordinate box locations with building surfaces and finishes to avoid bridging wainscots, joints, finish changes, etc.

2. Recess boxes in the wall, floor, and ceiling surfaces in finished areas. Set boxes plumb, level, square and flush with finished building surfaces within 1/16 of an inch for each condition. Set

boxes so that box openings in building surfaces are within 1/8 of an inch of edge of material cut-out and fill tight to box with building materials. Back boxes with structural material to prevent rotation on studs or joists. Use gang boxes wherever more than one device is used at one location.

3. Surface mount boxes to building structures with a minimum of 1/4-inch spacing and with a minimum of two fasteners. Provide attachments to withstand an additional force of 100 pounds applied vertically or horizontally.

4. Set recessed boxes at the following heights to the bottom of the box, except where noted otherwise in the Plan Set:

    a. Convenience outlet receptacles in finished areas at 18 inches above floor.

    b. Lighting switches, dimmers, etc., at 42 inches above floor.

    c. Wall mounted telephones at 60 inches above floor.

    d. Boxes for outlets on cabinets, countertops, shelves, and above countertops at 2 inches above the finished surface or 2 inches above the back splash. Verify size, style, and location with the supplier or installer of these items before installation.

5. Set surface-mounted receptacle and lighting boxes in wet areas 42 inches above the finished floor to the center of the box, unless called out otherwise in the Plan Set.

6. Set surface-mounted boxes for lighting switches within 12 inches of the door opening on the strike or lock side of the door or on the side closing last unless indicated otherwise in the Plan Set.

7. Arrange boxes used in wet areas to drain moisture away from devices or enclosures for equipment and make conduit connections from below.

8. Set floor boxes level and adjust to finished floor surface.

D. CONDUIT INSTALLATION

Install conduit as a complete and continuous system without wires. Mechanically secure to boxes, fittings, and equipment. Electrically connect conduits to all metal boxes, fittings, and equipment.

1. All field or manufactured ferrous metal threaded connections of conduits and fittings shall be installed with a coating of electrically conductive, corrosion resistant, copper colloidal compound such as "Shamrock Kopr-Shield™ Compound" or equivalent.

2. Keep conduits clean and dry. Close each exposed end.

3. Properly ground each metallic box, cover, lid, hatch, conduit, etc., in compliance with the National Electrical Code and Specification Section 16060.

4. When blowing through conduits, cover electrical components installed in enclosures to avoid blowing dirt, shavings, or moisture into equipment.

5. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel, monofilament plastic line, or woven polyester pull line with not less than 200-lb tensile strength. Leave at least 8 inches of slack at each end of the pull wire.

6. Install exposed raceways in lines parallel or perpendicular to the building or structural member's lines except if structure is not level then follow the surface contours as much as practical. Do not crossover or use offsets if they can be avoided by installing the raceway in a different routing.

7. Run parallel or banked conduits together, on common supports where practical.

8. Make bends in parallel or banked runs concentric (common radius point, expanding radius). Use factory elbows only where elbows can be installed concentrically; otherwise, provide field bends for parallel raceways.

9. Select surface raceway outlet boxes to which lighting fixtures are attached of sufficient diameter to provide a seat for the fixture canopy.

10. Provide surface metal raceway outlet box and the backplate and canopy at the feed-in location of each end-stem suspension fluorescent lighting fixture.

11. Labeling

With the exception of conduits supplying power to lighting and convenience receptacles, all conduits shall be labeled in the following manner.

a. Conduits shall be labeled at each entrance and exit of a raceway, box, and device. Labels shall be placed no more than 3 inches from the relevant entrance or exit and shall be positioned in a manner where they can best be read by technicians and maintenance personnel.

Exception:

- *Only one label shall be required for conduits less than 6 feet in length where the entire conduit can be seen from a single point.*

b. The labels used shall be permanent items manufactured specifically for tagging conduits in direct sunlight and wet environments.

c. The conduit label shall be the full conduit number as listed on the Cable and Conduit Schedule.

d. The conduit label shall be attached near the ends of conduit stub ups through floors and penetrations into vaults even if equipment is set over the conduit.

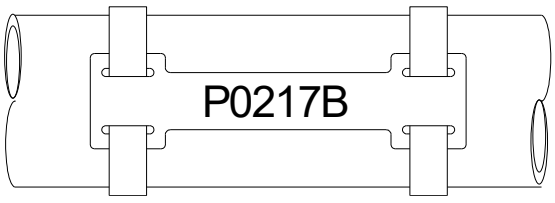


Figure 4.2.D.11

Example of a Conduit Label

E. RACEWAY TERMINATIONS AND CONNECTIONS

1. Join raceways with fittings designed and approved for the purpose and make joints tight.

2. Make connections waterproof and rustproof by application of a watertight, conductive thread compound. Clean threads of cutting oil before applying thread compound.

3. PVC–RMC Conduits

   Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.

4. Apply PVC adhesive by brush.

5. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.

6. Cut ends of conduit square with hand or power saw or pipe cutter. Ream cut ends to remove burrs and sharp ends. Make conduit threads cut in the field with the same effective length and same thread dimensions and taper as specified for factory-cut threads.

7. Flexible Connections

   Use maximum of 18 inches of flexible conduit for equipment subject to vibration, noise transmission, removal, or movement; and for all motors. Do not use flexible conduit in place of elbows, offsets, or fittings to attach to fixed equipment. Recessed and semi-recessed lighting fixtures may use up to 6 feet of flexible conduit, or 11 feet of premanufactured lighting "whips." Use LFMC in wet or damp locations. Do not strap flexible conduit to structures or other equipment.

8. Provide double locknuts and insulating bushings at conduit connections to boxes and cabinets. Align raceways to enter squarely and install locknuts with dished part against the box. Use grounding type bushings where connecting to concentric or eccentric knockouts.

Exception:

- *In wet areas, conduit entries that are made into the side or top of an enclosure shall be made using Myers hubs.*

9. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align raceways so the coupling is square to the box and tighten the chase nipple so no threads are exposed.

10. Support conduit connections to motors or other equipment independently of the motor or equipment. Raise or drop vertically to the nearest practicable point of connection to the unit. Run vertical drops to the floor and fasten with a floor flange. Unsupported drops are not permitted. Horizontal runs on the floor or on equipment are not permitted. Drop or raise at the appropriate closest location. Run conduit on equipment frames or supports to closely follow the contours of the equipment. Locate conduit to maintain access to all equipment services and adjustment points and so as not to interfere with operation of the equipment.

11. Connect conduit to hubless enclosures, cabinets, and boxes with double locknuts and with insulating type bushings. Use grounding type bushings where connecting to concentric or eccentric knockouts. Make conduit connections to enclosures at the closest point possible where the devices are located to which the circuits contained in the conduit will connect.

Exception:

- *In wet areas, connect to enclosures, boxes, and devices from the bottom side. In rare cases where bottom entry is not possible, side and top entries shall be made using Myer-type hubs.*

F. RACEWAY SUPPORT

Support raceways as specified in Section 16050.

1. Provide anchors, hangers, supports, clamps, etc., to support the raceways from the structures in or on which they are installed. Do not space supports further apart than 10 feet.

2. Provide sufficient clearance to allow conduit to be added to racks, hangers, etc., in the future.

3. Support raceway within 3 feet of every outlet box, junction box, panel, fitting, etc.

4. Support raceway and boxes in an approved manner by:

   a. Expansion shields in concrete or solid masonry;

   b. Toggle bolts on hollow masonry units;

   c. Wood screws on wood;

   d. Metal screws on metal.

5. Raceway in wet areas shall have clamp backs or other appropriate spacers to hold them a minimum of 1/2 inch off the surface. Horizontal runs on the roof surface shall be blocked at every 5 feet to hold them a minimum of 2 inches above roof surface.

G. INSTALLING PVC-COATED RGS CONDUITS

1. Follow the manufacturer's requirements and recommendations when installing PVC-Coated RGS conduits.

2. Seal the connections to protect the conduit.

3. Provide manufacturer's PVC repair compound where the thickness of the conduit coating has been reduced or damaged (from bending, threading, nicking, etc.)

H. BENDS AND OFFSETS

1. Fabricated bends and offsets shall be made with manufacturer-approved bending tools, by manufacturer-certified personnel.

2. Where possible, use standard elbows, conduit fittings, or junction boxes to avoid fabricated bends.

3. Make bends and offsets uniform and symmetrical. Make bends and offsets so that the inner diameter is not reduced. Use expanding plugs for bends in PVC conduit of 2-inch trade size or larger. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.

I. PENETRATIONS FOR RACEWAYS

1. Do not bore holes in floor and ceiling joists outside center third of member depth or within 2 feet of bearing points. Holes shall be 1-inch diameter maximum.

Exception:

- *Unless specifically approved by Structural Engineer.*

2. Penetrate through roofs with core drill hole 1/2 to 1 inch larger than conduit, flash with neoprene, caulk conduit in place and seal with silicone sealant under flashing. Sleeve roof opening where non-concrete roof construction occurs.

J. CONDUIT SEAL OFFS

Install raceway seal-off fittings according to manufacturer's written instructions. Locate fittings at suitable, approved, and accessible locations as per NEC Article 500 and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces.

Install raceway seal-off fittings in compliance to NFPA 70 and NFPA 820.

4.3 PULLBOXES

A. PULLBOX STRUCTURAL INSTALLATION

Strict compliance must be followed regarding the installation of conduits, conductors, junction boxes, and grounding inside pullboxes.

1. Install pullboxes outside of classified areas. Field verify measurements to assure compliance.

Exception:

- *Unless specifically called out otherwise in the Plans.*

B. PULLBOX CONDUIT, CONDUCTOR, JUNCTION BOX, AND GROUNDING INSTALLATION

The six types/categories of electrical circuits as defined in Section 3.1.B.1 shall be installed as described herein (reference Figure 4.3.B).

1. Installing circuits in conduits NOT Identified As 100 percent Continuous in Pullboxes

    a. Conduits NOT identified as 100 percent continuous shall terminate at the penetration into the pullbox with a PVC Schedule 40 bell-end.

    b. Cables and conductors shall be open-wire within the pullbox.

    c. Coil 2 wraps at 24 inches per wrap of each open wire. Bind the wraps with Ty-Rap® cable fasteners.

    d. Support open wires a minimum of 18 inches above the pullbox floor on 316L stainless supports mounted near the edges of the pullbox, leaving room in the center for safe entry, work, and exit. Secure wires with Ty-Rap® cable fasteners.

    e. Physically separate power and control circuits as much as possible.

    f. Plug the ends of all open conduits with a removable filler to minimize water entry into and out of the pullbox. Repair plugging after the movement of open wiring.

    g. Seal around all conduit penetrations with non-shrink grout.

2. Installing Conduits Identified As 100 Percent Continuous in Pullboxes

    a. All conduits identified as 100 percent continuous passing through, or terminating in, a pullbox shall terminate in a TYPE J1, TYPE J2, or TYPE J3 junction box for pulling purposes, termination, and rerouting.

b. Provide separate junction boxes for the types of circuits listed below. Under no circumstance shall these circuit types be combined in a common junction box.

   i. Non-linear power circuits (TYPE J1).

   ii. Intrinsically safe circuits (TYPE J2). Note: intrinsically safe instrumentation and control circuits may be combined in TYPE J2 junction boxes.

   iii. Instrumentation circuits, not intrinsically safe (TYPE J3).

c. All conduit entries into junction boxes shall be watertight. Conduit entries made into the side or top shall be made with Myer-type hubs.

d. All conduits shall be mounted and supported with 316L stainless steel hardware.

e. Conduit composition and protective coating shall be per Sections 3.1 and 3.2.

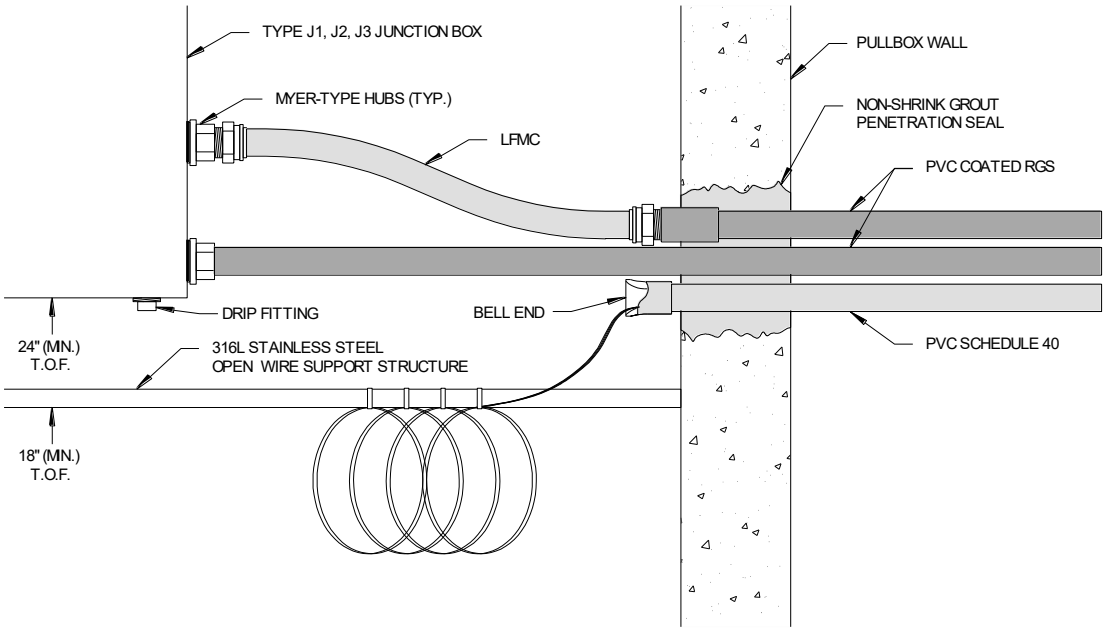


Figure 4.3.B

Typical Conduit Penetrations in Pullboxes

3. Installing Junction Boxes in Pullboxes

a. Junction boxes shall be NEMA 4X, 316L stainless steel, 18" x 18" x 6" (minimum) and shall comply with NEC 314.28(A)(1) and 314.28(A)(2).

b. Junction boxes shall be mounted with 316L stainless steel hardware at a height of 24 inches minimum from the bottom of the junction box to the floor of the pullbox.

c. Junction boxes shall be mounted on separate walls.

d. Junction boxes shall be provided with a water drip fitting mounted to the bottom of the box.

e. Coil 4 wraps at 12 inches per wrap of each cable and conductor in a junction box.

f. Splicing shall not be allowed in junctions boxes.

Exception:

- *Unless specifically called out otherwise in the Plans.*

4. Installing Grounding in Pullboxes

Reference Specification 16060.

4.4 EQUIPMENT VAULTS

A. EQUIPMENT VAULT INSTALLATION

Install vaults for underground raceway systems true to line and grade. Provide a compacted foundation of 3/8-inch minus crushed rock for the support of the vault. The minimum size for the foundation gravel base is 6 inches greater in each direction of the length and width of the vault and 6-inches deep. Ground vaults as per Section 16060-3.

B. EQUIPMENT VAULT CONDUIT INSTALLATION

Reference Figure 4.4.B.

1. All conduits entering an equipment vault shall terminate in a junction box.

   Exception:

   - *Unless specifically called out otherwise in the Plans.*

2. Conduit composition and protective coating shall be per Sections 3.1 and 3.2.

3. Conduits NOT identified as 100 percent continuous shall change from PVC to PVC-Coated RGS at least 24 inches before entering the equipment vault.

4. Conduits identified as 100 percent continuous shall terminate in a TYPE J1, TYPE J2, or TYPE J3 junction box.

   a. Provide separate junction boxes for the types of circuits listed below. Under no circumstance shall these circuit types be combined in a common junction box.

      i. Non-linear power circuits (TYPE J1).

      ii. Intrinsically safe circuits (TYPE J2). Note: intrinsically safe instrumentation and control circuits may be combined in TYPE J2 junction boxes.

      iii. Instrumentation circuits, not intrinsically safe (TYPE J3).

5. All conduit entries into junction boxes shall be watertight. Conduit entries made into the side or top shall be made with Myer-type hubs.

6. All conduits shall be mounted with 316L stainless steel hardware.

7. Conduits entering an equipment vault shall connect to the equipment through a wall-mounted junction box.

8. Conduits shall enter the vault below the junction box and connect to the box through a conduit "T" with a drain fitting as shown. Moisture from the conduit shall not be allowed to enter the junction box.

Exceptions:

- *Conduits in classified vaults shall be provided with a conduit seal-off fitting and may enter the vault at or above the junction box.*

- *Conduits in non-classified vaults may enter the vault at or above the height of a junction box if the conduit "T" with drain fitting is replaced with a conduit seal-off fitting. This fitting may be filled with a removable product but shall be properly filled to eliminate the possibility of the passage of water or water vapor.*

9. Seal around all conduit penetrations with non-shrink grout.

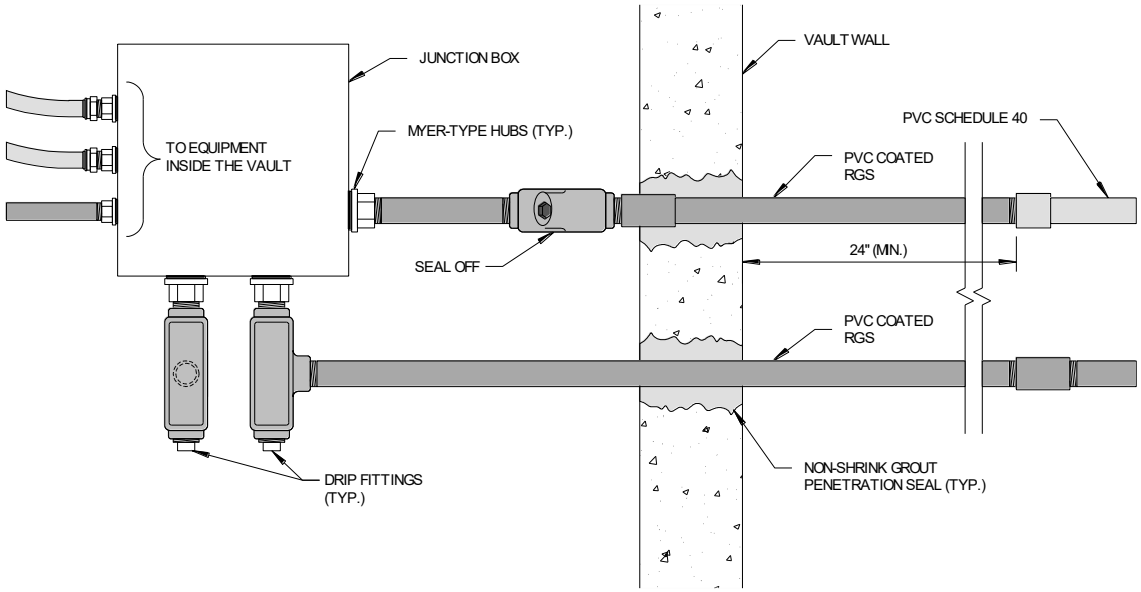


Figure 4.4.B

Typical Conduit Terminations in Equipment Vaults

C. EQUIPMENT VAULT JUNCTION BOX INSTALLATION

1. Junction boxes shall be NEMA 4X, 316L stainless steel, 12" x 12" x 6" (minimum) and shall comply with NEC 314.28(A)(1) and 314.28(A)(2).

2. Junction boxes shall be mounted with 316L stainless steel hardware at a height of 24 inches minimum from the bottom of the junction box to the floor of the vault.

3. Coil 4 wraps at 12 inches per wrap of each cable and conductor in a junction box.

D. EQUIPMENT VAULT GROUNDING INSTALLATION

Reference Specification 16060, Grounding and Bonding.

E. CONNECTIONS TO THE EQUIPMENT

1. LFMC conduit shall be provided from the wall to the equipment.

4.5 HANDHOLES

A. HANDHOLE INSTALLATION

Install handholes for underground raceway systems true to line and grade. Provide a compacted foundation of fine sand or 3/8 minus crushed rock for the bearing surface edges of the handholes.

The handholes shall be installed per the NEC sections 314, and other applicable sections of the NEC.

B. HANDHOLE CONDUIT INSTALLATION

1. End all conduits with a vertical riser.

2. Conduits NOT identified as 100 percent continuous shall be allowed to extend into the handhole as a PVC conduit. Provide a PVC bell-end in each conduit as shown in Figure 4.5.B.2. Provide a removable filler at the end of each conduit to eliminate the possibility of water entry.

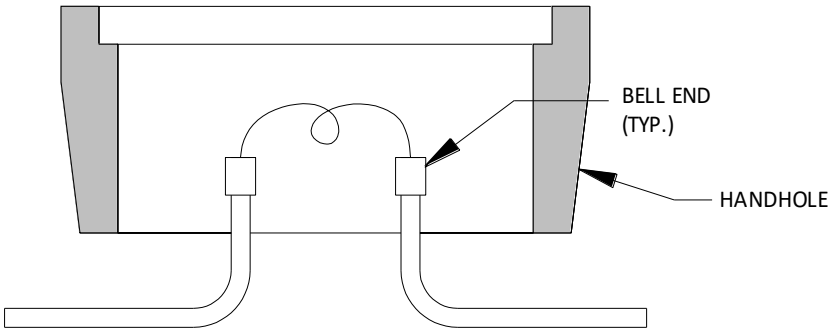


Figure 4.5.B.2

Typical PVC Conduit Terminations in a Handhole

3. Conduits identified as 100 percent continuous shall terminate into the bottom of a TYPE J1, TYPE J2, or TYPE J3 junction box, in PVC-Coated RGS conduit as shown in Figure 4.5.B.3. The door of the J-Box shall face upwards.

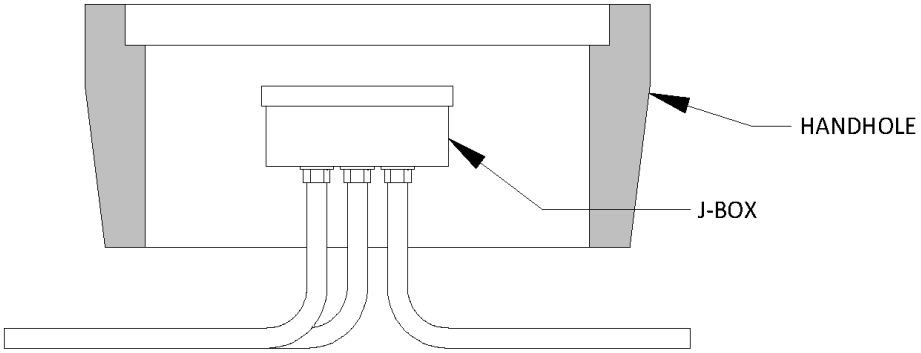


Figure 4.5.B.3

Typical 100 Percent Continuous Conduit Terminations in a Handhole

Exception:

- *Where a handhole contains only two conduits, and is being used solely as a pulling point, where one conduit is simply an extension of the other, a junction box may be replaced with a PVC-Coated RGS conduit pulling body.*

C. HANDHOLE GROUNDING

1. All handholes with metal conduits or with metal lids shall be grounded per Section 16060-3.

4.6 INSTALLATION OF CONDUITS UNDERGROUND AND IN CONCRETE

A. UNDERGROUND RACEWAYS

1. The minimum conduit depth shall be 24 inches.

   Exceptions:

   - *Electrical utility conduit depth shall be 36 inches.*
   - *Unless required otherwise by utility company.*
   - *Unless required to be shallower due to physical constraints (see requirements below).*
   - *Unless under a concrete slab (see requirements below).*
   - *Conduits contains a grounding electrode conductor shall be 30-inches deep.*

2. Conduits that require a buried depth of less than 18 inches shall require a 6-inch-thick concrete covering over that portion of such conduits. Such concrete covers need not be formed but shall be colored red or shall be painted red on top.

3. Conduits under a concrete slab-on-grade shall be separated from the slab and from the supporting soil by at least 3 inches with soft sand on all sides.

4. Provide separation of underground instrumentation conduits from power and control conduits by a minimum of 12 inches. Avoid parallel runs of instrumentation conduits with power and control conduits as much as possible. Where instrumentation conduits are required to crossover power or control conduits, maintain the 12-inch separation using depth and make the crossover as close to 90 degrees as possible.

   Exception:

   - *Provide 18 inches of separation between instrumentation conduits and non-linear power conduits.*

5. Run conduits as straight as practicable. Make changes in direction and/or grade of sufficient length to allow a gradual change (3-foot radius minimum). Make slight offsets with 5-degree couplings.

6. Run trenches true and clear of stones or soft spots. Place 4-inches of fine sand in the trench bottom and tamp into place. Provide preformed plastic spacers on top of sand spaced 5-feet on center.

   After the raceway is placed in the trench, backfill 6 inches with sand, then with native earth backfill passing a No. 8 sieve, free of stones. Do not tamp on top of the conduit until the final backfill is placed. Tamp or water-settle the final backfill to finish the grade. Compact the backfill as specified under Section 02300 "Site Earthwork."

7. Mark direct buried conduit by placing a red marking tape a minimum of 12 inches below grade during backfilling of the trench.

8. Seal conduit connections to eliminate leakage.

B. CONCRETE ENCASED RACEWAYS

Raceways encased in structural concrete must be defined in detail and presented to the Structural Engineer for approval at least 7 days prior to installation. As a minimum, approval will be based on the assurance that there will be no physical interference and that structural integrity will not be jeopardized.

1. In general, conduits encased in concrete may take the most direct route providing they do not jeopardize the structural integrity of the slab or interfere with process-related piping or equipment.

2. Conduits shall be at least 1-1/2 inches to the edge of a concrete body. If a structural block-out is desired for conduit bundling near the edge of a concrete body, then submit the desired layout to the Engineer for approval and design as defined in this Section.

3. Conduit density, crossover, and routing must be minimized and coordinated to assure that structural integrity is not jeopardized.

4. At the point-of-exposure out of the slab, conduits must be perpendicular to the slab surface from all angles.

5. No part of an elbow's bending radius shall be seen at the point-of-exposure from the slab.

C. CONDUITS IN ELEVATED SLABS

See “CONCRETE ENCASED RACEWAYS” above.

D. CONDUITS UNDER SLABS ON GRADE

1. No conduits will be encased in slabs less than 8 inches in depth.

2. For slabs-on-grade, all conduits larger than 3/4-inch trade size must be run underground below the slab.

3. All conduits desired to be installed within slabs on grade shall be submitted to the Engineer for approval and design as defined in this Section.

Exceptions:

- *Conduits shown on the Plans as being designed into slabs on grade do not require further Engineering approval.*

E. CONDUIT TRANSITIONS

Where raceway exits from grade or concrete, provide the following:

1. All conduits exiting grade or concrete shall be PVC-Coated RGS.

Exception:

- *Raceways used for the containment and protection of bare grounding electrode conductors shall be PVC Schedule 80. No portion of these conduits shall be metallic.*

2. For equipment to be moved into place at a later date, install a PVC-Coated RGS coupling flush with the floor slab. Insert a threaded flush plug into the coupling. Provide a pull wire looped backed into the conduit that can be reached after removal of the plug.

3. Only the straight portion of conduits shall exit grade or concrete. No curved portion of a factory or field-bent conduit shall be visible existing the penetration, even when covered or hidden by equipment.

F. CONDUIT STUB-UPS INTO EQUIPMENT AND ENCLOSURES

1. Where conduits are stubbed up into open bottom equipment and enclosures, extend the bottom of the conduit threads 1/2 inch above grade. Provide ground bushing and end fittings, flush with fitting and 2-inch stub, above the bottom of the enclosure. Stub conduits to a uniform height (plus or minus 1/8 of an inch) and align within plus or minus 1/4 inch.

   Exception:

   - *Conduits that do not meet the requirements of being 100 percent continuous, stubbing up directly under a Motor Control Center that is mounted on a housekeeping pad, shall be allowed to terminate as a PVC conduit with a bell-end.*

2. Locate stub-ups directly under the section gutter into which the conductors they contain are to be routed. Terminate conduit with insulating, grounding type bushing bonded to the ground bus of the equipment.

3. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends are not visible above the finished slab.

4. Unless otherwise noted on the Plans, spare conduits stubbing up through concrete floors and not adjacent to a wall shall be finished flush with floor with an RGS coupling. Provide an in-set metal plug (male thread) into coupling flush with floor.

5. Unless otherwise noted on the Plans, spare conduits stubbing up through concrete floors or grade, and adjacent to a wall or housekeeping pad shall extend 12 inches above slab/grade. The exterior edge of the conduit shall be a minimum of 1 inch from the wall/pad.

6. All stub-ups shall be provided with pull string.

7. Provide conduit labels on all stub-ups which are not flush mounted.

4.7 PROTECTION

Provide final protection and maintain conditions, in a manner acceptable to manufacturer and installer that ensures coatings, and finishes are without damage or deterioration at the time of Substantial Completion.

A. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

B. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

4.8 CLEANING

On completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

4.9 QUALITY CONTROL

A. TESTS

1. Conduits identified as meeting the requirements of 100 percent continuity shall be tested between source and destination as follows:

    a. Testing shall be performed using a Digital Voltmeter or Biddle ohmmeter.

    b. Testing values shall not exceed 5 ohms.

    c. If testing values exceed 5 ohms, then corrective action shall be taken to reduce the resistance to 5 ohms or below.

    d. These measurements shall be documented, signed, and submitted to the Engineer for approval.

***** END OF SECTION *****

SECTION 16140

WIRING DEVICES

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section includes the various types of receptacles, connectors, switches, and finish plates.

1.2 RELATED WORKS SPECIFIED ELSEWHERE

Section	Items
16050	Basic Electrical Materials and Methods
16130	Raceways and Boxes

1.3 SUBMITTALS

See Section 01300.

1.4 QUALITY ASSURANCE

See Section 16050.

1.5 COORDINATION

A. WIRING DEVICES FOR OWNER FURNISHED EQUIPMENT

Match devices to plug connectors for Owner-furnished equipment.

B. CORD AND PLUG SETS

Match cord and plug sets to equipment requirements.

1.6 DEFINITIONS

Reference Section 16050, “Definitions.”

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. AVAILABLE MANUFACTURERS

Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include the following:

1. Wiring Devices

    a. Arrow Hart Div., Cooper Industries.

    b. Bryant Electric, Inc.

    c. Hubbell Inc.

    d. Killark Electrical Mfg. Co.

    e. Leviton Mfg. Co., Inc.

    f. Pass & Seymour/Legrand.

2. Multi-Outlet Assemblies

    a. Wiremold Co.

2.2 WIRING DEVICES

Comply with NEMA Standard WD 1, "General Purpose Wiring Devices." Terminals shall be rated for 75 degrees C (min.).

A. ENCLOSURES

NEMA 1 equivalent, except as otherwise indicated.

B. COLOR

Ivory except as otherwise indicated or required by Code.

C. RECEPTACLES, STRAIGHT-BLADE AND LOCKING TYPE

Except as otherwise indicated, comply with Federal Specification W-C-596 and heavy-duty grade of UL Standard 498, "Electrical

Attachment Plugs and Receptacles." Provide NRTL labeling of devices to verify compliance.

1. General Purpose Convenience Outlets

    a. Duplex receptacle configuration

    b. Nylon face

    c. Staked screw terminals for line, neutral, and ground connections.

    d. Provisions for split bus

    e. NEMA 5-20R

2. Special Purpose Receptacles

    a. Staked screw terminals for line, neutral, and ground connections.

    b. NEMA configuration as indicated.

D. RECEPTACLES, STRAIGHT-BLADE, SPECIAL FEATURES

Comply with the basic requirements specified above for straight-blade receptacles of the class and type indicated, and with the following additional requirements:

1. Ground-Fault Circuit Interrupter (GFCI) Receptacles – Class A (5 mA) Personal Protection

    UL Standard 943, "Ground Fault Circuit Interrupters," with integral NEMA 5-20R duplex receptacle arranged to protect only the connected receptacle and no other receptacles connected on the same circuit. Design units for installation in a 2-3/4-inch-deep outlet box without an adapter.

2. USB Charging Receptacles

    UL Listed NEC Class 2 Power Supply integrated into NEMA 5-20R duplex receptacle. Power supply shall feature two USB Type A ports and shall comply with the USB Battery Charging Specification 1.2. Charging output shall be at least 1.5 Amps at each port simultaneously. Power supply shall be FCC Part 15

compliant. Units shall be suitable for installation in a 2-3/4-inch-deep outlet box without an adapter, and shall be compatible with standard GFCI-style faceplates. Leviton T5832 or equal.

E. RECEPTACLES, INDUSTRIAL HEAVY-DUTY

Conform to NEMA Standard PK 4 "Plugs, Receptacles, and Cable Connectors of the Pin and Sleeve Type for Industrial Use."

F. RECEPTACLES IN HAZARDOUS (CLASSIFIED) LOCATIONS

Comply with NEMA Standard FB 11 "Plugs, Receptacles, and Connectors of the Pin and Sleeve Type for Hazardous Locations" and UL Standard 1010 "Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations."

120 VAC, 1 PH, 20 A and less, receptacles used in Class I, Divisions 1 and 2 areas, shall be dead-front, delayed action, circuit breaking type, rated for use in Class I, Division 1 and 2, Groups B, C, and D areas. These receptacles shall be rated NEMA 3, 7BCD, 9FG, and 12 and shall be suitable for use in explosion proof, dust-ignition proof, and raintight applications. Receptacles shall be rated 20 A, 125 VAC with 3/4" hubs; Crouse-Hinds #ENR 21201 with ENP 5201 plug; Killark UGR2-20231 with UGP-20231QW plug, or equivalent.

G. CONVENIENCE RECEPTACLES IN WET LOCATIONS

Convenience receptacles in wet locations shall comply with NEC Article 406.9 and shall be 20 A, 125 VAC rated terminated with binding screws.

H. PENDANT CORD/CONNECTOR DEVICES

Matching, locking type, plug and plug receptacle body connector, NEMA L5-20P and L5-20R, heavy-duty grade.

1. Bodies

Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.

2. External Cable Grip

Woven wire mesh type made of high-strength galvanized-steel wire strand and matched to cable diameter and with attachment provision designed for the corresponding connector.

I. CORD AND PLUG SETS

Match voltage, current ratings, and number of conductors to requirements of the equipment being connected.

1. Cord

Rubber-insulated, stranded copper conductors, with type SOW-A jacket. Grounding conductor has green insulation. Ampacity is equipment rating plus 30 percent minimum.

2. Plug

Male configuration with nylon body and integral cable-clamping jaws. Match to cord and to receptacle type intended for connection.

J. SNAP SWITCHES

Quiet-type ac switches, NRTL listed and labeled as complying with UL Standard 20 “General Use Snap Switches,” and with Federal Specification W-S-896.

1. Lighting Switches

120/277 Vac only, rated 20 amperes.

2. Motor Rated Switches

Horsepower rated for application indicated.

K. OCCUPANCY SENSING LIGHT SWITCH

Provide occupancy sensing light switches in all office, lab, kitchen, break rooms, and restrooms.

1. Switches shall be 120/277 V, passive infrared/ultrasonic, commercial grade, white, with adjustable time delay of 30 seconds to 30 minutes, Leviton OSSMT-MDW or equal.

L. WALL PLATES

Single and combination types that mate and match with corresponding wiring devices. Features include the following:

1. Color

   Matches wiring device except as otherwise indicated.

2. Plate-Securing Screws

   Metal with heads colored to match plate finish.

3. Material for Interior Finished Spaces

   Lexan, except as otherwise indicated.

4. Material for Interior Unfinished Spaces: Galvanized steel.

5. Material for Laboratories: Stainless steel.

6. Material for Exterior or Wet Locations: Cast Aluminum.

2.3 MULTI-OUTLET ASSEMBLIES

A. Comply with Standard UL 5, “Surface Metal Raceways and Fittings.”

B. COMPONENTS OF ASSEMBLIES

Products of a single manufacturer designed to be used together to provide a complete matching assembly of raceways and receptacles.

C. RACEWAY MATERIAL

Metal, with manufacturer’s standard corrosion-resistant finish.

D. WIRE

No. 12 AWG.

PART 3 EXECUTION

3.1 INSTALLATION

A. IDENTIFICATION

Each receptacle, whether convenience, or dedicated, shall be labeled with the circuit from which its power is derived. Label as "CKT-XX" where XX = numerical circuit number.

1. Only one Panelboard servicing the site:

   Label as "CKT-XX" where XX = numerical circuit number within the Panelboard.

2. More than one Panelboard servicing the site:

   Label as "CKT XX-YY" where XX = Panelboard number and YY = numerical circuit number within the Panelboard.

   Example:
   A receptacle powered from circuit 03 of Panelboard [01 PB 02] would be labeled "CKT 02-03."

B. RECEPTACLE BOXES

1. Reference Section 16130 for box types.

2. Mounting Height

   a. Indoor, in DRY Areas

      Indoor receptacle boxes in DRY areas shall be mounted 12 inches above the floor unless shown otherwise on the Plans.

   b. Indoor, in WET Areas

      Indoor receptacle boxes in WET areas shall be mounted 42 inches above the floor unless shown otherwise on the Plans.

c. Outdoor

Outdoor receptacle boxes shall be mounted 18 inches above grade unless shown otherwise on the Plans.

3. Reference Section 16130 for box cover types.

C. CONVENIENCE RECEPTACLES

Convenience receptacles shall be 20 A, duplex, white, GFCI, straight blade, 3-wire, grounding, unless called out otherwise on the Plans.

In addition to any GFCI requirements, all receptacles, convenience or dedicated, located in break rooms and kitchens shall be AFCI.

D. DEDICATED RECEPTACLES

Dedicated receptacles shall be 20 A, simplex, gray, non-GFCI, straight blade, 3-wire, grounding, unless called out otherwise on the Plans.

In addition to any GFCI requirements, all receptacles, convenience or dedicated, located in break rooms and kitchens shall be AFCI.

Dedicated receptacles shall include a red phenolic placard with 3/8-inch lettering over the receptacle stating:

NON-GFCI RECEPTACLE
FOR (*specific device*)
NOT INTENDED FOR GENERAL USE

E. ARRANGEMENT OF DEVICES

Except as otherwise indicated, mount flush, with long dimension vertical, and grounding terminal of receptacles on bottom. Group adjacent switches under single, multigang wall plates.

1. See “Raceways and Boxes” Section for mounting height of devices.

2. Verify locations of outlets and switches in cabinetry with cabinet supplier and Owner prior to installation.

F. INSTALLATION PRACTICES

1. Install devices and assemblies plumb, level, flush and secure. Provide spacers on device screws to flush yokes or flanges to surface of wall within 1/16 of an inch where boxes are not flush with the wall surface. Install wiring devices such as receptacles to withstand 50 pounds force applied perpendicular to the device face with a maximum deflection of 1/16 of an inch.

2. Protect devices and assemblies during painting.

3. Use corrosion resistant devices in kitchen areas and outdoors.

4. Wiring connections shall be made by compression on the screw terminals. The wire shall be neatly and symmetrically wrapped around the screw a minimum of 180 degrees.

G. LIGHT SWITCH ORIENTATION

Install switches with the "off" position down. Install three and four way switches so the load is "off" when all switch handles are down.

H. TERMINATION PRACTICES

Connect phase, neutral, and grounding wires to devices with full loops around screws installed to tighten with tightening of the screw. Trim insulation to within 1/8 of an inch of screw terminal.

I. WALL PLATES

Install after painting is complete. Install with an alignment tolerance of 1/16 of an inch to plumb. Install at flush mounted devices so that all four edges are in continuous contact with finished wall surface without the use of mats or similar devices. Do not use plaster fillings.

3.2 GROUNDING

Connect receptacle or switch ground lug to device box for devices other than isolated ground type.

3.3 FIELD QUALITY CONTROL

Test wiring devices for proper connections, polarity, and ground continuity. Perform this testing with testing equipment designed for testing polarity and connections.

Operate each operable device at least six times.

Demonstrate charging the owner's electronic devices at each USB receptacle.

Test ground-fault circuit interrupter operation with local fault simulations, using a tester designed for such testing, and according to manufacturer recommendations. Testing with integral test switches on the receptacle is not sufficient for this testing.

Replace damaged or defective components, and retest.

***** END OF SECTION *****

SECTION 16210

ELECTRICAL UTILITY SERVICES

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section consists of electrical service and connection to the commercial power utility system (Power Company) and the work required in conjunction with the Power Company for their revenue metering. For this project the Power Company is **Penninsula Light Co.**

1.2 RELATED WORKS SPECIFIED ELSEWHERE

Section	Items
01500	Temporary Facilities
16050	Basic Electrical Materials and Methods
16060	Grounding and Bonding
16120	Conductors and Cables
16130	Raceway and Boxes

PART 2 PRODUCTS

2.1 MATERIALS

A. Primary circuit to utility transformer, including vaults conduit, primary cable and utility transformer: provided by the Power Company.

B. Current transformer and revenue metering: provided by the Power Company.

C. Meter socket, current transformer enclosure, and connecting conduit: provided by the Contractor.

PART 3 EXECUTION

3.1 APPLICATION

The Contractor shall make application for service to the Power Company on the Owners behalf. A lump sum bid item has been added to the bid proposal for purposes of bid evaluation. Contractor shall be paid the actual invoice cost from the Power Company.

Coordinate with the Power Company to ensure that their metering and service requirements are met.

A. The Contractor is responsible for any work necessary to place the service in operation as a complete installation. Provide any materials required and do any work necessary that is not provided or completed by the Power Company.

B. Pay any service charges or construction fees required for the electrical services to the Project.

C. Provide excavation and backfill for the Power Company's circuits and vaults. Locate the trench for such circuits as directed by the utility.

D. Provide excavation, for vaults and conduits, to utility requirements.

3.2 INSTALLATION

A. The Power Company will:

1. Install the revenue meter.

2. Install the primary conductors, conduits, and utility transformer.

B. The Contractor is responsible to provide and/or install the following:

1. Excavation for vaults/junction boxes and trench associated with the Primary circuit.

2. Meter base and current transformer (CT) enclosure.

3. Secondary conductors from the utility transformer to the service disconnect.

***** END OF SECTION *****

SECTION 16230

GENERATOR ASSEMBLIES

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section consists of a packaged diesel engine generator set [01 GEN 01] with accessories as specified herein.

1.2 RELATED WORK SPECIFIED ELSEWHERE

Section	Item
01300	Submittals
01550	Generator Engine Exhaust System
16050	Basic Electrical Materials and Methods
16060	Grounding and Bonding
16410	Enclosed Switches and Circuit Breakers

1.3 DEFINITIONS

A. FULL LOAD

The generator delivering 100 percent of its rated output power.

B. MAXIMUM FREQUENCY DIP AND PEAK

The maximum allowable frequency deviation, in percent, below and above the generator's specified output frequency during application-specific starting and stopping steps as specified in 1.5.

Example: A 10 percent MAXIMUM FREQUENCY DIP AND PEAK on a 480 Vac, 3 PH, 60 Hz generator equates to ±10 percent (±6 Hz) maximum deviation from 60 Hz, or 54 Hz absolute minimum to 66 Hz absolute maximum frequency limits during the worse-case specified step changes while either loading or unloading.

C. MAXIMUM FREQUENCY RECOVERY TIME PERIOD

The maximum period of time, in seconds, for the frequency to recover back to its specified steady-state operating band following load transitions from no load to full load or from full load no load.

Example: A 5 second MAXIMUM VOLTAGE RECOVERY TIME PERIOD requires that the generator repeatedly recover from full load added or removed load steps within 5 seconds maximum. This means that during a full load transition, in either direction, the generator frequency may deviate from its specified steady-state operating band for a maximum of 5 seconds before it has fully recovered back to its specified steady-state operating band.

D. MAXIMUM STEADY-STATE FREQUENCY OPERATING BAND

The maximum allowable frequency deviation, in percent, below and above the generator's specified operating frequency during steady-state operating conditions at any load between no load and full load.

Example: 0.5 percent MAXIMUM STEADY-STATE FREQUENCY OPERATING BAND on a 480 Vac, 3 PH, 60 Hz generator equates to ±0.5 percent (±0.3 Hz) maximum deviation from 60 Hz, or 59.7 Hz absolute minimum to 60.3 Hz absolute maximum frequency limits at any stable operating load from no load to full load.

E. MAXIMUM VOLTAGE DIP AND PEAK

The maximum allowable voltage deviation, in percent, below and above the generator's specified output voltage during application-specific starting and stopping steps as specified in 1.5.

Example: 25 percent MAXIMUM VOLTAGE DIP AND PEAK on a 480 Vac, 3 PH, 60 Hz generator equates to ±25 percent (±120 Vac) maximum deviation from 480 Vac, or 360 Vac absolute minimum to 600 Vac absolute maximum voltage limits during the worse-case specified step changes while either loading or unloading.

F. MAXIMUM VOLTAGE RECOVERY TIME PERIOD

The maximum period of time, in seconds, for the voltage to recover back to its specified steady-state operating band following load transitions from no load to full load or from full load no load.

Example: A 5 second MAXIMUM VOLTAGE RECOVERY TIME PERIOD requires that the generator repeatedly recover from full load added or removed load steps within 5 seconds maximum. This means that during a full load transition, in

either direction, the generator voltage may deviate from its specified steady-state operating band for a maximum of 5 seconds before it has fully recovered back to its specified steady-state operating band.

G. MAXIMUM STEADY-STATE VOLTAGE OPERATING BAND

The maximum allowable voltage deviation, in percent, below and above the generator's specified operating voltage during steady-state operating conditions at any load between no load and full load.

Example: 2 percent MAXIMUM STEADY-STATE VOLTAGE OPERATING BAND on a 480 Vac, 3 PH, 60 Hz generator equates to ±2 percent (±9.6 Vac) maximum deviation from 480 Vac, or 470.4 Vac absolute minimum to 489.6 Vac absolute maximum voltage limits at any stable operating load from no load and full load.

H. NO LOAD

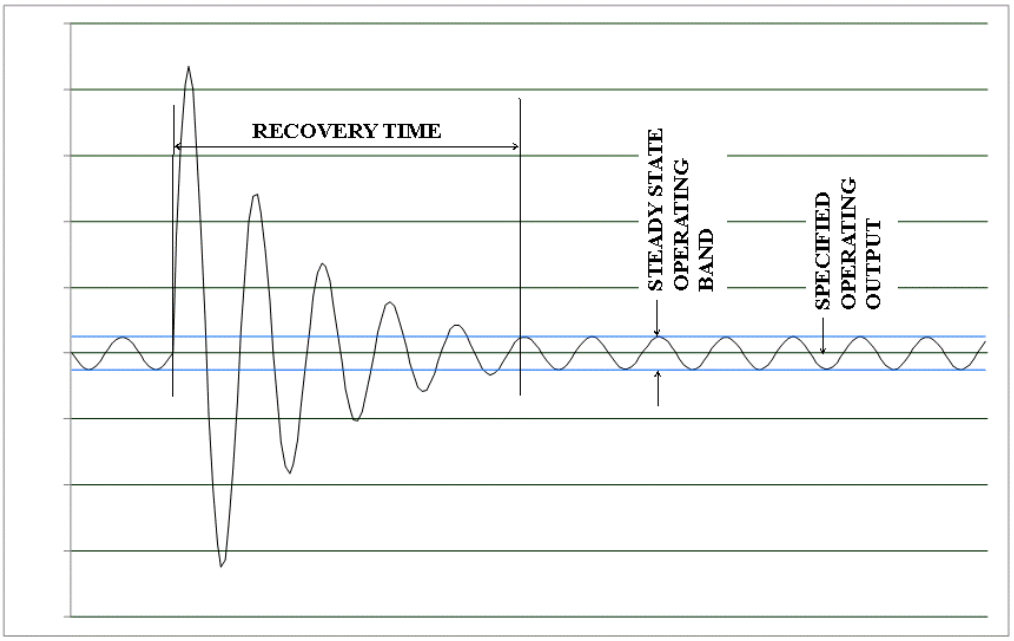
The generator delivering 0 percent of its rated output power.

I. STANDBY POWER OUTPUT RATING

The power output rating equal to the power the generator set delivers continuously under normally varying load factors for the duration of an electrical utility power outage. The power output rating is the gross electrical power output of the generator set minus the total power requirements of the electric motor driven cooling fan, water pump, and other auxiliary loads related to the generator set operations.

J. DEFINITIONS REFERENCE GRAPH

The following graph is a reference chart to better define the following terms "MAXIMUM VOLTAGE RECOVERY TIME PERIOD," "MAXIMUM STEADY-STATE VOLTAGE OPERATING BAND", "MAXIMUM FREQUENCY RECOVERY TIME PERIOD," and "MAXIMUM STEADY-STATE FREQUENCY OPERATING BAND." The Y axis can either be voltage or frequency and the X axis is time.



1.4 REFERENCES

A. The latest Washington State adopted, published edition of a reference shall be applicable.

B. All Washington State amendments adopted prior to the effective date of this Contract shall be applicable.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. National Fire Protection Association (NFPA)

   a. NFPA 30 Flammable and Combustible Liquids Code

   b. NFPA 37 Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines

   c. NFPA 70 National Electrical Code

   d. NFPA 110 Standard for Emergency and Standby Power Systems

e. NFPA 704 Hazardous Identification System

2. International Fire Code (IFC)

3. International Building Code (IBC)

4. National Electrical Manufacturers Association (NEMA)

a. NEMA MG 1: Motors and Generators

5. International Mechanical Code (IMC)

6. Underwriters Laboratory (UL)

a. UL 2200 Generator Engine Generator Assemblies

b. UL 142 Steel Aboveground tanks for Flammable and combustible Liquids.

1.5 PERFORMANCE REQUIREMENTS

A. Engineering calculations indicate a standby power output rating requirement of **100** kW at 80 percent power factor at **480/277** volts, 3 phase, 60 hertz while operating under the site conditions listed in Part 1.8 of this Section in an ambient temperature range of 0 to 104 degrees F at less than 90 percent rated capacity. The manufacturer shall calculate generator unit size according to the following bus rated loads and starting steps:

Step No./ Device No.	Device Description	Motor Code	Load Hp	Load kVA	Starter Type	No. of Pulses VFD only)
Step 1						
01 XFMR 01	Transformer, 480-208/120 V, 3 ph			25.0	28kVA	
01 XFMR 02	Transformer, 480-208/120 V, 3 ph			15.0	18kVA	
01 UV 01	UV bank			5.0	5.5kVA	
Step 2						
01 AB 01	Aeration Blower		5.0		VFD	6
01 MBS 01	Membrane Scour Blower No. 1		5.0		VFD	6
01 PMP 01	Permeate Pump No. 1		5.0		VFD	6
01 NPP 01	Non-pot Water Pump no. 1		3.0		VFD	
02 RDS 01	Rotary Drum Screen No. 1		1.0		VFD	

Step No./ Device No.	Device Description	Motor Code	Load Hp	Load kVA	Starter Type	No. of Pulses VFD only)
02 IP 01	Influent Pump No. 1		3.0		VFD	6
02 MXR 01	Anoxic Basin Mixer	K	3.0		FVNR	
02 RP 01	RAS Pump No. 1		3.0		VFD	6
Step 3						
01 WB 02	WAS Blower		7.5		VFD	6
01 MBS 02	Membrane Scour Blower No. 2		5.0		VFD	6
01 PMP 02	Permeate Pump No. 2		5.0		VFD	6
02 OCU 01	Odor control Unit	L	2.0		FVNR	
02 WC 01	Screenings Washing Compactor		2.0		VFD	
02 IP 02	Influent Pump No. 2		3.0		VFD	6
02 WP 01	Waste Sludge Pump	J	3.0		FVNR	
02 RP 02	RAS Pump No. 2		3.0		VFD	6

B. The Generator shall be suitable for operation with pulse width modulated variable frequency drives (connected as loads as shown on the Plans and operating motors throughout a speed range of 6 to 60 hertz) without detrimental effects on voltage or frequency regulation and stability.

C. MAXIMUM VOLTAGE DIP AND PEAK

Shall not exceed 25 percent.

D. MAXIMUM FREQUENCY DIP AND PEAK

Shall not exceed 10 percent.

E. MAXIMUM STEADY-STATE VOLTAGE OPERATING BAND

Shall not exceed 2 percent.

F. MAXIMUM STEADY-STATE FREQUENCY OPERATING BAND

Shall not exceed 0.5 percent.

G. MAXIMUM VOLTAGE RECOVERY TIME PERIOD

Shall not exceed 5 seconds.

H. MAXIMUM FREQUENCY RECOVERY TIME PERIOD

Shall not exceed 5 seconds.

I. ALTERNATOR OUTPUT WAVEFORM

At no load, harmonic content measured line-to-line or line-to-neutral does not exceed 5 percent total and 3 percent for single harmonics. The telephone influence factor, determined according to NEMA MG 1, does not exceed 50.

J. SUSTAINED SHORT-CIRCUIT CURRENT

For a 3-phase, bolted short circuit at the system output terminals, the system will supply 300 percent of rated full load current for not less than 10 seconds to coordinate circuit breaker tripping. This system shall include over-voltage relay protection to preclude damage to any generator system component.

K. TEMPERATURE RISE OF GENERATOR

Within limits permitted by NEMA MG 1, when operating continuously at full nameplate rating, the temperature rise of the generator shall not exceed 250 degrees F over 100 degrees F ambient.

L. STARTING TIME

The maximum allowable time period to cold start the generator, while operating at the low end of the specified temperature range, and have its voltage and frequency sufficiently stable for a transfer switch to accept or automatically initiate a power transfer, shall be 10 seconds.

1.6 SUBMITTALS

For each generator set submit under provisions of Section 01300 and as specified herein.

A. PRODUCT DATA

Provide the manufacturer and a full description of the generator set and associated components. Include features, ratings, and performance including, but not limited to:

1. Engine including the following:

    a. Horsepower at rated speed and load

    b. Emission Ratings

c. Lubrication oil capacity

2. Overall dimensions of generator set system including the sub-base fuel tank, and the enclosure.

3. Fuel consumption for 1/4, 1/2, 3/4, and full load of generator set

4. Electrical governor

5. Coolant heater

6. Alternator

   a. Electrical rating (kVA, reactance, time constants, temperature rise, etc.).

7. Voltage regulator type, make, model, and wiring diagram

8. Noise levels at twenty-three feet (7 meters) in a free field

9. Exhaust pipe and muffler sizing backpressure calculations

10. Warranty and Service Agreement documentation

11. Vibration isolation calculations, Plans and seismic certification from manufacturer per the seismic information listed in Part 1.8B of this Section.

12. Bill of Materials

13. Wiring Diagram

B. QUALITY ASSURANCE

Provide documentation showing all CD&Es (compliances, deviations, and exceptions) for this Specification.

C. GENERATOR SIZING CALCULATIONS

Submit calculations showing that the submitted generator's standby power output rating is capable of meeting the specified loads in the specified steps listed. The calculations shall show that the generator meets the specified performance requirements.

D. OPERATION AND MAINTENANCE MANUAL

1. Field Test Reports

Indicate and interpret test results for compliance with manufacturer's published standards for unit provided. Provide written approval of installation in accordance with all manufacturers' recommendations.

2. Operation and Maintenance Data

Provide information to be included in the operation and maintenance equipment manuals specified in Section 01300, Section 11000, and as specified herein.

3. Test Reports

The O&M manual shall include a copy of the factory test data and the field test report.

4. Service Agreement and Warranty

Include copies of the Service Agreement and Warranty in the Operation and Maintenance Manual.

1.7 QUALITY ASSURANCE

See Section 16050.

A. SOURCE LIMITATIONS

1. Obtain engine generator set from a single supplier with responsibility for the complete system. Furnish a new product built from components with proven reliability and compatibility. The generator set shall be coordinated to operate as a unit as evidenced by records of prototype testing by the OEM.

2. The warranty shall be supported by the original distributor, not offset to an engine manufacturer, an alternator manufacturer, or a new manufacturer's distributer.

3. The local representative for the generator manufacturer shall have the minimum qualifications and meet the minimum requirements:

   a. Shall have represented the product for a minimum of 5 years.

   b. Shall provide, on request, a reference list of five similar projects, no older than 2 years, with site contact information.

   c. Shall provide formal classroom training for service and maintenance of generators and transfer switches on a regular basis. The schedule and pricing for this training shall be available on request. The training shall be conducted in a location that is within a 1 day drive of the job site.

   d. Shall have a field service group, with no fewer than 10 qualified field service technicians, dedicated to generator repair and maintenance with dedicated service vehicles, parts, and tooling needed for general maintenance and common repairs.

   e. Shall have qualified field service technicians with a minimum of 2 years of generator field experience on the product being supplied and shall be factory trained and certified.

   f. Shall have qualified field service technicians with a current EL-07 Maintenance Electrician License as required by the Washington State Department of Labor and Industries.

   g. Shall have a warehouse of with sufficient parts located within 150 miles of the job site.

4. Only a factory direct or a first tier distributor shall be acceptable. Second tier dealers are not approved.

5. Only approved local distributors shall supply equipment provided under this contract. Equipment by non-local distributors shall not be accepted.

6. The distributor shall be the authorized engine distributor for the prime mover.

B. PRODUCT SELECTION FOR RESTRICTED SPACE

The site and building are designed around the approved generator sets. This includes sizing of fuel tanks, proper airflow, NEC clearance requirements, and access space. The Contractor, in concurrence with the Engineer, shall make all changes necessary required to meet the design requirements when submitting on an alternate generator at no additional cost to the Owner.

C. Generator set to be UL 2200 listed "Stationary Engine Generator Assemblies."

D. EMISSIONS

EPA certified for all current EPA emissions requirements.

E. FACTORY TEST

Test assembled generator set at the factory prior to shipment to the job site. The power factor for the factory test shall be at 0.8 p.f.

1. Show the following conditions at load and no load on the Generator Set: Charging System Volts, Voltage Output, Frequency, Coolant Temperature, and Oil Pressure, and other pertinent information on the test report. Provide a plot of the transient voltage and a plot of the frequency response versus time as a result of a full load single step.

2. Perform manufacturer's standard factory tests.

3. Test for a minimum of 30 minutes at full load per NFPA 110.

F. REGULATORY REQUIREMENTS

1. The NEC defines the following items:

    a. Article 700 – EMERGENCY SYSTEMS

    b. Article 701 – LEGALLY REQUIRED STANDBY SYSTEMS

    c. Article 702 – OPTIONAL STANDBY SYSTEMS

2. For this project the installation shall meet all requirements of an NEC 702 system. Generator shall be provided with all options and features required for installation as part of this system.

1.8 PROJECT/SITE CONDITIONS

A. ENVIRONMENTAL REQUIREMENTS

Engine generator system is designed, engineered, and rated to withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: Minus 5 degrees F to 122 degrees F.

2. Relative Humidity: 0 to 95 percent.

3. Elevation: Sea level to **500** feet.

B. SEISMIC REQUIREMENTS

The entire generator package including all mounted accessories shall comply with the requirements of the latest editions of 2021 IBC and of ASCE 7-16 Minimum Design Loads and Associated Criteria for Building and Other Structures, Chapter 13 "Seismic Design Requirements for Nonstructural Components," as referenced and amended by the IBC. Seismic design parameters are as follows:

1. Risk Category III, Seismic Design Category D.

2. Component Importance Factor: Ip = 1.0.

3. Design response acceleration parameters:

   a. S_{DS} = 0.959g

   b. S_{D1} = 0.617g

1.9 WARRANTY AND MAINTENANCE

A. WARRANTY

1. The manufacturer shall warrant the materials and workmanship of the generator set for a minimum of 5 years, or 2,500 hours from the registered commissioning and startup.

2. The warranty shall be comprehensive and shall include all components included in the generator package. No deductibles shall be allowed for travel time, service hours, repair part costs, etc., during the warranty period.

B. 2-YEAR MAINTENANCE SERVICE

Beginning at time of Substantial Completion, provide 24 months full maintenance service performed by qualified service technicians of the manufacturer's designated service organization. Include quarterly inspections to check for defects and operational abnormalities. Include routine preventive maintenance (oil changes, filter changes, belt adjustments, etc.) as recommended by the manufacturer and perform adjustments as required to bring the generator performance back into compliance with the original specifications. Provide OEM parts and supplies to complete all service to support all factory warranty requirements with written reports to the Owner upon completion of visits. No deductibles shall be allowed for travel time, service hours, repair part costs, etc., during the warranty period.

Provide a 2-hour load bank test on the generator at 11 months and 23 months from the time of Substantial Completion.

1.10 EXTRA MATERIALS

Reference Specification Section 16050 for spare parts.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. APPROVED MANUFACTURERS

1. Rehlko (formerly Kohler) as provided by Power Systems West.

2. Cummins Power Generation as provided by Cummins Northwest.

3. MTU as provided by Pacific Power Group.

4. Caterpillar as provided by NC Power Systems or Western States Equipment Company.

5. Generac as provided by Energy Systems.

2.2 ENGINE

A. FEATURES

1. Four-stroke cycle diesel engine of either vertical in-line or V-type suitable for operation on No. 2 diesel fuel.

2. Engine speed shall be governed by an electronic governor. Refer to frequency requirements specified earlier in this Specification.

B. COMPONENTS

1. Oil Pump

   Gear type lubricating oil pump for supplying oil under pressure to main bearings, crankpin bearings, pistons, piston pins, timing gears, camshaft bearings, and valve rocker mechanism.

2. Oil Filters

   Full flow oil filters conveniently located for servicing, with a spring-loaded bypass valve to ensure oil circulation.

3. Air Filter

   Dry type air filter.

4. Cooling System

   Sufficient to cool the engine when the generator set is delivering full rated load in an ambient temperature of 104 degrees F.

   a. Engine-driven, centrifugal-type water circulating pump.

   b. Thermostatic valve.

5. Coolant/ Jacket/ Block Heater

   As described in Part 2.6-B of this Section.

6. Electrical starters sufficient to start the engine within 10 seconds of call to start.

7. Batteries

   Lead acid batteries shall be of sufficient capacity to permit starting the generator engine a minimum of four times without recharging. Batteries are to be mounted in an earthquake- and drip-proof rack on the skid, frame, or other approved separate location with required connections provided.

8. Battery Heater

   As described in Part 2.6-B of this Section.

9. Battery Charger

   a. Silicone rectifier static type, self regulated with high current and full float operation with a filtered output.

   b. The charger shall be capable of providing a 10 A DC high current charging rate when the battery voltage is below the "float voltage set point." Full floating charging when voltage is above the set point.

   c. Battery charger operates from 120 volts, single phase AC connected to Generator Auxiliary Device Panel (GADP) as per Section 2.6.A.

   d. The charger shall be complete with automatic equalizing timer, and high/low battery voltage alarm.

   e. The battery charger shall be factory mounted with vibration isolators to prolong service life.

   f. Battery charger shall include standard NFPA outputs where generator is legally required for life safety.

10. Provide watertight flex connections for all conduits and piping attached to generator.

2.3 ALTERNATOR

A. Four pole, 1,800 rpm revolving field generator.

B. Enclosure shall be of drip-proof construction.

C. Insulation Class H.

D. Wiring shall be 12-lead, reconnectable, and configured for the specified voltage, phasing, neutral point, and frequency.

E. ALTERNATOR HEATER

As described in Part 2.6-B of this Section.

2.4 VOLTAGE REGULATOR

An electronic voltage regulator shall be provided.

2.5 CONTROL PANEL

The Control panel shall be of the rotatable dead-front type, vibration free mounted on the generator set. The generator control panel and the generator main circuit breaker shall be installed per NEC clearances and provide accessibility to equipment. The tops of control panels and the circuit breakers shall be mounted a maximum of 72 inches above the finished floor.

A. The control panel shall operate at 12 or 24 VDC from the generator/battery electrical system as required by manufacturer based on the size of the system.

B. Control panel shall include the following functions/devices:

1. Automatic Starting System

a. Provides three 15 second cranking cycles and two rest periods followed by a lockout and alarm.

b. Operation is initiated by the closing of a remote Form A contact in the automatic transfer switch control circuit.

2. Indicating light for alarm condition.

3. Indication for the following:

a. Running

b. Low coolant level

c. High coolant temperature

d. Low oil pressure

e. Over speed

f. Over crank

g. AC volts for each phase

h. AC current for each phase

i. Frequency

j. Lube oil pressure

k. Coolant temperature

l. Run Time

m. Number of Starts

4. Engine “AUTO-OFF-MANUAL” control selector switch.

5. Red colored emergency shutdown pushbutton/switch.

6. Time delay relay to permit operation at “NO-LOAD” after retransfer of load to normal source (cool down timer).

7. Automatic safety controls which shut down the engine on:

   a. Low lubricating oil pressure

   b. Low coolant level

   c. High jacket water temperature

   d. Engine over speed

8. Include a Form A (N.O. Dry) contact for remote connection for each of the following Generator functions.

   a. Running

   b. General Alarm

   c. Fail (shall include, as a minimum, any combination of conditions in 8 above)

d. AUTO-OFF-MANUAL control switch in Auto Mode

e. Low Battery Voltage

f. Low Oil Pressure

g. High Coolant Temperature

h. Low Fuel Level

i. High Fuel Level

j. Fuel Tank Leak

9. Control Cabinet Heater

As described in Part 2.6-B of this Section.

2.6 ACCESSORIES

A. GENERATOR AUXILIARY DEVICE PANEL

The generator manufacturer shall provide, install, and prewire a Generator Auxiliary Device Panel (GADP) as part of the generator system with the following minimum features:

1. The GADP shall consist of a NEMA 1 gasketed 240/120 VAC rated single phase load center with a main breaker and appropriately sized branch circuit breakers for the battery charger and the heaters listed below under GENERATOR HEATERS. Available power to 208/120 VAC, single phase.

Exception:

The GADP load center can be replaced with one or more 20 A, 4-plex receptacle sets in cast aluminum boxes under the following conditions:

a. The battery charger and all heater loads are 120 VAC, single phase,

b. The sum of the battery charger and all heater loads does not exceed 1920 VA (16 A),

c. All loads are prewired by the manufacturer with grounded plug cables,

d. The receptacles are placed within reach of all load plugs,

e. If required, multiple 4-plex receptacle sets are connected together by the manufacturer (provide a single electrical connection point for the Contractor).

2. For outdoor generators, the GADP shall be securely mounted within the enclosure in a location easily accessible by the operator and to a Contractor-provided power conduit.

3. The GADP shall be internally connected to the described loads by the generator manufacturer.

4. It is the intent that the Contractor need only provide a single power conduit and associated conductors to the manufacturer-provided GADP and terminate the conductors to a main circuit breaker, neutral, and ground. All connections for heater controls and devices shall be prewired and pretested by the manufacturer.

B. GENERATOR HEATERS

1. Alternator Heater

Thermostatically controlled alternator heater. Provide if shown in the table below.

2. Battery Heater

Thermostatically controlled battery heater. Provide if shown in the table below.

3. Control Cabinet Heater

Interior cabinet-mounted, thermostatically controlled heater. Provide if shown in the table below.

4. Coolant Heater

Engine mounted, thermostatically controlled immersion type engine coolant heater to ensure a minimum coolant temperature of 120 degrees F at ambient room temperature of 5 degrees F. Provide as shown in the table below.

5. Fuel Heater

Thermostatically controlled engine fuel heater. Provide if shown in the table below.

Provide the following generator set heaters:

Device	Voltage Configuration	Wattage (W)
Coolant Heater	208v, 1ph or 120v	~1,500

C. CIRCUIT BREAKERS

1. Provide an output main circuit breaker according to the plans and specifications section 16410. This breaker shall be lockable in its open position. The breaker shall have an auxiliary contact that is open when the breaker is in the open position. This circuit shall be prewired by the generator manufacturer to dedicated terminals in the generator control panel. Wire between these devices in LFMC conduit.

2. Provide a generator field protection circuit breaker, or other means to protect the alternator.

3. Provide a load bank circuit breaker according to the plans and that meets specification section 16410.

D. EMERGENCY STOP

Emergency disconnecting means shall:

1. Disable all prime mover start control circuits

2. Initiate a shutdown requiring a mechanical reset

3. Be lockable in the open/disabled position

4. Be readily accessible

5. Be clearly labeled “EMERGENCY GENERATOR SHUTDOWN”

E. DECALS, PLACARDS, AND SIGNS

1. The generator manufacturer shall provide all decals and signage as required by the regulatory and/or inspecting agency for the particular installation, including, but not limited to the following:

   a. One hazardous material placard, diamond shape, 4 color (red, white, blue, yellow) with numbers 020 (diesel, kerosene, fuel oil) in accordance with NFPA 704.

   b. A permanent sign at the fill point for the fuel tank. The sign shall include the filling procedure and tank calibration chart. The filling procedure shall require the person filling the tank to determine the gallons required to fill it to 90 percent of capacity before commencing the fill operation.

2. The Contractor shall provide the following in an easily viewable location on the fuel tank unless noted otherwise:

   a. One 3" x 12" decal labeled “Diesel” (black/white).

   b. At each entrance to the room, one 8" x 33" decal labeled “Danger Combustible Liquid” with white letters no less than 3 inches in height and 1/2 inch in stroke on a red background.

   c. At each entrance to the room one 3" x 12" decal labeled “No Smoking” (red/white).

F. VIBRATION ISOLATORS

1. Provide vibration isolators between the unit and the sub-base fuel tank. The isolation mountings shall consist of malleable cast iron top and bottom housings incorporating steel spring or elastomeric construction and shall be provided with built-in leveling bolts, elastomeric pad and built-in resilient chocks to control oscillation and withstand lateral forces in all directions. Isolators shall be presized and installed in accordance with the recommendations of the generator set manufacturer.

2. Vibration isolation efficiency shall be 96 percent at 1,800 rpm. Provide Korfund or equal.

3. Calculations shall be provided with the vibration isolation submittal demonstrating that the specified efficiency can be met with the project specific system characteristics.

4. Vibration isolators may be waved with manufacturer's documentation that the entire generator package including mounted accessories is IBC certified without them.

G. ANCHORS

Anchors used to secure the generator to the base or other stable surface shall be designed and sized by the manufacturer. Anchors shall be cast-in-place 316 stainless steel anchor bolts or drilled-in 316 stainless steel anchors set with epoxy adhesive. Expansion type anchors shall not be acceptable. The Contractor shall provide and install these anchors.

2.7 SUBBASE TANK

A. Provide dual wall UL 142 listed sub base tank sized to meet 24 hours runtime at full load or 270 gallons, whichever is greater. The external tank profile shall be "flat" within ±0.25 inches of vertical offset per 100 inches of horizontal length (±0.14 degrees maximum).

B. LEVEL SWITCH

Provide a liquid level float switches, Pneumercator LS600 or equal, assembly capable of the following:

1. High level alarm set at 90 percent tank capacity

2. Low level alarm set at 30 percent tank capacity

C. LEAK DETECTION SWITCH

Provide secondary containment leak detection. Provide Pneumercator LS600LD or equal.

D. OVERFILL PREVENTION VALVE

Provide an overfill prevention mechanical valve set to shut off fuel flow when the tank level reaches 95 percent tank capacity. The overfill prevention valve shall be sized and coordinated with the fuel tank manufacturer to fit the fill port. Provide Guillotine Inc., or equal.

E. DROP TUBE

Provide aluminum drop tube at the fuel fill, fuel return, and fuel supply ports. The drop tube with diffuser or suction strainer shall terminate a minimum of 6 inches from the bottom of the tank and shall be installed in a manner, which avoids excessive vibration.

F. FUEL FILL CONNECTION

Provide a 2-inch quick connect adapter and cap. Materials of construction shall be A36 carbon steel or aluminum meeting ASTM B221.

G. SPILL CONTAINER

Provide a 5-gallon spill container with a hinged, lockable cover and a manual drain valve into the primary tank. The spill container shall be of steel construction with a powder coated finish. The spill container shall be Morrison Bros. Fig. 516 or equal.

H. NORMAL VENT

Provide a 2-inch-diameter upward vent for normal atmospheric venting. The normal vent shall terminate outside, 12 feet above adjacent ground level. Vent piping shall be Schedule 40 Type S, Grade A steel pipe conforming to ASTM A53. The contractor shall provide all supports for the vent.

I. PRESSURE VACUUM VENT

A pressure/vacuum vent shall be installed at the top of the normal vent pipe, set at 1 oz per square inch. The body construction shall be Aluminum with stainless steel seat and poppet and the vacuum gasket shall be constructed of fuel resistant material. The pressure/vacuum vent shall be in accordance with NFPA 30. Provide Morrison Bros. Fig. 748 or equal.

J. EMERGENCY VENTS

Supply emergency vents for pressure relief only, Manufacturer shall size to prevent a pressure greater than 2.5 psi for the secondary containment tank and primary tank. The emergency vents shall terminate outside. Construction shall be aluminum with painted cast iron cover and Viton O-ring seat material; galvanized materials shall not be used. Mounting connection shall be male NPT. Vents shall be UL listed and in accordance with NFPA 30. Provide Morrison Bros. Fig. 244 or equal.

2.8 EXHAUST SYSTEM

A. Sufficiently sized to ensure against loss of power due to excessive backpressure in accordance with engine manufacturer's recommendations. Include a drain plug and drip leg in low point of exhaust piping to protect engine. Terminate exhaust piping with a rain cap.

B. The exhaust systems shall be mounted inside the enclosure.

C. Provide a stainless steel flexible exhaust connector, with an exhaust temperature test fitting, flanged for service disconnection.

D. Provide a critical grade silencer. Silencer construction shall be steel with high temperature paint or aluminized finish.

2.9 ENCLOSURE

A. ACOUSTICAL ENCLOSURE

The Generator shall be provided with a factory acoustical weather protective enclosure.

1. The enclosure shall reduce the sound pressure level of the generator set while operating at full rated load to an average of 72 dBA at any location 23 feet (7 meters) from the generator set in a free field environment.

2. The enclosure shall be constructed of minimum 12-gauge steel for framework and 14-gauge steel for panels. The enclosure shall have hinged access doors to maintain easy access for all operating and service functions. All hardware and hinges shall be stainless steel. All doors shall be lockable and include retainers to hold the door open during servicing. The roof shall be cambered to prevent the accumulation of water. The roof and walls shall be designed to withstand snow and wind loads per the IBC.

3. All sheet metal shall be primed for corrosion protection and finish painted with a color chosen by the Owner from the manufacturer's standard options.

4. The air intake and exhausts shall be sized to provide ample airflow for the generator set operation at rated load in ambient temperature of 100 degrees F.

2.10 FINISH

The entire standby generator set assembly with accessories is to be factory painted, color chosen by Owner from manufacturer's standard colors. Generator set manufacturer shall provide appropriate epoxy/polyurethane coating system for high heat conditions.

PART 3 EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

Deliver engine generator set and system components to their final locations in protective wrappings, containers, and other protection that will exclude dirt and moisture and prevent damage from construction operations. Remove protection only after equipment is safe from such hazards. Field repair of material or equipment made defective by improper storage or site construction damage by other trades may be cause for rejection of installation.

3.2 INSTALLATION

A. Install the complete generator set and accessories per the manufacturer's installation instructions.

1. Anchor the generator set to concrete housekeeping base or pad with high strength anchors and adequate penetration suitable for the Seismic Design Category as specified in the Plans.

2. Make all electrical connections between accessory items, which are not factory wired, prior to requesting the test engineer.

B. Maintain minimum workspace around unit and components per manufacturer's installation shop plans and NFPA 70 NEC.

C. Provide a complete fill of lubricating oil.

D. Provide a complete fill of fuel in diesel storage tank before testing.

E. Provide a complete fill of manufacturer approved antifreeze (ethylene-glycol) and water to protect the engine and heat exchanger cooling system to minus 25 degrees F.

F. Contractor shall locate generator control panel and the generator main circuit breaker per NEC clearances and provide accessibility to equipment. Neither shall be mounted more than 72 inches above the floor. Include all costs associated with relocating the standard control/service panel

arrangement on generator set to maintain code requirements in the Bid Cost.

G. The generator set shall not be started up or tested in the field until all exhaust piping has been insulated as specified and shown on the Plans. All intake and exhaust louvers and fuel system components shall be fully functional.

H. The emergency stop may be located remotely from the generator in a readily accessible location, or may be installed on the exterior of the generator enclosure. It shall not be installed within the generator enclosure, nor shall it be installed within the generator equipment room.

3.3 IDENTIFICATION

Identify field installed wiring, components, and provide warning signs as specified in Section 16050.

3.4 GROUNDING

Provide ground continuity to facility electrical ground system as indicated in the Plans and Specification 16060.

3.5 FIELD QUALITY CONTROL

A. Provide services of a factory authorized service representative to provide inspection results of field visit and field testing in writing.

B. TESTING AGENCY

Provide the services of a qualified independent testing agency to perform specified field quality-control testing.

C. TESTING

1. Prior to Energization

After installing disconnect switches and circuit breakers, perform visual and mechanical inspection of enclosure and devices.

2. Provide third party breakers testing per Specification 16050, Section 3.

Check connections and mounting for proper torque.

Correct or replace malfunctioning units and retest.

Remove any burrs, filings, or other foreign materials from enclosure. Completely wipe down and vacuum enclosure.

3. After Energization

After electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

Correct malfunctioning units on site where possible and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

D. FIELD TEST

Test the assembled generator set after installation at the job site is complete.

1. Advise the Engineer, the Integrator, the Contractor, the local Fire Prevention Inspector, and the Owner of the proposed time and date of the field test at least 2 weeks in advance so that the test may be witnessed if desired.

2. Under supervision of a factory authorized service representative, pretest all system functions, operations, and protective features. Provide all instruments and equipment required for tests. Adjust to ensure operation is according to specifications.

3. Fuel, lubricating oil, and antifreeze shall be checked for conformity to the manufacturer's recommendations and these specifications under the environmental conditions present and expected.

4. Accessories that normally function while the set is standing by shall be checked prior to cranking the engine. These shall include, but not be limited to: all electric heaters, battery charger(s), etc.

5. Cold Start Test

   a. The unit shall demonstrate the ability to start from a "cold" standby condition (i.e., normal standby mode with engine coolant temperature established by properly functioning water-jacket heater).

6. Calibration and PLC Signal Status Check

    a. Calibrate all sensors and instruments.

    b. Verify the scaling and connections of each signal to the PLC. Coordinate this work with the Integrator.

7. Generator Load Testing

8. Generator load testing shall be provided using a manufacturer-provided temporary load bank at 1.0 power factor. The generator shall be operated at 50 percent of full load rating for thirty minutes, followed seamlessly by thirty minutes at 80 percent of full load rating, followed seamlessly by one hour at 100 percent full load rating.

9. After the first 15 minutes at full load, the following shall be recorded at 15-minute intervals (four recordings).

    a. Voltage (phase to phase and phase to ground) and phase rotation

    b. Amperage (each phase)

    c. Frequency

    d. Fuel pressure, oil pressure, and water temperature

    e. Exhaust gas temperature at engine exhaust outlet

    f. Ambient temperature

    During the load test period, check for exhaust leaks, path of exhaust gases outside the building or enclosure, cooling air flow, movement during starting and stopping, vibration during 80 percent and 100 percent loading.

    A certified copy of the test results shall be given to the Engineer and supplied with the O&M manuals.

10. Subbase Fuel Tank Test

11. The following test shall be observed by the local Fire Prevention Inspector:

    a. Prior to any filling of combustible or flammable liquids the base tank shall be pressure tested per NFPA 30, Section 2.4.2. Include the test report in the O&M manuals.

    b. The fuel fill container shall be tested for proper operation.

12. The Contractor shall demonstrate the backup power system is fully functional by simulating power outages. Provide 14 days written notice.

    a. Coordinate phase rotation prior to transferring power.

    b. Power outages shall be simulated to the extent allowed by the process as determined by the Owner. Any process areas or loads not directly associated with the Contractor's scope of work, but connected to the generator being tested, will be turned on/off by the Owner.

    c. In the event that the installed generator assembly is unable to start and operate the specified loads, at a minimum:

        i. Document the generator's output voltage current, and frequency during the demonstration including the point of failure.

        ii. Provide written descriptions of the general conditions encountered during the demonstration and any field diagnostic actions performed.

        iii. Document the changes, if any, between the test conditions and the table provided in section 1.5 Performance Requirements

        iv. Provide recommendations to remedy the failed test.

13. Refill the generator tank after completion of field testing.

E. RETEST

Correct deficiencies identified by field tests and observations, and retest until specified requirements are fully met.

3.6 TRAINING

A. The manufacturer of the generator set shall conduct specifically organized training sessions covering operation and maintenance of the unit for personnel employed by the Owner. The training sessions shall be conducted to educate and train the personnel in maintenance and operation of all components of the unit. Training shall include, but not be limited to, the following:

1. Preventative maintenance procedures
2. Trouble-shooting
3. Calibration
4. Testing
5. Replacement of components
6. Automatic mode operation
7. Manual mode operation
8. Fuel and monitoring system
9. Spare parts that have been provided

B. At least one training session, at least 3 hours in duration, shall be conducted at the site after startup of the system. The manufacturer shall prepare and assemble specific instruction materials for each training session and shall supply such materials to the Owner at least 2 weeks prior to the time of the training.

3.7 FINAL ADJUSTMENTS

A. Adjust voltage and frequency output of generator set to nominal ratings and mark gauges with plastic pen for normal, operation references for Owner.

B. Adjust time response of control system to meet site performance requirements.

C. Check all remote connections again for proper tightness.

3.8 CLEANING

Upon completion of installation and startup, inspect engine generator set. Remove paint splatters, other spots, dirt, and debris. Perform touchup painting to cover scratches and marks to finish. Match original finish of generator set.

***** END OF SECTION *****

SECTION 16410

ENCLOSED SWITCHES, FUSES AND CIRCUIT BREAKERS

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section consists of individually mounted switches and circuit breakers used for the following:

A. Feeder and equipment disconnect switches

B. Feeder and branch-circuit protection

C. Motor safety disconnect switches

1.2 RELATED WORKS SPECIFIED ELSEWHERE

Sections	Item
01300	Submittals
16050	Basic Electrical Materials and Methods
16140	Wiring Devices

1.3 SUBMITTALS

Submit under the provisions of Section 01300.

Manufacturer's Product Data for disconnect switches, circuit breakers, and accessories specified in this Section.

Maintenance data for tripping devices to include in the operation and maintenance manual specified in Section 16050.

1.4 QUALITY ASSURANCE

See Section 16050.

Obtain disconnect switches and circuit breakers from one source and by a single manufacturer.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. AVAILABLE MANUFACTURERS

Subject to compliance with requirements, manufacturers offering disconnect switches and circuit breakers that may be incorporated into the work include the following:

1. General Electric Co.; Electrical Distribution and Control Division.

2. Siemens Energy & Automation, Inc.

3. Square D Co.

4. Eaton, Cutler Hammer.

2.2 DISCONNECT SWITCHES

A. MOTOR SAFETY DISCONNECT SWITCHES

Motor safety disconnect switches shall be provided when the motor starter is not in sight of the associated motor or when shown on the Plans. Motor safety disconnect switches shall be provided with the following specifications.

1. Separately Enclosed Knife Type Switches

   a. Switches shall not be fused unless specifically shown otherwise on the Plans.

   b. Switches shall include pad lockable handles, lockable in both the open and closed positions.

   c. Switches shall be rated at 600 V.

   d. Switches shall include two auxiliary contacts, rated at 10 A at 250 Vac each, connected to the switch pivot arm that are open when the switch is open, closed when the switch is closed.

   e. Switches shall be rated at motor horsepower or as per the Plans, whichever is the larger.

f. Switch enclosures shall be NEMA 4X stainless steel unless specifically stated otherwise in the Plans or through the approval of the Engineer.

2. Switches Incorporated into a Field Control Panel

a. Three Phase Switches, 15 HP and Smaller.

Switches shall be 2-position, OFF-ON, 90 degree, 600 VAC, 20 A, 32 A, or 40 A rating, 4-pole, front door installation; Allen Bradley 194L-E**aa**-1754 or equal,

where:

aa = 20 for motors less than 10 HP,
aa = 32 for a 10 hp, 460 VAC motor,
aa = 40 for a 15 hp, 460 VAC motor.

The 4th pole is reserved for switch position sensing.

Associated switch actuators shall be OFF-ON, 90 degree, front/door installation, IP66 rated, 22.5 mm central hole mount, square, grey/black handle with padlock provision, 64 mm x 64 mm; Allen Bradley 194L-HC6E-175I or equal.

b. Single Phase Switches.

Reference Specification 16940, Control Panels.

2.3 DISCONNECT PLUGS

A. MOTOR DISCONNECT PLUGS AND RECEPTACLES

Motor safety disconnect plug and receptacle shall be provided as shown on the Plans and shall be provided to the following specifications:

1. Plugs and receptacles shall be motor rated and UL 2682 listed.

2. Plugs and receptacles shall have an integral mechanism to ensure the load is broken before the plug can be removed.

3. Plugs and receptacles shall be rated at 600 V.

4. Receptacles shall have a dead front construction.

5. Plugs and receptacles must be able to close at least once on a conditional short-circuit current of 65,000 amps.

6. Plug and receptacle wire terminals shall be spring assisted to prevent loosening due to conductor yielding, shocks, vibrations, or thermal cycling.

7. Plug and receptacle shall be able to withstand ambient temperatures between -40 degrees C to +60 degrees C.

2.4 ENCLOSED CIRCUIT BREAKERS

A. ENCLOSED, MOLDED-CASE CIRCUIT BREAKER

NEMA AB 1, with lockable handle in both the open and closed positions.

B. CHARACTERISTICS

Frame size, trip rating, number of poles, and auxiliary devices as indicated on the Plans with interrupting rating to meet available fault current.

1. Main and feeder breakers shall be molded case breakers with thermal magnetic trip.

2. Motor circuit breakers shall be magnetic only trip with adjustable trip setting.

3. Branch circuit breakers shall be molded case, thermal-magnetic trip, trip-free with non-interchangeable, non-adjustable trip unless otherwise noted.

C. APPLICATION LISTING

Appropriate for application, including switching fluorescent lighting loads (SWD) or heating, air-conditioning, and refrigerating equipment (HACR).

D. CIRCUIT BREAKERS, 200 A AND LARGER

1. Trip units shall be interchangeable within frame size.

2. Provide trip units with separate field-adjustable settings of instantaneous trip, short-time trip, short-time delay, long-time trip, and long-time delay. Commonly known as an LSI breaker.

E. CIRCUIT BREAKERS, 400 A AND LARGER

The same features as 200A and larger, and adjustable ground fault pickup. Commonly known as an LSIG breaker.

F. MOLDED-CASE SWITCH

Where indicated, molded-case circuit breaker without trip units.

G. LUGS

Mechanical lugs and power-distribution connectors suitable for copper conductors of the number and size indicated.

H. SHUNT TRIP

Where indicated.

I. ACCESSORIES

As indicated.

NEMA AB 1, Type 4X stainless steel unless stated otherwise in the Plans.

2.5 ENCLOSED CIRCUIT BREAKERS

A. Reference Specification 16050 for spare parts.

PART 3 EXECUTION

3.1 COORDINATION OF ELECTRICAL PROTECTION DEVICES

A. The Contractor shall provide coordination of circuit breakers, fuses, and other associated protective devices.

1. For adjustable breakers, provide the values for continuous, short-time, instantaneous, ground fault, and other relevant trip and delay settings. Adjust breakers as per 3.4.

2. Provide to the Owner and Engineer calculations, plots, and overlays that clearly show proper coordination of protection circuits.

3.2 INSTALLATION

A. Install the disconnect switches and circuit breakers level and plumb in locations as indicated, according to manufacturer's written instructions.

B. Install wiring between disconnect switches, circuit breakers, control, and indication devices.

C. Connect disconnect switches and circuit breakers and components to wiring system and to ground as indicated and as instructed by manufacturer.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

D. Identify each disconnect switch and circuit breaker according to requirements specified in Section 16050.

3.3 FIELD QUALITY CONTROL

A. TESTING

1. Prior to Energization

After installing disconnect switches and circuit breakers, perform visual and mechanical inspection of enclosure and devices.

Provide third party breaker testing per Specification 16050, Section 3.

Check connections and mounting for proper torque.

Remove any burrs, filings, or other foreign materials from enclosure. Completely wipe down and vacuum enclosure.

2. After Energization

After electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

Correct malfunctioning units on site where possible and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

3.4 ADJUSTING

Set field-adjustable disconnect switches and circuit-breaker trip ranges as indicated.

Provide fuses for fused disconnect switches to coordinate with manufacturer's listed maximum fuse size for equipment supplied by the disconnect switch.

***** END OF SECTION *****

SECTION 16415

TRANSFER SWITCHES

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section consists of the following types of power transfer switches:

A. Automatic Transfer Switches.

1.2 RELATED WORKS SPECIFIED ELSEWHERE

Section	Item
01300	Submittals
01600	Materials and Equipment
01800	Testing, Commissioning, and Training
02300	Site Earthwork
Division 3	Concrete
09900	Painting
11000	Equipment General Provisions
Division 15	Mechanical
Division 16	Electrical
16120	Conductors and Cables
16130	Raceway and Boxes

1.3 DEFINITIONS

A. 2-POSITION

A 2-position ATS transfers immediately from one switch position to another. 2-position ATS can apply to both “Open Transition” and “Closed Transition” switches.

B. 3-POSITION, DELAYED TRANSFER

A 3-position “delayed transfer” ATS can be held in the “center” (no load connection) position for a programmable delayed period of time before completing its transfer to the calling position. Delayed transfer applies to transfers in either direction. Delayed transfers can only apply to “Open Transition” switches.

C. AUTOMATIC TRANSFER SWITCH

Automatic transfer switches shall be defined as power transfer switches used to automatically switch system power away from faulty utility service power to backup generator power then back again to utility power when valid utility power is reacquired.

Automatic transfer switches can be configured for automatic generator starting, waiting for generator stability, then transferring the system bus to the generator. They are also configurable for switching back to utility power under selectable conditions.

Automatic transfer switches can be set up for automatic generator testing and shutdown.

D. CLOSED TRANSITION

A "Closed Transition" ATS provides a "make-before-break" transition when performing automatic generator tests. To make this type of transition, the voltage, frequency, and phase shift between the power sources must be within specified and programmable tolerances. Typical tolerances are $\delta V <= \pm 5$ percent, $\delta f = \pm 0.2$ percent, and the phase shift between ±5 electrical degrees. This may take from several seconds to several minutes and is only used during system testing where transition delays are not critical. During power failures, the transitions are "break-before-make" like an open-transfer switch where time delays are minimal.

E. DELAYED TRANSFER

A "Delayed Transfer" ATS provides a programmable delay in the "neutral position." When in this mode, the load circuit is completely disconnected from both the normal and standby power sources. A delay in this position allows load circuits to dissipate electrical and mechanical energy before being re-energized.

F. NEUTRAL POSITION

The neutral position describes a position of the transfer switch when the load leads are connected to neither the normal nor the standby source. In this position, the load circuit is completely disconnected. This position should not be confused with the neutral bus or with neutral bus switching.

G. NON-AUTOMATIC TRANSFER SWITCH

Non-Automatic Transfer Switches are identical to ATS switches with the exception that they include a selector switch that allows manual transfer.

Non-Automatic Transfer Switches shall not be permitted.

H. MANUAL TRANSFER SWITCH

Manual transfer switches are double-throw switches with a center "OFF" position. Transfers are manually made by physically operating a switch handle to any one of three positions, "NORMAL," "OFF," "STANDBY."

I. NEUTRAL SWITCHING

In a neutral-switching ATS, the neutral load bus is switched between power source neutrals in the same manner as the power leads.

J. NORMAL POSITION

A switch is in its "NORMAL" position when it is connected to the primary (utility) power source.

K. OPEN TRANSITION

An "Open Transition" ATS provides a "break-before-make" transition under all transition conditions.

L. STANDBY POSITION

A switch is in its "STANDBY" position when it is connected to the secondary (generator) power source. This position may also be referred to as the back-up position.

M. TIME DELAY DEFINITIONS

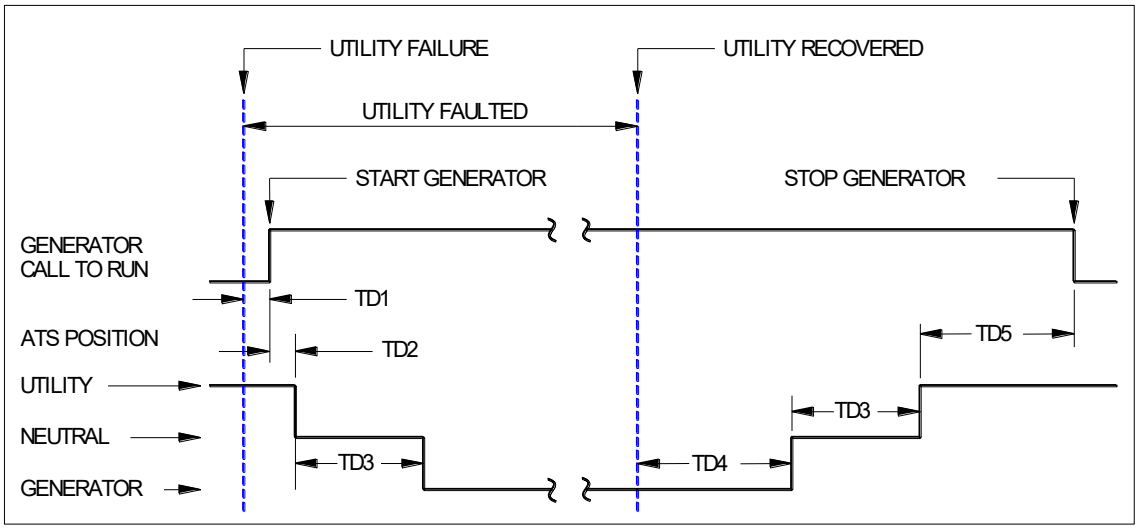
TD1 "Call Delay" is the delay from the ATS sensing faulty utility power and the issue of a generator call to run command.

TD2 "Off Utility Delay" is the delay from the ATS issuing a generator call to run command and the transfer of the ATS away from the "UTILITY" position.

TD3 "Hold Neutral Delay" is the period of time that the ATS will hold the switch in its "neutral" (or "center" or "disconnected") position when transferring from the "UTILITY" position to the "GENERATOR" position and from the "GENERATOR" back to the "UTILITY" position. In this neutral position, the load side of the ATS is disconnected from both utility and generator power. This delay allows the electronic equipment ample time to dissipate their residual power for proper reapplication of power flowing a shutdown. This delay only applies to 3-position delayed-transfer switches.

TD4 "Hold Generator Delay" is the delay of the ATS to switch back to utility power after the utility has been sensed as healthy.

TD5 "Cool-Down Delay" is the duration of generator runtime after the ATS has switched back to utility. This cool down period is intended to shut the generator off only after a relaxed cooling period.



3-POSITION SWITCH SIMPLIFIED TIMING DIAGRAM

N. UVTL

Utility Voltage Transition Level.

O. GVTL

Generator Voltage Transition Level.

1.4 SUBMITTALS

Submit four copies of the following:

A. Manufacturer's Product Data for transfer switches and accessories specified in this Section.

B. Manufacturer's Product Data for trapped-key interlocks and accessories specified in this Section, and documentation of compatibility with hardware specified under other Sections.

C. O&M Manual requirements are outlined in Section 01300 and shall also contain the following information:

1. Two-year maintenance service agreement as described below.

2. Screenshots and descriptions detailing how to step through the setup and configuration menus.

3. Field test results as described herein.

1.5 MAINTENANCE

A. ATS

Beginning at the time of Substantial Completion, provide a 24 months full maintenance service performed by skilled employees of the manufacturer's designated service organization. Provide OEM parts and supplies to complete all service to support all factory warranty requirements with written reports to the Owner upon completion of visits.

PART 2 PRODUCTS

2.1 MANUFACTURERS

Subject to compliance with requirements, provide products by the following:

A. TRANSFER SWITCHES

All automatic transfer switches shall be compatible with the selected genset.

1. General Electric Co.; Electrical Distribution & Control Div.

2. Eaton, Cutler-Hammer.

3. ASCO

4. Rehlko (formerly Kohler)

5. Cummins Power Generation/Onan

6. Square D

7. MTU

2.2 PROCUREMENT

A. The party responsible for the procurement of the automatic transfer switch shall be the single source of responsibility for submittal, products provided, warranty, startup and service purposes.

B. All automatic transfer switches shall be provided by the contractor that is supplying the generator set as defined in Specification 16230.

C. The generator and automatic transfer switches may be of different manufacturers.

2.3 AUTOMATIC TRANSFER SWITCHES

A. RATINGS

1. Phases: As shown on the Plans.

2. Poles: As shown on the Plans.

3. Voltage Rating: As shown on the Plans.

4. Current Rating: As shown on the Plans.

5. Fault Current Rating: As shown on the Plans.

6. Neutral: With neutral bus unless indicated otherwise on the Plans.

7. Enclosure: As shown on the Plans.

B. FEATURES

Reference “DEFINITIONS” in this specification.

1. UL 1008/CSA certification.

2. Open Transition

3. Delayed transfer (3-position) switch, capable of transferring the connected load from its “normal” power source to a “neutral” (disconnected) position for a programmable period of time, then from the “neutral” position to its “standby” power source, and capable of retransferring back to its "normal" power source with mirrored positions and delays.

   Delay settings:

Setting	Timing Function(1)	Initial Duration
TD1	Call Delay	1 second
TD2	Off Utility Delay	0 seconds
TD3	Hold Neutral Delay	30 seconds
TD4	Hold Generator Delay	30 minutes
TD5	Cool-Down Delay	5 minutes

(1) Reference “Time Delay Definitions”

4. Power switching shall be provided for all phases.

5. Power sensing shall be provided for all phases.

6. Switch transfer control sensing shall be provided on all phases.

7. Switching mechanism shall be a discrete purpose device specifically designed for Automatic Transfer Switches.

8. Electrically operated by solenoid mechanisms and held by mechanical latches.

9. High current-breaking capacity with silver-surfaced contacts equipped with arc barriers and magnetic blow-out coils.

10. Contacts rated in accordance with UL 1008 for current carrying and switching capabilities.

11. Suitable for repetitive load transfer switching. Minimum 1,000 transfer cycles under full load conditions and minimum 2,000 cycles under no load conditions.

12. Interlocked to prevent supplying the load from more than one source at a time.

13. Adjustable close differential voltage monitoring relays provided on all three phases to sense voltage on the "NORMAL" and "STANDBY" sources.

14. Auxiliary Contacts

    a. All auxiliary contacts shall be isolated, dry, Form C, suitable for 120V, 10A inductive loads, NEMA B10 rated, wired to easily-accessible terminals in the low voltage control area.

    b. Provide, as a minimum, the following status outputs:

        i. Switch in utility power position.

        ii. Switch in generator position.

        iii. Switch fault.

        iv. Generator call status. This status signal is one of two identical outputs. One can be directly connected to the generator to call a start operation. The second is electrically isolated from the generator connection and intended for connection to monitoring equipment.

15. Molded case breakers are not acceptable.

16. Intelligent display panel with push-button navigation switches. The display shall be clearly visible in both bright (sunlight) and no light conditions. The display panel shall be capable of providing the following functions and capabilities:

    a. Display source condition information, including AC voltage for each phase of normal source. Voltage for all three phases shall be displayed on a single screen for easy viewing of voltage balance. Line to neutral voltages shall be displayed for 4-wire systems.

b. Display source status, to indicate source is connected or not connected.

c. Display load data, including 3-phase AC voltage, 3-phase, frequency, kW, and kVA.

d. The display panel shall allow the operator to view and make the following adjustments in the control system, after entering an access code:

   i. Set nominal voltage and frequency for the transfer switch.

   ii. Adjust voltage and frequency sensor operation set points.

   iii. Set up time clock functions.

   iv. Set up load sequence functions.

   v. Enable or disable control functions in the transfer switch, including program transition.

   vi. Set up exercise and load test operation conditions, as well as normal system time delays for transfer time, time delay start, stop, transfer, and retransfer.

e. Display real time clock data, including date, and time in hours, minutes, and seconds. The real time clock shall incorporate provisions for automatic daylight saving time and leap year adjustments. The control shall also log total operating hours for the control system.

f. Display service history for the transfer switch. Display source connected hours, to indicate the total number of hours connected to each source. Display number of times transferred, and total number of times each source has failed.

g. Display fault history on the transfer switch, including condition, and date and time of fault. Faults to include controller checksum error, low controller DC voltage, ATS fail to close on transfer, ATS fail to close on retransfer,

battery charger malfunction, network battery voltage low, and network communications error.

C. OPERATION

1. When “normal” voltage falls below invalid UVTL, then

   a. The ATS starts the generator.

2. When the “standby” voltage is above valid GVTL, then

   a. After a programmable delay in the “normal” position, the switch transfers from the “normal” position to the “neutral” position.

   b. After a programmable delay in the “neutral” position, the switch transfers from the “neutral” position to the “standby” position.

3. When “normal” voltage is above valid UVTL, then

   a. After a programmable delay in the “standby” position, the switch transfers from the “standby” position to the “neutral” position.

   b. After a programmable delay in the “neutral” position, the switch transfers from the “neutral” position to the “normal” position.

   c. After the switch returns to the “normal” position, the transfer switch shuts off the generator after a programmable cool down delay.

4. Two separately adjustable time delays prevent transfer and retransfer on voltage dips.

5. Seven-day exercise timer provides periodic exercising of generator.

   a. Timer is programmable as to day of week, time of day, and duration for exercising.

   b. Programmable as to whether generator is exercised with or without load being transferred

6. Initially preset the UVTL at:

    a. Valid >= 90 percent nominal system voltage

    b. Invalid <= 80 percent nominal system voltage

    c. Relay will pull in at the “valid” level and drop out at the “invalid” level.

7. Initially preset the GVTL at:

    a. Valid >= 90 percent nominal system voltage

    b. Invalid <= 75 percent nominal system voltage

    c. Relay will pull in at the “valid” level and drop out at the “invalid” level.

8. Initially preset the utility and generator frequency transition levels at:

    a. Valid >= 95 percent of system frequency

    b. Invalid >= 90 percent of system frequency

PART 3 EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

Deliver transfer switch components to their final locations in protective wrappings, containers, and other means of protection that will exclude dirt and moisture and prevent damage from construction operations. Remove protection only after equipment is safe from such hazards. Field repair of material or equipment made defective by improper storage or site construction damage by other trades may be cause for rejection of installation.

3.2 INSTALLATION

A. Install transfer switch per the manufacturer’s installation instructions.

B. Maintain minimum workspace around unit and components per manufacturer’s installation shop drawings and NFPA 70 NEC.

3.3 IDENTIFICATION

Identify field-installed wiring, components, and provide warning signs as specified in Section 16050.

3.4 GROUNDING

Provide ground continuity to facility electrical ground system as indicated in the Contract Provisions.

3.5 FIELD QUALITY CONTROL

A. ADJUSTING AND PRETESTING

Pretest all system functions, operations, and protective features. Provide all instruments and equipment required for testing. Adjust the time delays, and trip point settings to ensure operation is within accordance to the specifications.

B. FIELD TEST

Test the transfer switch after installation is complete.

1. Advise the Engineer of the test date well in advance so that the test may be witnessed if desired.

2. Perform manufacturer's standard field tests.

3. Provide documented field test results to Owner and Engineer.

4. Provide trip set points and time delays in the O&M manual.

***** END OF SECTION *****

SECTION 16420

MOTOR CONTROLLERS

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section includes AC motor controllers rated 600 volts and less that are supplied as enclosed units within motor control centers or as individual units mounted in equipment specified under other sections.

1.2 RELATED WORK SPECIFIED ELSEWHERE

Section	Items
13451	Programmable Logic Controller (PLC) Programming
16050	Basic Electrical Materials and Methods
16120	Conductors and Cables
16410	Enclosed Switches, Fuses, and Circuit Breakers
16442	Motor Control Equipment
16910	PLC Hardware and Software Procurement
16940	Control Panels

1.3 DEFINITIONS

A. ANALOG AMMETER

A dial-type, d'Arsenval movement, analog meter measuring motor ampacity, either directly or indirectly from a current transformer connected to one of the motor leads.

B. COMPLETE COMBINATION STARTER

The terms STARTER, MOTOR STARTER, COMBINATION MOTOR STARTER, and COMBINATION STARTER are all equivalent to COMPLETE COMBINATION STARTER as described here.

A Complete Combination Starter consists of all power, control, and communication devices required to completely and safely operate a motor in HAND control. It consists of a lockable Overcurrent Protective Device (OCPD) such as a circuit breaker or a fused disconnect, a Power Module (RVSS, VFD, or Magnetic) for controlling/applying power to the motor, Motor Overload Protection (MOP) circuits, and other ancillary circuits for complete control and protection of the motor and starter power devices. It

includes an enclosure with operator interface control and monitoring devices.

C. FST (FIELD SERVICE TECHNICIAN)

A Field Service Technician (FST) is defined as a “hands-on” field representative qualified and authorized to perform technical start-up and trouble-shooting work on the manufacturer’s motor starters including drive programming and configuration.

D. FVNR (FULL VOLTAGE NON REVERSING) STARTER

FVNR starters operate motors in only one direction. These starters instantly apply full line voltage to the motor terminals through a contactor relay.

See MAGNETIC STARTER.

E. FVR (FULL VOLTAGE REVERSING) STARTER

FVR starters operate motors in both forward and reverse directions. These starters instantly apply full line voltage to the motor terminals through two separate (one forward and one reverse) contactor relays.

See MAGNETIC STARTER.

F. HIM (HUMAN INTERFACE MODULE)

HIM units are programmable human interfaces to RVSS and VFD drives and are used to configure the drive protection and control options. These devices are typically provided with programming/operating buttons and visual displays.

G. IGBT (Insulated Gate Bipolar Transistors)

IGBTs are embedded devices used to provide power switching in the DC-to-AC inverter section of VFD power modules.

H. MAGNETIC MOTOR STARTER

Because FVNR and FVR starters use an electromagnetic contactor relay to transfer power to the motor, these devices are a part of the MAGNETIC STARTER family of motor starters.

See FVNR, FVR.

I. POINT OF ANALYSIS

The Point of Analysis is a point indicated on the electrical one line diagram(s) where the contractor is responsible to comply with the Total Harmonic Current Distortion (THDC) limits of the IEEE-519, 2014 standard. By defining this point, the Engineer is providing all manufacturers a common point to calculate their THDC values.

The "available short circuit current" (I_{SC}) value required for IEEE-519 calculation shall be taken from the electrical one line diagram(s) of the Plans as the BOLTED FAULT CURRENT at the Point of Analysis.

The "average maximum demand current" (I_L) value required for IEEE-519 calculation shall be taken from the UTILITY LOAD DEMAND column of the LOAD SUMMARY table on the electrical one line diagram(s) of the Plans. Only loads "downstream" of the Point of Analysis shall be utilized in the calculation of I_L.

J. RAMP RATE, RVSS

The RVSS ramp rate is defined as the time, in seconds, for the RVSS to increase motor speed from zero to full speed or decrease motor speed from full speed to zero.

K. RAMP RATE, VFD

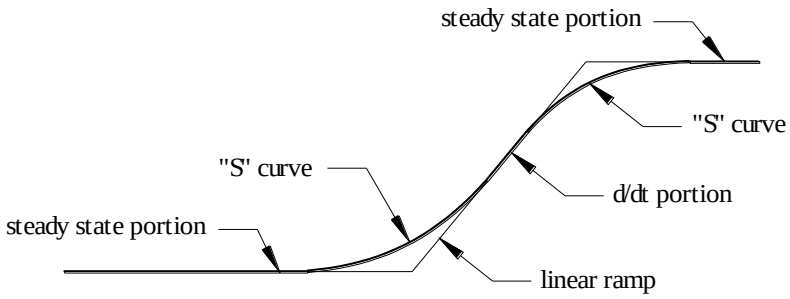
The VFD ramp rate is defined as the time, in seconds, for the VFD to increase its output frequency from 0 Hz to 60 Hz or decrease its output frequency from 60 Hz to 0 Hz.

L. SCRS (SILICON CONTROLLED RECTIFIERS)

SCRs are GE's trade name for a thyristor (a four-layer unidirectional switching device). SCRs are triggered by the application of a gate current and are shut off at a zero-voltage crossover.

M. "S" CURVES

A modified linear-ramp curve with rounded edges between portions of the curve that are changing (d/dt portions) and portions of the curve that are not changing (steady state).



N. THD (TOTAL HARMONIC DISTORTION)

THD is defined as the ratio of the sum of the levels of all harmonic components to the level of the fundamental frequency.

O. VFD

The VFD is the manufacturer's integrated power module package without additional starter components, and consists of an embedded AC-to-DC converter, a DC link, and a DC-to-AC inverter, associated inverter "firing" control circuitry, and a microprocessor for power circuit firing control and motor/module protection. It is one of the key components that make up a COMPLETE COMBINATION VFD STARTER.

1.4 SUBMITTALS

Do not submit motor starters under a separate 16420 submittal. Submit motor starters under the MCC submittal, 16442.

Submit under the provisions of Section 01300.

Submit a complete Bill of Materials (BOM) for each motor starter.

Submit drawings showing schematics for each motor starter. Schematics shall include all physical devices and connections of power and control circuits. Schematics shall include diagrams or descriptions clearly describing internal VFD logic where applicable. All devices on the schematics shall be tagged with their associated BOM number.

Submit drawings of door-mounted devices with associated BOM numbers.

Submit the name and phone number of the technical person that will be made available to the Engineer/Integrator for support of PLC networking to the manufacturer's networked devices.

Submit the name and phone number of the technical person that will be made available to the Engineer/Integrator for support of internal drive programming and configuration.

Submit Manufacturer's product data for motor controllers and accessories specified in this Section.

Submit maintenance data for tripping devices to include in the operation and maintenance manual specified in Section 16050.

Submit compiled load current and overload relay list after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

1.5 QUALITY ASSURANCE

See Section 16050.

1.6 COORDINATION

The Contractor shall acquire the full and complete nameplate data for each motor and document this data for insertion into the O&M Manual. This data shall be made available during FIELD TESTING AND COMMISSIONING work as described in Section 3.5.

Coordinate the sizing and settings of each starter's Overcurrent Protective Device (OCPD) and Motor Overload Protection (MOP) device with associated motor's nameplate data.

1.7 EXTRA MATERIALS

Reference Specification Section 16050 for spare parts.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. AVAILABLE MANUFACTURERS

Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include the following:

1. Allen-Bradley Co.; Industrial Control Group.

2. Eaton Corp.; Westinghouse & Cutler-Hammer Products.

3. Square-D.

When motor starters are integrated into Motor Control Centers (MCCs), the starters shall be fabricated, tested, and UL labeled by the MCC manufacturer.

2.2 PRODUCT SHIPMENT AND STORAGE

A. PRODUCT SHIPMENT

The motor starters shall be delivered to the project's System Integrator (reference specification 16940) for temporary connection and integrated testing with the site PLC prior to being delivered to the jobsite. This testing will be coordinated by the System Integrator and combined into a complete witness test of both the PLC and motor starter controls. All hardwire connections between the PLC(s) and the motor starters shall be tested during the witness test. For the test, all motor starters (whether FVNR, FVR, RVSS, or VFD) shall be powered at their full operational voltage and shall be connected and tested against a voltage-rated AC squirrel cage motor. Allow for the Owner and Engineer to witness these tests. Provide a minimum of 15 days' notice prior to the test.

The System Integrator shall be responsible for repackaging and shipping to the jobsite. The Contractor is responsible for unloading the shipment.

B. PRODUCT STORAGE

Motor starters, whether in MCCs or stand alone, shall be packaged, covered, and protected from weather and physical damage during storage before final installation.

2.3 COMBINATION MOTOR STARTERS, GENERAL

A. ENCLOSURES

1. For Starters Internal to MCCs

For starters internal to MCCs, reference Section 16442 (Control Centers) and reference the MCC NEMA rating(s) on the Plans.

2. For Starters Not Internal to MCCs

Reference Plans for enclosure requirements.

B. COMPLIANCE

1. Standards

Motor starters shall be Underwriter's Laboratory (UL) listed and labeled, and comply with the latest applicable standards of ANSI, IEEE, and the National Electrical Code.

C. GENERAL DEVICES AND COMPONENTS

All combination motor starters shall include the following devices:

1. Overcurrent Protective Device (OCPD).

a. The OCPD shall be a NEMA AB 1, motor circuit breaker protector, magnetic only, with field-adjustable short-circuit trip-coordinated with motor locked-rotor amperes for the specific motor being powered.

b. The OCPD shall be lockable in the OPEN position and shall include an auxiliary Form A contact that is open when the OCPD is electrically tripped or manually opened.

c. The OCPD shall be lockable from the front panel, without the operator having to open the panel door.

d. The OCPD shall be sized by the motor controller manufacturer for the motor being served and shall be selectively coordinated with OCPDs upstream as per Section 16410.

2. Control Devices (reference Specification 16940)

The following minimum requirements apply:

a. Provide surge protective devices across each AC and DC relay coil.

b. Provide control and timing relays per Section 16940.

c. Provide LED “push-to-test” indicating lights.

d. Provide combination electromechanical motor start counter and motor run time (elapsed time) meters per Section 16940. Battery backed LCD displays will not be accepted.

e. Provide Phase Monitor Relays that monitor phase loss, phase imbalance, phase reversal, under-voltage, and over-voltage, with a Form A contact that is active on any of these conditions.

Exception:

- *Programmable starters that provide the Phase Monitor Relay functions as described above do not require an additional discrete phase monitor relay.*

f. Door-Mounted Devices

Provide door-mounted devices as specifically shown on the Plans.

Door-mounted devices, such as elapsed time meters, motor start counters, indicating lights, ammeters, selector switches, reset pushbuttons, etc., shall not be replaced with electronic panel functions.

g. Devices Mounted Internal to the Enclosure

Motor starters shall include all components and devices necessary to provide the electrical control functionality shown on the Motor Starter Elementary Wiring Diagrams on the Plans.

Electromechanical relays and timers shall not be replaced with electronic logic functions.

Exception to 2:

- *Unless specifically approved by the Engineer.*

3. Control Circuit Requirements

a. Control functions shall match those shown on the Motor Starter Elementary Diagrams including manual requirements by the operators.

Provide additional circuits and devices as required by the starter manufacturer for power circuit isolation; however, these additions shall not change the features or functionality of the intended design.

b. Provide additional fusing or device protection as required to protect the drive's electronic power and control circuits and to comply with UL requirements.

c. Motor starters shall be provided with independent fused "control power" circuits. A fault in one motor control circuit shall only disable that associated motor.

i. Motor starter control circuits shall be 120 volts AC.

ii. If motor power is derived from voltage configurations that directly provide 120 volts AC line-to-neutral (240/120 volts AC or 208/120 volts AC systems), then each control circuit shall be provided with an individual fuse protective device at 120 volts AC.

iii. If motor power is derived from 480 Vac, then each control circuit shall be provided with an independent control transformer with a 120-volt AC fused secondary. The fuse shall be factory mounted to the top of the transformer.

iv. Motor starter control circuits may include remote panel heaters, motorized dampers, blower enclosure cooling fans, or other small power devices. Size the control transformers and fuses to handle all connected loads shown on the Plans plus an additional 25 percent.

D. SPECIAL POWER CIRCUITS

Some motor starters require "special power circuits" as listed below. These circuits are not included in the G&O Motor Elementary Wiring Diagrams. If required, the manufacturer shall provide the power contactors and control circuits. Special Power Circuits include the following functions and are applicable to motor starter types as listed below:

Function	**VFD**
Line Filter Switching	X
Isolation Contactor	X

These functions shall be provided as described on the Plans and within these Specifications.

E. WORK BY MANUFACTURER

1. All starters

a. The manufacturer shall provide motor controls as defined in these specifications and as shown on the Motor Starter Wiring Diagrams in the Plans.

b. The manufacturer shall provide complete combination motor starters as described in this section of this specification.

c. The manufacturer shall provide all physical (external) control relays and timers per Motor Starter Wiring Diagrams in the Plans. These devices shall <u>not</u> be integrated into programmable starter devices (VFDs, RVSSs, Smart Overload Relays, Extended I/O, etc.).

d. The manufacturer shall provide additional internal controls and external relays/contactors for "special power circuits" as required for drive protection and manufacturer's warranty.

2. Starters with Programmable Devices

Motor starters containing programmable devices (VFDs, RVSSs, Smart Overload Relays, Extended I/O modules, etc.) shall be configured as follows:

a. The manufacturer shall provide internal fault logic for protection of motors and starter power devices. These are the manufacturer's programmed conditions as required to warrant the system. A relay "FAULT" output will be programmed true on these fault conditions.

b. The manufacturer shall provide HIM programming as follows:

i. HIM Display:

(1) The HIM will always display the "fault code" if faulted.

(2) If not faulted, then the HIM will display motor speed or motor amps (owner selection).

ii. HIM Key Pad:

(1) The system can be placed in the PROGRAMMING mode only through password entry. The password shall be provided to the owner.

(2) START, STOP, RESET, HAND, OFF, AUTO keys are inactive (locked out) unless in the programming mode.

3. Networked Starters.

a. For VFD motor starters the manufacturer shall provide internal logic for control of "RUN", "SPEED REFERENCE", and "PUMP SET OK" functionality per the Motor Starter Wiring Diagrams in the Plans. If different pin assignments are used by the manufacturer, then these shall match the external and internal logic connections as shown in the plans and shall be clearly documented during

submittal. Extended I/O modules (EIOMs) shall be added as required to meet these conditions.

For non-VFD motor starters, the manufacturer shall provide internal logic for control of "RUN" and "PUMP SET OK" functionality per the Motor Starter Wiring Diagrams in the Plans. If different pin assignments are used by the manufacturer, then these shall match the external and internal logic connections as shown in the plans and shall be clearly documented during submittal. Extended I/O modules (EIOMs) shall be added as required to meet these conditions.

b. The manufacturer shall configure and program the internal logic functions and HIM unit, as described in these specifications and on the Plans.

c. The manufacturer shall provide all drive digital inputs to be readable by the PLC over the network.

d. The manufacturer shall provide full support to the PLC programmer for the acquisition and transfer of networked I/O.

F. WORK BY INTEGRATOR OR FST

1. General

The manufacturer shall allow for field adjustments by a qualified FST and shall support the efforts of the FST during the panel shop witness testing and during startup and commissioning as defined in this specification. Reference Section 3.5.

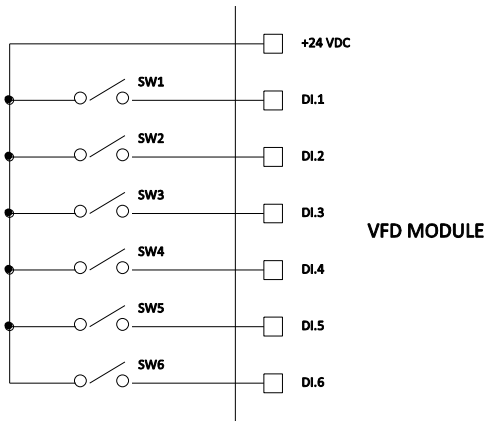
The manufacturer shall provide the FST directly or authorize the FST work to be performed by the Integrator. If authorized to be performed by the Integrator, then

a. Such adjustments and settings shall not affect the manufacturer's warranty or transfer the manufacturer's liability to the Integrator, and

b. Such work by the Integrator shall be financially compensated for by the manufacturer.

2. Witness Testing

The FST shall demonstrate complete functionality of internal logic functions for “RUN”, “SPEED REFERENCE”, and “STARTER READY” functionality during shop witness testing.



Example of a 6-input test switch bank

To do this, the FST shall provide a simple 6-bit switch harness similar to that shown above for testing output functions with up to six digital inputs. The FST shall disconnect the starter wiring to selected inputs, verify the output against all possible input combinations using the switches, document the result, and reconnect the starter wiring. This example shows a 6-input test (64 possible combinations). The FST shall prepare a logic table showing input status against the resulting output.

If the internal logic operates properly, then the entire starter will be tested for proper operation with both internal and external controls functioning as unit.

If corrections need to made as a result of the test, then the manufacturer shall support the changes either directly or by authorizing the Integrator to perform this work as the FST.

3. Settings Specific to the Application:

The FST shall provide drive module configuration settings as listed below. These changes shall not affect the manufacturer’s warranty or reduce the manufacturer’s liability.

a. Current limit settings,

b. Motor protection settings,

c. Final settings for the fixed maximum and minimum speeds,

d. Providing frequency notch (avoidance) bands,

e. Final settings for the fixed acceleration and deceleration ramp rates,

f. Others with approval.

2.4 MAGNETIC MOTOR STARTERS

NEMA ICS 2, Class A, full voltage, reversing or non-reversing (FVR or FVNR respectively), across the line.

Reference section COMBINATION MOTOR STARTERS, GENERAL

A. THE POWER CIRCUIT

1. Overcurrent Protective Device (OCPD).

   Reference GENERAL DEVICES AND COMPONENTS, Section 2.3C.

2. Magnetic Contactor.

   The magnetic contactor shall be NEMA rated, Size 1 minimum. IEC contactors will not be permitted.

3. Motor Overload Protection (MOP).

   a. Intelligent Overload Relay Protection

      Where motor starters are shown on the Plans to be networked together or to a PLC, either directly or through network switches, such combination motor starters shall include Intelligent Overload Relays complete with communication equipment and protocols compatible with the approved system control PLC.

      Overload Relays shall be powered from the communication network or from the combination motor starter's 120 Vac control power supply and shall feature ambient temperature

compensation, visible trip indication, selectable trip Classes of 10, 15, 20, and 30, selectable manual/auto-manual reset, and a minimum of four discrete 120 Vac inputs and two Form C contacts rated at 1.5 amps at 240 volts AC minimum. One of the contacts shall be programmable for motor shutdown.

Provide additional distributed I/O modules and associated power supplies, as required, to meet the data transfer networking requirements and shown on the Motor Starter Elementary Wiring Diagrams on the Plans.

Exception to A:

- *Unless specifically shown otherwise on the Plans or unless specifically approved by the Engineer.*

B. THE CONTROL CIRCUIT

Reference GENERAL DEVICES AND COMPONENTS, Section 2.3C.

2.5 VFD MOTOR STARTERS

A. GENERAL

The drive is designed to provide variable speed control of a standard NEMA MG 1, Design B, 3-phase, induction motor by adjusting output voltage and frequency. Output power is of suitable capacity and wave form to provide step-less speed control of the specified 3-phase motor throughout a continuous speed range under variable or constant load (as applicable) not exceeding the motor's full load rating.

Controller is suitable for and coordinated with the thermal, electrical, and mechanical characteristics of the motor actually furnished to which it is connected.

Coordinate the drive capability with the torque characteristics (variable or constant torque) of the actual equipment furnished, which is driven by the motor to which the drive is connected.

B. THE POWER CIRCUIT

1. Technology

a. The Bridge

Power switching devices shall be IGBTs.

VFD motor starters shall be six-pulse, Pulse Width Modulated (PWM).

b. Control Type

Most motors on this project are Variable Torque. Reference Division 11 motor specifications for listing of Constant Torque motors.

Variable Torque Output Rating:

Three-phase, 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.

2. Overcurrent Protective Device (OCPD)

Reference GENERAL DEVICES AND COMPONENTS, Section 2.3C.

3. The VFD

a. Capable of sustaining 115 percent of motor rated full load current indefinitely.

b. Operates in an ambient temperature of 0 to 40 degrees C.

c. Maintains displacement power factor of 0.95 or better over the entire speed range.

4. Motor/Drive Protection, Adjustments, and Auto Reset

a. VFD shall include self diagnostics for detection of failed circuitry.

b. Fault detection shall shut down motor operation as shown on the Plans. Upon removal of fault condition, the drive shall automatically reset and attempt to restart.

c. Upon return of power after an outage, the drive shall automatically restart.

d. In addition to other specified standard protective functions the VFD shall provide the following:

i. Drive over-temperature trip.

ii. Short-circuit protection.

iii. Fault current protection of AC to DC rectifier section.

iv. Adjustable current limit of 50 to 110 percent of full-load rating.

v. Stall prevention.

vi. Surge protection from input line AC transients (lightning/surge arrestor).

vii. Electrical isolation between power and logic circuits.

viii. Able to withstand output terminal line-to-line short circuits without component failure.

5. Line and Load Circuit Conditioning

a. Line Filtering

Line filtering shall be provided on all VFD starters

5 percent internal drive impedance is recommended, however, others solutions which fit in the space shown on the plans for the MCCs and limit non-linear loading to 22 Amps and TDD at the point of common coupling ~15 percent assuming all non-redundant motors running at 100 percent load. Reference “utility demand” loads column of sheet E-11.

Line filters may be a separate device or integral to the drive module.

b. Load Filtering

Passive load filtering shall be provided on all VFD starters to reduce motor winding voltage stress, improve drive stability, and assist in drive protection. The filter shall consist of a simple reactor or a passive combination RLC dv/dt filter as described below.

Provide 1.5 percent load reactor.

Line filters may be a separate device or integral to the drive module.

6. VFD Isolation

Circuits internal and external to the drive module required to control the isolation of the VFD module shall be provided by the manufacturer. Extended I/O modules (EIOMs) shall be added as required to meet this requirement.

C. THE CONTROL CIRCUIT

Reference GENERAL DEVICES AND COMPONENTS, Section 2.3C.

D. VFD SPEED CONTROL

VFD motor starters shall be provided with manual and automatic speed control. Automatic speed control may be derived from a signal source remote from the starter and may be hardwired, networked, or both for redundancy.

1. Manual Speed Control

Manual speed control shall be selected by the VFD as shown in the Motor Starter Wiring Diagrams in the Plans.

The Manual Speed Reference shall be derived from the drive's field-mounted speed potentiometer. Regardless of the manual range setting, the speed shall be limited to values between

"minimum speed" and "maximum speed" programmed in the VFD through the HIM.

2. Hardwired Speed Reference

Remote hardwired speed references shall be from an isolated 4-20 mA analog signal. Four mA shall equate to 0 Hz (0 percent speed). Twenty mA shall equate to 60 Hz (100 percent speed). Regardless of the 4-20 mA signal, the speed shall be limited to values between "minimum speed" and "maximum speed" programmed in the VFD through the HIM.

3. Networked Speed Reference

Remote networked speed references shall be transferred over a LAN between the controlling PLC and VFD drive. The range shall be between 0 and 100 percent, where 0 percent shall equate to 0 Hz (0 percent speed) and 100 percent shall equate to 60 Hz (100 percent speed). Regardless of the minimum speed reference sent over the LAN, the speed shall be limited to values between "minimum speed" and "maximum speed" programmed in the VFD through the HIM.

E. VFD DRIVE CONTROL

1. Microprocessor based digital logic control programmable from the HIM.

2. Speed Control

a. Maximum speed is field adjustable up to the rated 60 Hz motor speed.

b. Minimum speed is field adjustable from 0 to 75 percent of maximum rpm.

c. The minimum and maximum speeds are independently field adjustable through the HIM. Initial settings shall be preconfigured by the starter manufacturer for each VFD starter as shown in the table below.

d. Speeds shall increase and decrease at a linear ramp rate, independently adjustable for acceleration and deceleration through the HIM. Initial settings shall be preconfigured by

the starter manufacturer for each VFD starter as shown in the table below.

	Ramp Rates (0-100% speed) in sec.		Speed Limits (in % full speed)	
Description	**Accel.**	**Decel.**	**Min.**	**Max.**
All VFD Starters	5	5	40	100

3. In addition to other specified features, provide the following:

   a. Low-frequency voltage boost.

   b. Coast to rest/stop.

   c. Minimum five-cycle logic power carryover during utility loss.

   d. Insensitivity to line rotation.

   e. Display of fault information.

   f. Slip compensation.

   g. Programmable "jump frequency."

F. VFD I/O TERMINALS

The VFD shall include, as a minimum, the I/O connections as shown on the motor starter elementary wiring diagrams on the Plans. Provide extended I/O modules, as required, to meet this objective.

The manufacturer shall make all signals to digital input pins available to the PLC over the network. This transmission of data shall made seamless to the PLC listed in specification 16910.

G. NETWORK COMMUNICATIONS

Where motor starters are shown on the Plans to be networked together or to a PLC, either directly or through network switches, such VFD combination motor starters shall include communications equipment and protocols compatible with the approved system control PLC.

Provide the minimum command and status parameters as shown on the schematic(s) and I/O tables on the Plans.

Provide additional distributed I/O modules and associated power supplies, as required, to meet the data transfer networking requirements listed here and shown on the schematic(s) and I/O tables on the Plans.

The manufacturer shall provide technical assistance to the Integrator as required to create a reliable and clear transfer of data packets between the motor starters and the PLC as identified in Specification 16910.

2.6 EXTRA MATERIALS

Reference Specification 16050 for spare parts.

PART 3 EXECUTION

3.1 APPLICATION

Apply motor starters as described on the Plans.

3.2 INSTALLATION

Install independently mounted motor control devices according to manufacturer's written instructions and the NEC.

A. IDENTIFICATION

Identify motor control components and control wiring according to Section 16050.

B. LOCATION AND MOUNTING

Locate controllers as shown on the Plans. Provide the mounting methods for each separate starter enclosure as shown on the Plans. Reference Section 16050.

3.3 WIRING INSTALLATION

A. Install wiring between motor control devices according to Section 16120.

B. Bundle, train, and support wiring in enclosures.

C. Make all control wiring connections to provide a complete and operational system. Provide additional terminals, wire guides, and gutters as required for a safe and protected system.

3.4 CONNECTIONS

Tighten connectors, terminals, bus joints, and mountings. Tighten field-connected connectors and terminals including screws and bolts according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD TESTING AND COMMISSIONING

A. GENERAL TESTING REQUIREMENTS

1. Testing procedures described herein shall apply to all starters associated with the Project.

2. Complete testing of motor starters shall be provided and shall include:

   a. The services of a qualified independent testing agency to perform breaker testing as described below.

   b. The assistance of the starter manufacturer's **Field Service Technician** (FST) as described below. Throughout this contract, the Field Service Technician shall be provided by the manufacturer.

      Special Note:

      Areas of field testing and commissioning where the work responsibilities are shown as "FST/INTEGRATOR" may be performed by either the manufacturer's FST or the Integrator (if so, authorized by the manufacturer and agreed upon by the Integrator). If the work is authorized to be performed by the Integrator, then such work shall not affect the manufacturer's warranty or transfer the manufacturer's liability to the Integrator.

3. Motor starter tests shall also be coordinated with the following representatives:

   a. The System Integrator,

   b. The motor/pump Manufacturer,

c. The Engineer,

d. The Owner.

B. TESTING PROCEDURES BEFORE MAKING ELECTRICAL CONNECTIONS TO THE STARTER (FST ASSISTANCE NOT REQUIRED)

1. Megger the motor leads per Specification 16120.

2. If the starter is powered from a separate feeder, then megger the feeder per Specification 16120.

3. For molded case circuit breakers 100 amps and larger, provide independent testing agency to perform circuit breaker tests as stated in NETA ATS, Section 7.6. Certify compliance with test parameters. Provide the Engineer a copy of the test results signed by testing agency.

4. Perform visual and mechanical inspection of enclosure and devices. Remove and replace damaged units with new.

5. Connect power, control, instrumentation, and communication conductors to the motor starter. Verify the integrity of all connections.

6. Remove any burrs, filings, or other foreign materials from enclosure.

7. Completely wipe down and vacuum enclosure.

C. ENGAGING THE FST AT THE JOBSITE PRIOR TO ENERGIZATION

Engage an FST to be present when energizing or commissioning motor starters. Under the direction of the FST, the following minimum tests shall be performed, documented, and dated by the FST. These documents will be provided as a part of the MCC or Motor Starter Sections of the O&M Manual.

The FST shall:

1. Check connections and device mounting for proper torque.

2. Check alignment of plug-in devices with stationary parts.

3. Check operating mechanisms for binding, lubrication, etc.

4. Verify that all pilot lights are LED type. Replace if not.

5. Verify that analog meters are scaled roughly two times the motor's FLA.

6. Test the validity of the control, instrumentation, and communication circuits.

7. Test all breakers for proper physical movement and door interlocking. Repair or replace as required.

8. Set the motor protection values for the specific motors being controlled.

9. Verify the drive's initial minimum and maximum speed ranges per the table in Section 2.6F.

10. Set the acceleration and deceleration rates per the tables in Section 2.5 and Section 2.6, FACTORY SETTINGS, for RVSS and VFD units respectively.

11. The FST shall energize the starter.

D. SERVICES OF THE FST/INTEGRATOR AT THE JOBSITE AFTER ENERGIZATION

The FST/INTEGRATOR shall:

1. Verify motor rotation and direction. Coordinate this work with the pump/motor manufacturer. Wiring corrections shall be made by the Contractor.

2. Test the starter protection circuits.

3. Test the starter RESET control.

4. Test the starter for proper operation and functionality per design. Verify manual and automatic speed controls and transfers.

5. In coordination with the pump or blower manufacturer, the Owner, and the Engineer, run VFD-controlled motors through their

minimum and maximum speed ranges. Identify the frequencies at which the motor speeds cause excessive resonant frequency vibrations (as determined by the pump/blower manufacturer). Identify the frequencies just above and below the resonant frequency and program the VFD drive to lock out the band of frequencies in between (the "notch frequencies"). Perform this task for each resonant frequency. Document the lower and upper frequencies of the lockout bands.

6. Test the starter network communications and functionality with associated PLC or network controller. Coordinate this work with the System Integrator.

7. Test all starter digital and analog I/O connectivity, functionality, and scaling with the PLC, whether hardwired or networked. Coordinate this work with the System Integrator.

8. Test starter cooling fan circuits.

9. Test minimum and maximum speeds.

10. Correct malfunctioning units on site where possible and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

E. ADJUSTMENTS AND STARTER PERFORMANCE VERIFICATION BY THE FST/INTEGRATOR

1. The FST/INTEGRATOR shall provide adjustments, calibrations, and final settings for RVSS units, VFD drives, and Motor Overcurrent Protective (MOP) devices as required to meet design intent and process requirements and make all necessary adjustments and calibrations as required to provide acceptable motor starting and operational performance. Motor nameplate data shall be provided to the FST by the Contractor.

2. The FST/INTEGRATOR shall provide the final OCPD breaker trip setting for the motor circuit being protected.

3. The FST/INTEGRATOR shall document all such adjustments and calibrations in a table similar to that shown below (as a minimum) and initial and date each final setting. This table shall be submitted to Engineering for approval and acceptance. All Status "As Left" conditions must be checked off as "OK" before completion. The

final table shall be provided as a part of the MCC or Motor Starter Sections of the O&M Manual.

Include adjustments made to "smart relays" such as the AB E300. Parameters that are factory default may be included but are not required.

Parameter Adjusted		Value				
Ref. No.	**Parameter Description**	**As Found**	**As Left**	**Status "As Left"**	**Date/Time**	**Test Performed By (Initials)**

3.6 DEMONSTRATION

A. DEMONSTRATION OF FULLY FUNCTIONAL MOTOR CONTROLLERS

1. Provide all testing required to demonstrate complete functionality for all motor/motor starter systems including speed control, speed notching, manual and auto control, motor acceleration and deceleration, upper and lower speed limits (in manual and auto modes), and motor protection.

2. Cycle power to each starter while their motors are running. Provide a minimum of two cycle tests per motor/starter.

B. TRAINING

1. The FST shall provide basic starter operation training immediately following commissioning.

2. The FST shall provide a minimum of 4 hours of training 30 to 90 days after commissioning (time defined by Owner). The training shall demonstrate FVNR, RVSS, and VFD controller operation and troubleshooting to the Owner's operators and maintenance personnel. Include training related to equipment operation and maintenance procedures.

3. Schedule training with at least 7 days' advance notice.

3.7 CLEANING

Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean devices internally, using methods and materials recommended by manufacturer.

***** END OF SECTION *****

SECTION 16440

PANELBOARDS

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section consists of lighting, power, and distribution panelboards, and associated auxiliary equipment rated 600 V and less.

1.2 RELATED WORKS SPECIFIED ELSEWHERE

Section	Item
01300	Submittals
16050	Basic Electrical Materials and Methods
16060	Grounding and Bonding

1.3 SUBMITTALS

Submit under the provisions of Section 01300.

A. PRODUCT DATA

For each type of panelboard, accessory item, and component specified.

B. SHOP DRAWINGS

For panelboards. Include dimensioned plans, sections, and elevations. Show tabulations of installed devices, major features, and voltage rating. Include the following:

1. Enclosure type and mounting.

2. Bus configuration and current ratings.

3. Short-circuit current rating of panelboard.

4. Features, characteristics, ratings, and factory settings of individual protective devices and auxiliary components.

C. PANELBOARD SCHEDULES

For installation in panelboards and inclusion in the maintenance manuals specified in Division 1. Submit final versions prior to closeout of project.

D. MAINTENANCE DATA

For panelboard components to include in the maintenance manuals specified in Division 1. Include manufacturer's written instructions for testing circuit breakers.

1.4 QUALITY ASSURANCE

See Section 16050.

Subject to compliance with requirements, provide products by the following:

A. REFERENCED STANDARDS

1. National Electrical Manufacturers Association (NEMA):

   a. NEMA 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).

   b. NEMA PB 1, Panelboards.

2. National Fire Protection Association (NFPA):

   a. 70, National Electrical Code (NEC).

3. Underwriters Laboratories, Inc. (UL):

   a. 50, Standard for Safety Cabinets and Boxes.

   b. 67, Standard for Safety Panelboards.

1.5 EXTRA MATERIALS

Reference Specification Section 16050 for spare parts.

All panelboards associated with a project shall be the same manufacturer.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. MANUFACTURERS

Subject to compliance with requirements, provide products by the following:

1. General Electric Co.; Electrical Distribution & Control Div.

2. Eaton, Cutler-Hammer.

3. Siemens Energy & Automation, Inc.

4. Square D Co.

2.2 PANELBOARD FABRICATION

A. MANUFACTURED UNITS

Standards: NEMA PB 1, NFPA 70, UL 50, UL 67.

B. RATINGS

1. Bus current, voltage, number of phases, and number of wires as shown on the Plans.

2. Short Circuit Fault Rating

a. 250 Vac or Less

10 kAIC minimum short circuit rating or as indicated on the Plans, whichever is the greater.

b. 600 – 251 Vac or Less

14 kAIC minimum short circuit rating or as indicated on the Plans, whichever is the greater.

3. Service Entry Equipment rated when indicated on the Plans.

C. BUS BARS

1. Main Bus Bars

a. Plated drawn copper of 98 percent conductivity sized to limit temperature rise to a maximum of 65 degrees C above an ambient temperature of 40 degrees C.

b. Drilled and tapped and arranged for sequence phasing of the branch circuit devices.

2. Ground Bus

a. Ground bus shall be full size (100 percent) rated unless shown otherwise on the Plans.

b. Ground bus shall be bonded to the box.

c. Provide additional isolated ground bus when indicated on the Plans.

d. Compression type connectors.

3. Neutral Bus Bars

a. Insulated, full size (100 percent) rated unless shown otherwise on the Plans.

b. Compression type connectors.

D. CONSTRUCTION

1. Interiors shall be factory assembled and designed such that switching and protective devices can be replaced without disturbing adjacent unit and without removing the main bus connectors.

2. Multi-Section Panelboards

a. Feed-through or sub-feed lugs.

3. Main Lugs

a. Compression type approved for copper and aluminum.

E. ENCLOSURES

1. Boxes

   a. Code gauge galvanized steel, furnished without knockouts.

2. Trim Assembly

   a. Code gauge galvanized steel, finished with rust-inhibited primer and manufacturer's standard paint inside and out.

3. Panelboard Mounted Integral to MCC

   a. Trims supplied with hinged door over all circuit breaker handles.

   b. Doors on panelboard front, with concealed hinges, secured with corrosion resistant chrome-plated flush catch and tumbler lock, all keyed alike.

   c. Nominal 20-inch wide by 5-3/4-inch deep with gutter space in accordance with NEC.

   d. Clear plastic cover for directory card on the inside of each door.

   e. Rated NEMA 1.

4. Power Distribution Panelboard

   a. Trims cover all live parts with switching device handles accessible.

   b. Less than or equal to 12-inches deep with gutter space in accordance with NEC.

   c. Doors on panelboard front, with concealed hinges, secured with corrosion resistant chrome-plated flush catch and tumbler lock, all keyed alike.

   d. Clear plastic cover for directory card on the inside of each door.

e. Enclosure

i. Outdoor Locations: NEMA 3R unless stated otherwise on the Plans.

ii. Indoor Wet Locations: NEMA 12 unless stated otherwise on the Plans.

iii. Indoor Dry Locations: NEMA 1 unless stated otherwise on the Plans.

F. SERVICE EQUIPMENT APPROVAL

Listed for use as service equipment for panelboards with main service disconnect.

1. Future Devices

Equip with mounting brackets, bus connections, and necessary appurtenances, for the overcurrent protective device ampere ratings indicated for future installation of devices.

G. SPECIAL FEATURES

Include the following features for panelboards:

1. Skirt for Surface-Mounted Panelboards

Same gage and finish as panelboard front, removable, with flanges for attachment to panelboard, wall, and floor.

2.3 OVERCURRENT AND SHORT CIRCUIT PROTECTIVE DEVICES

A. MAIN OVERCURRENT PROTECTIVE DEVICE

1. Molded-Case Circuit Breaker, NEMA AB 1, handle lockable.

2. Vertical mounting unless stated otherwise in the Plans.

B. BRANCH OVERCURRENT PROTECTIVE DEVICES

1. Shall be bolt-on molded case circuit breakers

2. The minimum breaker size shall be 15 Amp unless stated otherwise on the Plans.

3. Characteristics

    a. Frame size, trip rating, number of poles, and auxiliary devices as indicated on the Plans.

    b. Fault current rating as defined herein and as indicated on the Plans.

    c. Where branch circuit breakers are shown on the Plans to be GFCI the GFCI shall be Class A (5 mA), sometimes called a "Personal Protection" GFCI.

4. Application Listing

    a. Appropriate for application, including Type SWD for switching fluorescent lighting loads and Type HACR for heating, air-conditioning, and refrigerating equipment.

5. Circuit Breakers, 200 A and Larger

    a. Reference Specification 16410.

6. Circuit Breakers, 400 A and Larger

    a. Reference Specification 16410.

7. Circuit breakers, under 200 A

    a. Reference Specification 16410.

8. Lugs

    a. Mechanical lugs and power-distribution connectors for copper conductors of number and size indicated.

PART 3 EXECUTION

3.1 INSTALLATION

Install panelboards and accessory items according to NEMA PB 1.1.

Setup, adjust and fasten in place flush trim and interiors.

Install circuit breakers as shown on the "Panelboard Schedule" for each panelboard. Record all circuit breaker installation deviations from the "Panelboard Schedule" and show on the Record Drawings the actual size and pole position of all circuit breakers installed.

Do not remove knockouts for breaker positions unless a breaker is to be installed (reference EXTRA MATERIALS, UNUSED CIRCUITS in this Section). Where twistouts or knockouts are removed in error, provide a circuit breaker (one pole, 20-ampere) to fill each position removed.

A. MOUNTING HEIGHTS

Top of trim 74 inches above finished floor, unless otherwise indicated.

B. MOUNTING

Plumb and rigid without distortion of box. Mount flush panelboards uniformly flush with wall finish. Provide spacers of neoprene or fiberglass to shim out from irregular surfaces or from damp surfaces.

C. CIRCUIT DIRECTORY

Prepare neatly typewritten panelboards directories in the same pole sequence as the panelboard stamping. Send a copy to the Owner for his records. Prior to typing the final directories, verify room and equipment names and numbers with the Owner and modify circuit descriptions of areas/spaces to conform with the Owner's desires. Obtain approval before installing.

D. PROVISION FOR FUTURE CIRCUITS

Install panelboards in such a manner as to leave access to the box, building chases, knockouts, etc., for future circuit additions. Place conduit in the rear line of knockouts where possible. Install spare conduits from flush-mounted panels up to accessible spaces.

E. WIRING IN PANELBOARD GUTTERS

Run neatly parallel and perpendicular to enclosure. Arrange conductors into groups, and bundle and wrap with wire ties.

3.2 IDENTIFICATION

Identify field-installed wiring and components and provide warning signs as specified in Section 16050.

Label each panelboard with engraved laminated-plastic or metal nameplates mounted with corrosion-resistant screws.

3.3 GROUNDING

Connect equipment grounding conductors to ground bus, except for circuits requiring isolated grounding.

Provide ground continuity to main electrical ground bus as indicated.

3.4 CONNECTIONS

Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Make insulation-resistance tests of each panelboard bus, component, and connecting supply, feeder, and control circuits.

2. Make continuity tests of each circuit.

B. TESTING AGENCY

Provide services of a qualified independent testing agency to perform specified testing.

C. TESTING

1. Prior to Energization

Provide third party breakers testing per Specification 16050, Section 3.

Check connections and mounting for proper torque.

Remove any burrs, filings, or other foreign materials. Completely wipe down and vacuum panelboard.

2. After Energization

After electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

Correct malfunctioning units on site where possible and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

3.6 ADJUSTING

Set field-adjustable switches and circuit-breaker trip ranges as indicated.

***** END OF SECTION *****

SECTION 16442

MOTOR CONTROL EQUIPMENT

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section consists of motor control equipment rated 600 V and less. All equipment supplied shall be compliant with the Build America Buy America Act (BABA).

1.2 RELATED WORKS SPECIFIED ELSEWHERE

Section	Item
01300	Submittals
03300	Cast-In-Place Concrete
16941	Programmable Logic Controller (PLC) Hardware
16050	Basic Electrical Materials and Methods
16420	Motor Controllers
16940	Control Panels

1.3 SUBMITTALS

A. PRODUCT DATA

For each type of motor control center, accessory item, and component specified.

B. SHOP DRAWINGS

Include dimensioned plans, sections, and elevations. Show tabulations of installed devices, major features, and voltage rating. Include the following:

1. Enclosure type, wiring type.

2. Bus configuration, voltage and current ratings for horizontal bus and each separate vertical bus.

3. Short-circuit current ratings.

4. Features, characteristics, ratings, and factory settings of individual protective devices and auxiliary components.

5. Elevation drawing with dimensions.

6. Identification of units and their location in the MCC.

7. Bill of Materials for each control unit.

8. Wiring diagrams for power distribution circuits.

9. Elementary wiring diagrams for each motor starter including wire numbers, terminal connectivity to contactors, relays, and drive modules. Clearly show field wiring termination points and numbering.

10. Nameplate schedules.

C. FIELD TEST REPORTS

Indicate and interpret test results for compliance with performance requirements.

D. MAINTENANCE DATA

For components to include in the maintenance manuals specified in Division 1.

E. LOAD-CURRENT AND OVERLOAD-RELAY HEATER LIST

Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

1.4 QUALITY ASSURANCE

See Section 16050. Motor control centers must be factory assembled and wired as completed units by the manufacturer, except where shipping splits are required for shipping of the units. This requirement pertains to control wiring, PLC wiring, and similar wiring within the centers and/or to the "MCC side" of terminal blocks or terminal strips within the centers. Use of a third party to assembly and/or wire the centers is not permitted.

A. SOURCE LIMITATIONS

Obtain similar motor-control devices through one source from a single manufacturer.

B. PRODUCT SELECTION FOR RESTRICTED SPACE

Plans indicate maximum dimensions for motor-control centers, including clearances between motor-control centers and adjacent surfaces and items, and are based on types and models indicated. Other manufacturers' motor-control centers with equal performance characteristics and complying with indicated maximum dimensions may be considered. Refer to Division 1 Section "Substitutions."

1.5 DELIVERY, STORAGE, AND HANDLING

Protect motor control center during construction from moisture, dust, abrasion, or other damage or disfigurement, using plastic sheeting, kraft paper, space heaters, or other appropriate means. Field repair of material or equipment made defective by improper storage is not acceptable.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. MANUFACTURERS

Subject to compliance with requirements, provide products by the following:

1. Allen-Bradley

2. Eaton; Cutler Hammer

3. Square D Co.

2.2 MOTOR CONTROL CENTER FABRICATION

A. RATINGS

1. 600 V class, 3-phase, 60 hertz with operating voltage and number of wires as indicated on the Plans.

2. Bus bracing short circuit fault current rating: as indicated on the Plans.

B. ENCLOSURES

1. Free-standing, totally enclosed, metal-clad structure.

2. Sections nominally 20-inches wide by 20-inches deep by 90-inches high, bolted together to form a continuous assembly.

3. Suitable for mounting against a wall or back-to-back with other electrical units and not requiring rear or side access.

4. Designed to easily extend at either end with similar vertical structures.

5. Provide channel sills where indicated.

6. Enclosure

   NEMA 250, Type as indicated on the Plans.

C. WIRING

NEMA ICS 3, Class II, Type B.

1. Class C stranded, single copper conductor; No. 14 AWG minimum size for control wiring, No. 12 AWG minimum size for power wiring.

2. 600 volt rated MTW thermoplastic insulation. Insulation color as follows:

   a. Red for control circuits internally energized

   b. Yellow for control circuits externally energized

   c. Black for power wiring

   d. White for all grounded conductors

   e. Blue for dc conductors.

D. WIREWAYS

Continuous both vertically and horizontally.

1. Accessible from the front of the center.

2. Completely isolated from bus compartments and adjacent sections.

3. Vertical wireways adjacent to the slide-in units in each section, but accessible through a separate hinged door running the full height of each section between horizontal wireways.

4. Horizontal wireways at both top and bottom, each intersecting the vertical wireways of every section.

E. BUSING

1. Material

Tin plated copper.

2. Main Horizontal Bus

a. Ampacity

600 amperes RMS tin plated copper unless otherwise indicated on the Plans.

b. The main horizontal bus shall be at the top or the center, continuous without splices, except where shipping splits are required. Provide splice bars and hardware for shipping splits. Access to the horizontal bus is by removable barriers.

c. Extend the main horizontal bus the full length of the MCC with provisions for splicing additional sections to either end.

d. Lug connections to the bus are bolted.

3. Vertical Buses

   a. Ampacity

      Sized for maximum load on vertical section. 300 amperes RMS tin plated copper minimum.

   b. Securely bolted to the main horizontal bus with connections easily accessible for maintenance.

   c. Completely isolated and insulated by means of a barrier.

   d. Continuous from the top of the section to the lowest unit opening possible in the section.

   e. Lug connections to the bus are bolted.

4. Ground Bus

   a. Ampacity

      Tin plated copper, 50 percent of the RMS ampacity of the main horizontal bus. 300 amperes RMS minimum.

   b. Extend the full length of the MCC with provisions for splicing additional sections to either end.

   c. Copper ground bus at the bottom of the center, mechanically and electrically connected to each vertical structure.

   d. Provide ground lug connections.

   e. Lug connections to the bus are bolted.

5. Bracing

   a. Short circuit fault current rating: as indicated on the Plans.

   b. Bracing designed to avoid accumulation of dirt, lint, etc., on supports between phases.

   c. Supports are moisture-resistant, non-carbonizing and non-tracking.

d. Bracing designed to avoid accumulation of dirt, lint, etc. on supports between phases.

6. Barriers

a. Insulated horizontal and vertical bus barriers and a barrier cover below the vertical bus to protect the ends of the bus from contact with items entering the bottom of the enclosure.

F. SECTION UNITS FOR MOTOR CONTROL

1. Units consist of protective/disconnect devices, magnetic starters, control power transformers, control units, pilot lights, relays, terminal blocks and associated wiring mounted on a metal slide-in structure of a modular size.

2. Units of equal rating are interchangeable within the center structure and from center to center.

3. Unit components do not protrude into or restrict wireways.

4. Unit barriers isolate each unit from adjacent units, vertical bus and horizontal bus.

5. Pushbuttons, selector switches, and pilot lights are mounted on the draw-out compartment; but they are visible and operable externally through gasketed, die-cut openings in the unit door. Provide an external reset mechanism for overload relays on the unit door.

6. Plug-in contacts for bus connection of the units are silver plated, free-floating but captive in an insulating block and easily replaceable. The unit plug-in arrangement is completely self-aligning and fail-safe against accidental short or ground. Each plug-in control unit is retained in the structure.

7. Short-circuit protective devices in combination starters and branch circuit protective devices have an external operator. This operator is interlocked with the door so that the circuit must be de-energized before the door can be opened and the device cannot be closed with the door open. A semi-concealed interlock defeat mechanism is provided.

8. The lugs compartment does not interfere with routing of control or power wiring nor interrupt the vertical wireway in the vertical section where it is installed.

9. Locate units as indicated on Plans. Do not revise locations, layout, or number of sections of center from that shown on Plans.

G. IDENTIFICATION

1. Provide a main nameplate for each center, 2" x 10" minimum size with 1/2-inch engraved letters. Nameplate is Lamacoid or equal plastic laminate or engraved metal plate. Lettering is white; backgrounds are black. No abbreviations are permitted unless approved by the Owner. Engraving is subject to the Owner's approval.

2. Lugs [Main Breaker] compartment is identified by a 1" x 4" nameplate engraved "MAIN LUGS [BREAKER] COMPARTMENT."

3. Each unit door and each slide-in unit shall has a permanently attached, engraved nameplate: 3/8 of an inch letter unless otherwise shown.

4. Provide legend plates for all cover-mounted control devices, including pilot lights, selector switches and pushbuttons. Engraving is subject to the Owner's approval.

5. Provide nameplates for all relays, timers, transformers, fuses, terminal blocks, and switches mounted internally to the unit. Nameplates are Lamacoid sized to the scale of device to which they refer. Engrave as indicated for the device on the elementary wiring diagrams.

6. Identify conductors at each termination by yellow sleeve wire markers of the heat-shrink or stretch-on type with indelible black letters and numbers at each termination or splice.

    a. The manufacturer's standard internal wiring may be numbered per NEMA or manufacturer's standard.

H. FINISH

Ferrous parts are cleaned, rustproofed and finished with light gray baked enamel. Manufacturer's standard gray colors or accents are acceptable.

2.3 PROTECTIVE AND CONTROL DEVICES

A. CIRCUIT BREAKERS MEET NEMA STANDARD AB-1

1. Main breakers: molded case units with solid state long and short time trip circuits individually and separately adjustable for both time and pickup. Four wire systems have ground trip units. Provide two normally open individual dry auxiliary contacts, rated 10 A at 250 Vac, that open when the breaker is tripped or manually opened; closed when the breaker is closed.

2. Feeder breakers: molded case breakers with thermal magnetic trip, adjustable for magnetic pickup. Provide two normally open individual dry auxiliary contacts, rated 10 A at 250 Vac, that open when the breaker is tripped or manually opened; closed when the breaker is closed.

3. Motor circuit breakers: magnetic only trip with adjustable trip setting. Provide two normally open individual dry auxiliary contacts, rated 10 A at 250 Vac, that open when the breaker is tripped or manually opened; closed when the breaker is closed.

4. Branch circuit breakers: molded case, thermal-magnetic trip, trip-free with non-interchangeable, non-adjustable trip unless otherwise noted.

5. Breakers meet the integrated equipment rating required for the available short circuit current at the equipment in which they are used.

6. All breakers provided in MCC shall be coordinated with respect to their trip points by the MCC manufacturer.

B. MOTOR STARTERS MEET NEMA STANDARD ICS

1. Motor starters shall not include intrinsically safe areas or circuits. Intrinsically safe areas shall be located in electrical enclosures other than the MCC.

Where a field device directly associated with the starter requires an intrinsically safe interface, provide the power to the intrinsically safe circuit from the starter. In this manner, if power is lost to the control panel but the starter is still operable, then the field device and its associated intrinsic interface shall also remain operable.

2. Complete with three overload units of the melting alloy or bimetal type. The overload units are manual reset type.

3. Starter sizes as stated by NEMA, no half or third sizes or IEC devices or ratings are allowed. Minimum size NEMA 1.

4. 600 volt rated, three-pole with 120 Vac control power and 120 Vac coils.

5. Provide three normally open/normally closed (Form C) dry auxiliary contact sets, rated 10 A at 250 Vac, on each starter as a minimum.

   a. Provide a means of mounting up to two additional auxiliary contact sets on each starter.

   b. Provide additional auxiliary contact sets as required or indicated for specified functionality and interface with control systems.

C. MISCELLANEOUS PROTECTION AND CONTROL DEVICES

1. Fuses

   Power fuses, Class RK-5 silver element. Control fuses, Busman FNQ or equal.

2. Power Monitor Metering

   Reference Section 16940, Control Panels.

3. Surge Protection

   The main bus of the MCC shall be protected with a Surge Protective Device (SPD). Reference Section 16280.

4. Pilot Devices: Reference Section 16940.

5. Control Relays: Reference Section 16940.

6. Time Delay Relays: Reference Section 16940.

7. Intrinsically Safe Relays: Reference Section 16940.

8. Interval Timers: Reference Section 16940.

9. Running Time Meters

   Eagle Signal six digit non-reset or equal.

10. Ammeters

    Sized for approximately two times the Full Load motor Amps (FLA), ±2 percent accuracy, 3-1/2- to 4-inch size, GE "Big Look" or equal, Simpson, Weston, or Crompton.

11. Current Transformers

    One percent accuracy at burden and lead length as installed. G.E., Midwest, or Westinghouse.

12. Current Monitor

    Reference Section 16940.

2.4 OTHER MOTOR CONTROL CENTER MOUNTED EQUIPMENT

Sections may contain units, equipment or devices other than motor starters such as transformers, panelboards, power factor correction capacitors, metering equipment, programmable logic controllers, or similar devices or equipment. These items are standard products of the same manufacturer as the center and meet the requirements of the specification sections for those items.

Units, equipment, and devices are factory mounted in the center. Locate units, equipment and devices as indicated on Plans. Do not revise locations or layout of center from that shown on Plans.

PART 3 EXECUTION

3.1 INSTALLATION

Install motor control centers and accessory items according to NEMA ICS.

A. MOUNTING

1. Level, plumb and rigid without distortion of enclosure.

2. Install on floor or pad level within ±1/8 of an inch in a square yard.

3. Shim with stainless steel shims where necessary.

4. Bolt units to the floor with 3/8 of an inch stainless steel expansion anchors and bolts or weld to embedded steel channels.

5. Grout or caulk enclosure to floor or pad.

B. CONDUIT CONNECTIONS

1. Provide bushings on conduits entering from above or at the sides.

2. Provide grounded insulating bushings bonded to the ground bus or pad on conduits entering from below.

C. WIRING IN WIREWAYS

Arrange conductors into groups, and bundle and wrap with wire ties.

D. Prior to energization, remove bracing, packing materials, tape on movable parts, etc., as necessary. Check for damage to enclosure, cracked porcelain, chipped bushings, etc.

3.2 IDENTIFICATION

Identify field-installed wiring and components and provide warning signs as specified in Section 16050.

3.3 GROUNDING

Connect equipment grounding conductors to ground bus, except for circuits requiring isolated grounding.

Provide ground continuity to facility electrical ground system as indicated.

3.4 CONNECTIONS

Clean splice plates with Stoddard's Solvent before assembling.

Assemble all shipping splits.

Tighten bus splices, electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

Check factory connections for proper torque.

3.5 FIELD QUALITY CONTROL

A. TESTING

1. Prior to Energization

Provide third party breakers testing per Specification 16050, Section 3.

After installing disconnect switches and circuit breakers, perform visual and mechanical inspection of enclosure and devices.

Check connections and mounting for proper torque.

Remove any burrs, filings, or other foreign materials from enclosure. Completely wipe down and vacuum enclosure.

2. After Energization

After electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

Correct malfunctioning units on site where possible and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

3.6 ADJUSTING

Tighten all structural connections, barriers, racking mechanisms, etc.

Check alignment of plug-in devices with stationary parts.

Check operating mechanisms for binding, lubrication, etc.

Set field-adjustable switches and circuit-breaker trip ranges as indicated.

Check continuity and phase uniformity from unit to unit and for all control or metering circuits.

3.7 CLEANING

Vacuum equipment clean after installation; remove metal cuttings with a magnet or suitable means before assembling equipment; wipe insulating supports, bushings, etc., with a clean lint-free cloth; clean debris, shavings, etc., from breakers, bus, switches, relays, and similar components before startup.

***** END OF SECTION *****

SECTION 16460

LOW VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section consists of dry-type distribution and specialty transformers rated 1000 V and less.

1.2 RELATED WORKS SPECIFIED ELSWHERE

Section	Item
01300	Submittals
16050	Basic Electrical Materials and Methods

1.3 SUBMITTALS

Submit under the provisions of Section 01300.

A. PRODUCT DATA

Submit the following:

1. Nameplate ratings
2. Mounting methods
3. Dimensioned plans, sections, elevation views and minimum clearances

B. WIRING DIAGRAMS

Submit manufacturer's wiring diagrams and clearly identify terminals for tap changing and connecting field-installed wiring.

C. FIELD TEST REPORTS

Indicate and interpret test results for tests specified in Part 3.

D. MAINTENANCE DATA

Include in the maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

See Section 16050

1.5 DELIVERY, STORAGE, AND HANDLING

Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit throughout periods during which equipment is not energized and is not in a space that is continuously under normal control of temperature and humidity.

PART 2 PRODUCTS

2.1 MANUFACTURERS

Subject to compliance with requirements, provide transformers by one the following:

A. Cutler-Hammer/Eaton Corp.

B. GE Electrical Distribution & Control.

C. Siemens Energy & Automation, Inc.

D. Square D; Schneider Electric.

E. Federal Pacific.

2.2 TRANSFORMERS, GENERAL

A. DESCRIPTION

Factory-assembled and -tested, air-cooled units of types and sizes specified, designed for 60-Hz service.

B. CORES

Grain-oriented, nonaging silicon steel.

C. COILS

Continuous copper windings without splices, except for taps.

D. INTERNAL COIL CONNECTIONS

Brazed or pressure type.

E. ENCLOSURE

Class complies with NEMA 250 for the environment in which installed.

F. SOUND LEVELS

Manufacturer shall guarantee not to exceed the following:

1. Up to 9 kVA: 40 dB.

2. 10 to 50 kVA: 45 dB.

G. EFFICIENCY

Ventilated, dry type, 15 kVA and larger: Energy efficient meeting DOE 2016 requirements.

2.3 GENERAL-PURPOSE DISTRIBUTION AND POWER TRANSFORMERS

Comply with NEMA ST 20 and list and label as complying with UL 1561.

A. CORES

One leg per phase.

B. WINDINGS

One coil per phase in primary and secondary.

C. ENCLOSURE

As follows unless otherwise indicated.

1. Indoor, ventilated.

D. INSULATION CLASS

185 or 220 degrees C class for transformers 15 kVA or smaller;
220 degrees C class for transformers larger than 15 kVA.

1. Rated Temperature Rise

150 degrees C maximum rise above 40 degrees C for 220 degrees C class insulation; 115 degrees C maximum rise for 185 degrees C class insulation.

E. TAPS

For transformers 3 kVA and larger, full-capacity taps in high-voltage windings are as follows:

1. Taps, 3 through 25 kVA

Two 5-percent taps below rated high voltage.

2. Taps, 25 through 500 kVA

Six 2.5-percent taps, 2 above and 4 below rated high voltage.

F. WALL-MOUNTING BRACKETS

Manufacturer's standard brackets for wall mounted transformers up to 75 kVA.

2.4 CONTROL AND SIGNAL TRANSFORMERS

A. Units comply with NEMA ST 1 and are listed and labeled as complying with UL 506.

B. RATINGS

Continuous duty. If rating is not indicated, provide capacity exceeding peak load by 50 percent minimum.

C. DESCRIPTION

Self-cooled, 2 windings.

2.5 FINISHES

A. INDOOR UNITS

Manufacturer's standard paint over corrosion-resistant pretreatment and primer.

B. OUTDOOR UNITS

Comply with ANSI C57.12.28.

2.6 SOURCE QUALITY CONTROL

Design and routine factory tests comply with referenced standards.

PART 3 EXECUTION

3.1 INSTALLATION

Comply with safety requirements of IEEE C2.

Arrange equipment to provide adequate spacing for access and for circulation of cooling air.

Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.2 GROUNDING

Comply with NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near the transformer.

Comply with Division 16 Section "Grounding and Bonding" for materials and installation requirements.

3.3 FIELD QUALITY CONTROL

Test to ensure transformer is operational within industry and manufacturer's tolerances, is installed according to the Contract Documents, and is suitable for energizing.

A. TESTS

Include the following minimum inspections and tests according to manufacturer's written instructions.

1. Inspect accessible components for cleanliness, mechanical and electrical integrity, and damage or deterioration. Verify that temporary shipping bracing has been removed. Include internal inspection through access panels and covers.

2. Inspect bolted electrical connections for tightness according to manufacturer's published torque values or, if not available, those specified in UL 486A and UL 486B.

3. Insulation Resistance: Perform megohmmeter tests of primary and secondary winding to winding and winding to ground.

B. TEST FAILURES

Compare test results with specified performance or manufacturer's data. Correct deficiencies identified by tests and retest. Verify that transformers meet specified requirements.

3.4 CLEANING

On completion of installation, inspect components. Remove paint splatters and other spots, dirt, and debris. Repair scratches and mars on finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.

3.5 ADJUSTING

After installing and cleaning, touch up scratches and mars on finish to match original finish.

Adjust transformer taps to provide optimum voltage conditions at utilization equipment throughout normal operating cycle of facility. Record primary and secondary voltages and tap settings and submit with test results.

***** END OF SECTION *****

SECTION 16510

INTERIOR LUMINAIRES

PART 1 GENERAL

1.1 SCOPE

This work specified in this Section covers interior lighting devices, including luminaires, lamps, and power supplies, along with lighting accessories and controls; as well as luminaire mounting, installation, lamping, and testing.

1.2 RELATED WORKS SPECIFIED ELSEWHERE

Section	Item
01300	Submittals
16050	Basic Electrical Materials and Methods

1.3 DEFINITIONS

A. BALLAST

The power circuit of a gas-discharge (fluorescent, HID, etc.) lamp. Ballasts are either inductive or electronic.

B. COLOR RENDERING INDEX (CRI)

A figure-of-merit adopted by the Department of Energy that quantifies the color accuracy of lighting devices compared to incandescent light. CRI is normalized such that a score of 100 represents the output of an incandescent lamp.

C. COLOR TEMPERATURE

The color of the light produced by a particular lighting device, measured in kelvin. A higher kelvin temperature results in a “cooler” blue light, while lower kelvin temperatures are “warmer,” and more orange.

D. DIFFUSER

A modifier placed in front of a lamp to change the light intensity and distribution. Part of a LUMINAIRE.

E. DRIVER

The power circuit of an LED LAMP. May be part of a luminaire, or integrated into the lamp itself.

F. EMERGENCY LUMINAIRE

A LUMINARE intended to automatically supply illumination to critical areas in the event of failure of the normal supply.

G. ENGINE

See DRIVER in this section.

H. EXIT LIGHT

An illuminated sign or LUMINAIRE intended to indicate the path of egress. An exit light may or may not be an EMERGENCY LUMINAIRE.

I. GAS-DISCHARGE LAMP

General category of lamps that produce light by discharge of electricity through ionized gas. Types include Fluorescent and High-Intensity Discharge (HID). Powered by a BALLAST.

J. LAMP

The part of a LUMINAIRE that produces light.

K. LED LAMP

A lamp that uses Light Emitting Diodes (LEDs) to produce useful light. Powered by a DRIVER.

L. LUMEN MAINTENANCE FACTOR

The percent of the rated lumen output of a lamp still available after a specified period of time. A lamp capable of only half of its original output after will have a lumen maintenance factor of 0.50 or **L50**. May be used to specify the performance of a lamp after a particular number of hours, or the number of hours of operation at a particular level.

M. LUMINAIRE

A complete lighting device, exit light, or emergency lighting device. Luminaires consist of one or more LAMPS mounted in a fixture, along with DRIVERS or BALLASTS to power them, and lenses or diffusers to provide the correct lighting distribution.

N. OCCUPANCY SENSOR

A control device that switches a lighting circuit when a space is occupied.

O. PHOTOCELL

A control device that switches a lighting circuit in response to ambient light level.

P. TOTAL HARMONIC DISTORTION (THD)

The ratio of the root mean square of the harmonic content of a voltage or current signal, expressed as a percent of the magnitude of the fundamental.

1.4 REFERENCES

All applicable ANSI and UL standards.
IES LM-79, LM-80, TM-21.
NFPA 70 [NEC] (latest edition, with Washington State Amendments).
Washington State Energy Code (latest edition).
Washington State Administrative Code [WAC] (current edition).
International Building Code (latest edition, with Washington State Amendments).

1.5 SUBMITTALS

Submit under the provisions of Section 01300.

For each required product, submit data sheets with detailed descriptions of the product to be purchased. Identify each data sheet with the corresponding entry on the Lighting Schedule or Bill of Materials. Where data sheets offer a range of options and accessories, mark or highlight each selection, along with all final part numbers.

A. Submit on each luminaire in the Lighting Schedule. Submittal shall contain the following information, as a minimum:

1. Manufacturer and part number.

2. Product dimensions and weight.

3. Product environmental rating (NEMA rating).

4. Electrical ratings:

    a. Voltage, Current, and Power
    b. Power factor
    c. Efficacy

5. Lighting metrics:

    a. Lumen output
    b. Lumen maintenance factor at 25,000 hours
    c. Color temperature
    d. Color Rendering Index (CRI)
    e. Lighting distribution

6. Regulatory approvals and certifications, including NRTL listing

7. Battery and charging data (if applicable).

B. Submit on all lighting controls (switches, photocells, occupancy sensors, etc.). Submittal shall contain the following information, as a minimum:

1. Manufacturer and part number.

2. Product dimensions and weight.

3. Environmental rating (NEMA rating).

4. Electrical ratings (Voltage, Current, and Power).

5. Regulatory approvals, certifications, and labels.

6. Wiring diagrams showing both factory- and field-installed wiring for the specific application in this Project. Differentiate between factory- and field-installed wiring.

C. Submit maintenance data for luminaires and lighting controls in the operation and maintenance manual specified in Section 01300.

1.6 QUALITY ASSURANCE

See Section 16050. Coordinate luminaires, mounting hardware, and trim with all other items to be mounted on the ceiling, and all reserved or classified areas, including work of other trades.

1.7 EXTRA MATERIALS

Reference Specification Section 16050 for spare parts.

1.8 WARRANTY

A. WARRANTY

1. The manufacturer shall warrant the materials and workmanship of all luminaires for a minimum of 2 years from the time of Substantial Completion.

2. The warranty shall be comprehensive and shall include all components included in the luminaire package.

3. If during the warranty period the manufacturer refuses to honor a claim due to the actions of the contractor, the contractor shall replace all affected items at no cost to the owner.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. AVAILABLE MANUFACTURERS

Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include the following:

1. Acuity Brands, Inc.; Holophane, Lithonia

2. Eaton Corp.

3. GE Lighting

4. OSRAM Sylvania, Inc.

B. “OR EQUAL” PRODUCTS

Luminaires shall be the products specified in the Lighting Schedule in the Plans, or equal. Substitute products shall:

1. Use the same lighting technology (LED, Fluorescent, etc.) as the specified luminaire,

2. Have the same lumen output, color temperature, CRI, and IES distribution,

3. Not have an input wattage greater than 110 percent of the specified luminaire, and,

4. Have the same environmental ratings.

2.2 LUMINAIRES

A. POWER

1. Luminaires shall be powered at the voltage specified in the Lighting Schedule.

2. Power supplies, including ballasts, drivers, and transformers, shall be self-contained within luminaires.

B. QUALITY

1. MANUFACTURER LABELS AND MARKINGS

The exterior of lenses and diffusers shall have no visible logos, labels, trademarks, or monograms.

2. METAL PARTS

Metal parts shall be free from burrs, scratches, and sharp corners and edges.

3. TRANSMITTING AND REFLECTING SURFACES

Luminaires shall be provided and installed with all transmitting and reflecting surfaces required to produce the same distribution as the luminaires used as the basis of design, as shown in the Lighting Schedule.

4. FINISH

Provide manufacturer's standard finish, except where otherwise indicated, applied over corrosion-resistant treatment or primer. Finish shall be free from streaks, runs, holidays, stains, blisters, and other defects.

C. MAINTENANCE ACCESS

Any parts of luminaires not subject to the manufacturer's warranty shall be accessible for maintenance and owner-replaceable.

D. UV RADIATION

LED Luminaires shall not emit UV radiation

Luminaires fitted with gas discharge lamps shall block at least 99 percent of the UV radiation emitted by the lamps.

E. WET LOCATION LUMINAIRES

Unless otherwise stated in the Plans, luminaires installed in wet locations shall be rated:

1. NEMA 3R where not subject to splashing or hose-directed water.

2. NEMA 4 where subject to splashing or hose-directed water.

3. NEMA 4X where subject to corrosion or exposed to the process.

Contractor shall provide all materials required to obtain labeled environmental ratings.

F. HAZARDOUS (CLASSIFIED) LOCATION LUMINAIRES

Luminaires shall be NRTL listed for installation in the specific class, division, and group marked in the Plans (see Schedule of Classified Areas; Lighting Schedule).

G. FUSED LUMINAIRES

Provide fused luminaires for applications:

1. Installed more than eight feet above the floor;

2. Powered by 277 V circuits; or

3. Where required by code.

Install a listed fuse and fuse holder approved for the application by the luminaire manufacturer.

H. EMERGENCY AND BATTERY BACKED LUMINAIRES

All emergency luminaires shall be UL 924 listed. Additionally, emergency luminaires located in classified areas shall be UL 844 listed.

Emergency luminaires shall have the following features:

1. Self-contained internal battery, rated to provide a minimum of 90 minutes of emergency level illumination in the event of a power failure.

I. EXIT LIGHTS

All exit lights shall be UL 924 listed, and shall have the following features:

1. Internal illumination, always on.

2. Illuminated arrow indicating direction of egress.

3. Self-contained internal battery, rated to provide a minimum of 90 minutes of emergency level illumination in the event of a power failure.

4. 120VAC input power unless stated otherwise on the Plans.

2.3 LIGHTING TECHNOLOGIES

Each luminaire shall use the technology specified in the lighting schedule.

A. LED LUMINAIRES

LED Luminaires shall conform to UL 1598 (Luminaires) and UL 8750 (LED Equipment for Use in Lighting Products).

1. Drivers

   LED Drivers shall be manufacturer approved for the specific model of luminaire to be installed. Drivers shall meet the following specifications:

   a. UL 8750 listed.

   b. Certified by NRTL acceptable to the State of Washington.

   c. Compliant with FCC Part 15, Class A.

   d. Power Factor: greater than 0.90.

   e. Supply circuit THD: less than 10 percent.

   f. Temperature Rating: -20 to +40 degrees Celsius.

2. Lamps

   LED Lamps shall be an integral part of the luminaire, and rated to last the entire design lifetime of the luminaire. LED lamps shall have the following specifications:

   a. Color Temperature: 4000K, unless otherwise indicated.

   b. CRI: at least 80 CRI.

   c. Lamp Life: at least 60,000 hours, L80.

PART 3 EXECUTION

3.1 INSTALLATION

A. COORDINATION WITH OTHER WORK

1. Coordinate lighting with general electrical work, and with other trades.

2. Locate luminaires outside of classified areas and reserved electrical space, unless explicitly called for by the Plans.

3. Process equipment and piping has priority over lighting. Luminaires shall be placed to avoid conflict with the process and maintenance thereof.

4. Heating, Ventilation, and Air Conditioning (HVAC) equipment and ductwork has priority over lighting. Luminaires shall be placed to avoid conflict with HVAC.

5. Maintenance vehicle access has priority over lighting. Luminaires shall be placed to not impede maintenance vehicles.

6. Luminaires shall be mounted parallel to finished floor or grade, with no tilt angle unless explicitly called for by the Plans.

7. Adjust stem or chain lengths to suit field conditions where indicated mounting heights are not feasible.

B. LUMINAIRE SUPPORTS

1. Install luminaires with supports, brackets, and trim recommended by the luminaire manufacturer.

2. Bottom of luminaires shall be at the elevation noted in the Plans.

3. Luminaires shall be secured by manufacturer hardware and fasteners. Nails shall not be used to secure luminaires.

4. Supports shall be rated for four times the weight of the luminaire, or 45 kilograms (100 lbs.), whichever is greater. Luminaires weighing more than 23 kilograms (50 lbs.) shall be supported independently from the outlet box.

5. Luminaires shall be supported from building structure or ceiling framing. Provide additional framing to support luminaires that cannot be directly mounted to structural members. Structural integrity shall not be compromised due to installation of luminaires.

6. Hanging luminaires shall be supported at each quarter point and every 8 feet, minimum, by hardware that cannot be dislodged by upward force. Pendants and rods over 120-centimeters long (48 inches) shall be braced to limit swinging.

7. Luminaires in grid-type ceilings shall be supported by additional wires at each corner, independently anchored to the structural system above. Wires shall be the same type and size as the wires supporting the grid ceiling structure.

8. Surface-mounted luminaires shall be installed flush and tight to the finished ceiling. Surface-mounted luminaires more than 45-centimeters wide (18 inches) shall be supported at each corner, in addition to the outlet box.

9. Fluorescent luminaires with lamps longer than 120 centimeters (48 inches) shall be supported independently from the outlet box.

C. INSTALLATION METHODS

1. Unless preempted by other work, luminaires shall be installed at the positions and spacings shown on the Lighting Plan(s). Inform the Engineer of all lighting changes in writing. Plan symbols show the required position of the center of each luminaire, but may be undimensioned.

2. Luminaires in rows or grids shall be installed true to line. Continuous runs of luminaires shall be installed straight and true, with manufacturer's joining hardware.

3. Luminaires located in a common area shall be installed at the same level.

D. ELECTRICAL CONNECTIONS

1. All luminaires shall be grounded.

2. Each luminaire shall be powered by the circuit and operated by the control device(s) shown on the Plans.

3. All luminaires shall be connected according to manufacturer's wiring diagrams.

4. All screw terminals shall be torqued to manufacturer's specifications. If no torque values are published by the manufacturer, terminals shall be torqued to values specified in UL 486A.

5. All luminaires (except emergency luminaires and exit luminaires) shall be fitted with NEC 410.130(G)-type luminaire disconnect plugs. Ideal PowerPlug or equal.

6. Emergency and battery-backed luminaires shall be supplied by both switched lighting conductors AND unswitched charging conductors, powered by the same circuit.

7. Power conductors to exit lights shall not be switched.

E. LIGHTING CONTROLS

Lighting controls shall be installed according to the Plans.

Process areas shall have manual lighting controls.

Restrooms, garages, storage rooms, and other enclosed non-process spaces shall have occupancy sensors.

F. LAMPING

Lamps shall be selected and installed according to the Lighting Schedule and manufacturer's instructions.

Test lamp sockets and holders before installing lamps.

G. ENVIRONMENTAL RATINGS

Installation of luminaires shall meet all manufacturer requirements to maintain labeled environmental ratings.

H. CLEANING

Thoroughly clean dirt and debris from all internal and external surfaces. Vacuum interior of luminaires after installation.

Prior to commissioning, wipe all transmitting and reflecting surfaces with damp cloth.

I. SAFE DISPOSAL

Disposal of lamps and luminaires containing hazardous materials (mercury, etc.) shall comply with state and local rules.

3.2 FIELD QUALITY CONTROL

A. DAMAGED LUMINAIRES

During commissioning, Contractor shall inspect each installed luminaire for damage. Damaged luminaires and components shall be replaced at no cost to the owner. Contractor shall replace any transmitting or reflecting

surface that is scratched, shattered, or otherwise damaged before completion of work at no cost to the owner.

Metal parts that demonstrate corrosion during the project warranty period shall be replaced at no cost to the owner.

Contractor shall provide replacements for any lamps that fail prior to completion of work.

B. TESTING

Contractor shall demonstrate normal operation of each luminaire. Contractor shall interrupt electrical power to demonstrate proper operation of emergency luminaires.

Malfunctioning luminaires and components shall be repaired or replaced, then tested again.

Contractor shall demonstrate each lighting control to show correct operation, and repair or replace malfunctioning controls.

*****END OF SECTION*****

SECTION 16520

EXTERIOR LUMINAIRES

PART 1 GENERAL

1.1 SUMMARY

The work specified in this Section covers exterior lighting devices, including luminaires, lamps, and power supplies; along with outdoor lighting accessories and controls; as well as outdoor mounting hardware, light poles, and accessories; and luminaire mounting, installation, lamping and testing.

1.2 RELATED SPECIFIED ELSEWHERE

Section	Item
01300	Submittals
16050	Basic Electrical Materials and Methods

1.3 DEFINITIONS

A. BALLAST

The power circuit of a gas-discharge (fluorescent, HID, etc.) lamp. Ballasts are either inductive or electronic.

B. DRIVER

The power circuit of an LED Lamp. May be part of a luminaire, or integrated into the lamp itself.

C. EXTERIOR LUMINAIRE

Any LUMINAIRE mounted in an OUTDOOR AREA (as defined in Specification Section 16050).

D. GAS-DISCHARGE LAMP

General category of lamps that produce light by discharge of electricity through ionized gas. Types include Fluorescent and High-Intensity Discharge (HID). Powered by a BALLAST.

E. LAMP

The part of a LUMINAIRE that produces light.

F. LED LAMP

A lamp that uses an array of Light Emitting Diodes (LEDs) to produce useful light. Powered by a DRIVER.

G. LUMEN MAINTENANCE FACTOR

The percent of the rated lumen output of a lamp still available after a specified period of time. A lamp capable of only half of its original output after will have a lumen maintenance factor of 0.50 or **L50**.

H. LUMINAIRE

A complete lighting device, exit light, or emergency lighting device. Luminaires consist of one or more LAMPS mounted in a fixture, along with DRIVERS or BALLASTS to power them, and lenses or diffusers to provide the correct lighting distribution.

I. PHOTOCELL

A control device that switches a lighting circuit in response to ambient light level.

J. TOTAL HARMONIC DISTORTION (THD)

Total Harmonic Distortion (THD) is defined as the ratio of the sum of the levels of all harmonic components to the level of the fundamental frequency.

1.4 REFERENCES

All applicable ANSI standards.
American Association of State Highway and Transportation Officials [AASHTO]
UL 844, 924, 935, 1029, 1598, 8750.
IES LM-79, LM-80, TM-21.
NFPA 70 [NEC] (latest edition, with Washington State Amendments).
Washington State Energy Code (latest edition).
Washington State Administrative Code [WAC] (current edition).
International Building Code (latest edition, with Washington State Amendments).

1.5 SUBMITTALS

Submit under the provisions of Section 01300.

For each required product, submit data sheets with detailed descriptions of the product to be purchased. Identify each data sheet with the corresponding entry on the Lighting Schedule or Bill of Materials. Where data sheets offer a range of options and accessories, mark or highlight each selection, along with all final part numbers.

A. Submit on each luminaire in the Lighting Schedule. Submittal shall contain the following information, as a minimum:

1. Manufacturer and part number.

2. Product dimensions and weight.

3. Environmental rating (NEMA rating).

4. Electrical ratings:

    a. Voltage, Current, and Power

    b. Power factor

    c. Efficacy

5. Lighting metrics:

    a. Lumen output

    b. Lumen maintenance factor

    c. Color temperature

    d. Color Rendering Index (CRI)

    e. Lighting distribution

6. Regulatory approvals, certifications, and labels.

B. Submit on all lighting controls (photocells, motion detectors, etc.). Submittal shall contain the following information, as a minimum:

1. Manufacturer and part number.

2. Product dimensions and weight.

3. Environmental rating (NEMA rating).

4. Electrical ratings (Voltage, Current, and Power).

5. For luminaires to be mounted on poles:

a. Effective Projected Area (EPA)

6. Regulatory approvals, certifications, and labels.

7. Detailed wiring diagrams showing both factory- and field-installed wiring for the specific application in this Project. Differentiate between factory- and field-installed wiring.

C. Submit on all light poles. Submittal shall contain the following information as a minimum:

1. Manufacturer and part number.

2. Detailed dimensions and weight.

3. Mounting height.

4. Anchor bolt design.

5. Regulatory approvals, certifications, and labels.

6. Color and manufacturer finish.

D. Submit maintenance data for luminaires and lighting controls in the operation and maintenance manual specified in Section 01300.

1.6 QUALITY ASSURANCE

See Section 16050. Coordinate luminaires, mounting hardware, light poles with all other items to be mounted on the exterior of buildings, or on the facility grounds, including the work of other trades.

1.7 EXTRA MATERIALS

Reference Specification Section 16050 for spare parts.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. AVAILABLE MANUFACTURERS

Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include the following:

1. Acuity Brands, Inc.; Holophane, Lithonia

2. Eaton Corp.; Crouse-Hinds, Cooper

3. GE Lighting

4. OSRAM Sylvania, Inc.

B. "OR EQUAL" PRODUCTS

Luminaires shall be the products specified in the Lighting Schedule in the Plans, or equal. Substitute products shall:

1. Use the same lighting technology (LED, Fluorescent, etc.) as the specified luminaire,

2. Have the same lumen output, CRI, and IES distribution,

3. Not have an input wattage greater than 110 percent of the specified luminaire, and,

4. Have the same environmental rating.

Light poles shall be the products specified in the Lighting Schedule in the Plans, or equal. Substitute products shall:

1. Have the same dimensions (including weight) as the specified light pole,

2. Have the same mounting height and weight/EPA ratings,

3. Meet the harmonic vibration requirements, and,

4. Have the same finish.

2.2 LUMINAIRES

A. POWER

1. Luminaires shall be powered at the voltage specified in the Lighting Schedule.

2. Power supplies, including ballasts, drivers, and transformers, shall be self-contained within luminaires.

B. QUALITY

1. Manufacturer Labels and Markings

The exterior of lenses and diffusers shall have no visible logos, labels, trademarks, or monograms.

2. Metal Parts

a. Metal parts shall be free from burrs, scratches, and sharp corners and edges.

b. Sheet metal components shall be corrosion-resistant aluminum, except as otherwise indicated. Sheet metal shall be formed and supported to prevent warping and sagging.

c. Exposed structural metal shall be stainless steel.

3. Reflecting Surfaces

Minimum reflectance shall be as follows, except as otherwise indicated:

a. White surfaces: 85 percent.

b. Specular surfaces: 83 percent.

c. Diffusing specular surfaces: 75 percent.

d. Laminated silver metallized film: 90 percent.

4. Transmitting Surfaces

Transmitting surfaces (including lenses, diffusers, covers, globes, etc.) shall be 100 percent acrylic plastic or water-white, annealed crystal glass, except as otherwise indicated.

a. Plastic

High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

b. Lens Thickness

Minimum 3mm (1/8 inch), except where greater thickness is specified.

5. Finish

Provide manufacturer's standard finish, except where otherwise indicated, applied over corrosion-resistant treatment or primer. Finish shall be free from streaks, runs, holidays, stains, blisters, and other defects.

C. HOUSING

1. Luminaire housings shall be rigidly-formed, light-tight enclosures that will not warp, sag, or deform with use.

2. Luminaire housings shall have one of the following environmental ratings:

a. NEMA 3R where not subject to splashing or hose-directed water.

b. NEMA 4 where subject to splashing or hose-directed water.

c. NEMA 4X where subject to corrosion, or exposed to process.

3. Contractor shall provide all materials required to obtain labeled environmental ratings.

D. HAZARDOUS (CLASSIFIED) LOCATION LUMINAIRES

All luminaires shall be placed outside of the boundaries of classified locations.

E. FUSED LUMINAIRES

Provide fused luminaires for applications:

1. Installed more than eight feet above the floor,

2. Powered by 277 V circuits, or,

3. Where required by code.

Install a listed fuse and fuse holder approved for the application by the luminaire manufacturer.

2.3 LIGHTING TECHNOLOGIES

Each luminaire shall use the technology specified in the lighting schedule.

A. LED LUMINAIRES

LED Luminaires shall conform to UL 1598 (Luminaires) and UL 8750 (LED Equipment for Use in Lighting Products). LED luminaires shall have a manufacturer warranty of at least two years.

1. Drivers

LED Drivers shall be manufacturer approved for the specific model of luminaire to be installed. Drivers shall meet the following specifications:

a. UL 8750 listed.

b. Certified by NRTL acceptable to the State of Washington.

c. Compliant with FCC Part 15, Class A.

d. Power Factor: greater than 0.90.

e. Supply circuit THD: less than 10 percent.

f. Temperature Rating: -20 to +40 degrees Celsius.

2. Lamps

LED Lamps shall be an integral part of the luminaire, and rated to last the entire design lifetime of the luminaire. LED lamps shall have the following specifications:

a. Color Temperature: 4000K, unless otherwise indicated.

b. CRI: at least 80 CRI.

c. Lamp Life: at least 60,000 hours, L80.

2.4 LIGHT POLES

Light poles shall have the design and dimensions specified in the Lighting Schedule.

All light poles shall meet current AASHTO standards, and shall be certified by an NRTL acceptable to the State of Washington.

A. HAND HOLE

All light poles shall have integral hand holes within two feet of the base.

1. The hand hole shall be large enough to accommodate all electrical connections required by the plans.

2. The hand hole shall have one of the following environmental ratings:

a. NEMA 4X where subject to corrosion, or exposed to process.

3. The handhole cover shall be the same material, color, and finish as the light pole.

4. Light pole shall have a grounding terminal, located in the hand hole.

B. MECHANICAL RATINGS

The light pole shall have sufficient capacity to support all associated luminaires. Pole and luminaire installation shall be coordinated with, and rated for, the environmental conditions as listed on the Structural sheets.

C. HARMONIC VIBRATION

Where calculations suggest the combination of light pole and installed luminaire(s) will be subject to harmonic vibration, provide a damping device approved by the light pole manufacturer.

D. COORDINATION

The mounting system for the light pole, including the bolt pattern and cable entry, shall be coordinated before pouring the foundation.

Coordinate the light pole with the specified luminaires, so that the light pole is fully compatible with the luminaires to be installed.

PART 3 EXECUTION

3.1 INSTALLATION

A. COORDINATION WITH OTHER WORK

1. Coordinate lighting with general electrical work, and with other trades.

2. Locate luminaires outside of classified areas and reserved electrical space, unless explicitly called for by the Plans.

3. Process equipment and piping has priority over lighting. Luminaires shall be placed to avoid conflict with the process and maintenance thereof.

4. Heating, Ventilation, and Air Conditioning (HVAC) equipment and ductwork has priority over lighting. Luminaires shall be placed to avoid conflict with HVAC.

5. Vehicle access has priority over lighting. Luminaires shall be placed to maintain required clearance above right-of-way.

6. Adjust mounting heights to suit field conditions where indicated heights are not feasible.

B. LUMINAIRE SUPPORTS

1. Install luminaires with supports, brackets, and trim recommended by the luminaire manufacturer.

2. Luminaires shall be secured by manufacturer hardware. Nails shall not be used to secure luminaires.

3. Luminaires mounted on light poles shall be installed with manufacturer hardware. Luminaires shall be mounted and wired before raising the light pole.

4. Luminaires mounted on building exterior.

C. INSTALLATION METHODS

1. Unless preempted by other work, luminaires shall be installed at the positions and spacings shown on the Lighting Plan(s). Inform the Engineer of all lighting changes in writing. Plan symbols show the required position of the center of each luminaire but may be un-dimensioned.

2. Luminaires in rows or grids shall be installed true to line. Continuous runs of luminaires shall be installed straight and true, with manufacturer's joining hardware.

3. Luminaires located in a common area shall be installed at the same level.

D. ELECTRICAL CONNECTIONS

1. All luminaires and light poles shall be grounded.

2. Each luminaire shall be powered by the circuit and operated by the control device(s) shown on the Plans.

3. All luminaires shall be connected according to manufacturer's wiring diagrams.

4. Each light pole shall have a luminaire disconnect, located in the hand hole. The luminaire disconnect shall deenergize all current-

carrying conductors serving the light pole, comply with NEC 410.130 (G), and shall be listed.

3.2 FIELD QUALITY CONTROL

A. DAMAGED HARDWARE

During commissioning, Contractor shall inspect each lighting device. Damaged luminaires, supports, and components shall be replaced at no cost to the owner. Contractor shall replace any transmitting or reflecting surface that is scratched, shattered, or otherwise damaged before completion of work at no cost to the owner.

Metal parts that demonstrate corrosion during the project warranty period shall be replaced at no cost to the owner.

Contractor shall provide replacements for any lamps that fail prior to completion of work.

B. TESTING

Contractor shall demonstrate normal operation of each luminaire. Contractor shall interrupt electrical power to demonstrate proper operation of emergency luminaires.

Malfunctioning luminaires and components shall be repaired or replaced, then tested again.

Contractor shall demonstrate each lighting control to show correct operation, and repair or replace malfunctioning controls.

***** END OF SECTION *****

SECTION 16910

PLC HARDWARE AND SOFTWARE PROCUREMENT

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section consists of hardware and software procurement of Programmable Logic Controllers (PLCs). All equipment supplied shall be compliant with the Build America Buy America Act (BABA).

For programming requirements, reference specification 13451.

1.2 RELATED WORKS SPECIFIED ELSEWHERE

Section	Item
01300	Submittals
13451	PLC Programming
16050	Basic Electrical Materials and Methods

1.3 REFERENCES

Reference	Title
NEMA	National Electrical Manufacturers Association
ICS-1	General Standards for Industrial Control and Systems
ICS-1.1	Safety Guidelines for the Application, Installation and Maintenance of Solid State Control
ICS-4	Terminal Blocks for Industrial Use
ICS-6	Enclosures for Industrial Controls and Systems
Publication NO 250	Enclosures for Electrical Equipment (1000 V maximum)
NFPA	National Fire Protection Association
NEC	National Electric Code

1.4 SYSTEM DESCRIPTION

A. HARDWARE AND SOFTWARE REQUIREMENTS

1. The system includes racks, central processing units (CPUs), input/output (I/O) modules, communication modules, power supplies, and associated accessory items to provide a complete and functional process control system for the facility.

2. The system includes development and application software required by the PLC hardware to provide complete operation functionality for the facility.

B. PERFORMANCE REQUIREMENTS

Reference Specification Section 13451 for PLC Programming and Process Control Description.

1. The installed system is capable of performing the functional and operational algorithms required for control of the process.

1.5 DEFINITIONS

Reference specification 16050.

1.6 SUBMITTALS

A. Submit under the provisions of Specification Section 01300.

B. PRODUCT DATA

1. Submit an electronic version of the manufacturer's data sheets for hardware components including specific model numbers for each device and size of memory provided in each CPU.

2. Submit an electronic version of the manufacturer's installation and user's manuals.

3. If required by the software manufacturer provide a "runtime" license of the software to the Owner and provide copies of the license agreement to the Owner.

C. OPERATION AND MAINTENANCE MANUALS

1. Provide specific information including:

a. An electronic version of the manufacturer's published operation and maintenance manual, user's manual, and troubleshooting guide.

b. Information for obtaining assistance and troubleshooting, parts ordering information, and field service personnel requests.

1.7 QUALITY ASSURANCE

A. QUALIFICATIONS

Programmer must have testing hardware and sufficient programming experience to demonstrate operational functionality per Section 2 herein.

1.8 EXTRA MATERIALS

Reference Specification Section 16050 for spare parts.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the requirements, provide products by the following manufacturers:

1. Allen Bradley Company.

2.2 EQUIPMENT

A. Conform to NEMA ICS 1.1 for installation and application of the PLC system.

2.3 COMPONENTS

Hardware is sole sourced to BABA compliant Allen Bradley PLC products.

The PLC CPU, I/O, and communication cards shall be provided with the latest version of firmware.

A. CENTRAL PROCESSOR UNIT (CPU)

Allen Bradley: ControLogix family 1756 processors

B. ANALOG INPUT/OUTPUT (I/O) MODULES

Provide modules as defined in the PLC I/O tables in the Plans.

1. Analog Input Cards

Type 1:

Channels:	4
Input Type:	4-20 mA
Resolution:	16 bit or +/-15 bit
Differential?	Yes
Isolated?	Yes

Type 2:

Channels:	8
Input Type:	4-20 mA
Resolution:	16 bit or +/-15 bit
Differential?	Yes
Isolated?	No

2. Analog Output Cards

Type 1:

Channels:	4
Input Type:	4-20 mA
Resolution:	16 bit
Differential?	Yes
Isolated?	Yes

Type 2:

Channels:	8
Input Type:	4-20 mA
Resolution:	16 bit
Differential?	No
Isolated?	No

C. DIGITAL INPUT/OUTPUT (I/O) MODULES

Provide modules as defined in the PLC I/O tables in the Plans.

1. Digital Input Cards

Type 1:

Input Channels:	16
Input Voltage:	24 VDC
Signal Polarity:	Sinking/Sourcing (configure card for sourcing; +24VDC = true)

Type 2:

Input Channels:	32
Input Voltage:	24 VDC
Signal Polarity:	Sinking/Sourcing (configure card for sourcing; +24VDC = true)

2. Digital Output Cards

Type 1:

Output Channels:	16
Output Voltage:	24 VDC
Signal Polarity:	Sourcing

Type 2:

Output Channels:	32
Output Voltage:	24 VDC
Signal Polarity:	Sourcing

Type 3:

Output Channels:	16
Output Voltage:	Relay, Form A

Type 4:

Output Channels:	16
Output Voltage:	120 VAC
Signal Polarity:	Sourcing

D. POWER SUPPLY UNITS

1. For racks using separate power supplies, use the largest power supply available for that specific rack.

2.4 ACCESSORIES

Provide all accessories required, whether indicated or not, for a complete PLC control system to accomplish the requirements of the Plans and Specifications.

2.5 SOURCE QUALITY CONTROL

A. SHOP TEST

1. Submit a shop test plan indicating how the test will be conducted, and how equipment operation will be verified.

2. Provide a shop test after factory assembly of the PLC control panel and prior to shipment including the following:

   a. Conduct a burn-in period (minimum of 2 days) where the system is powered continuously and checked for proper operation and operating temperature.

   b. Provide sufficient PLC programming to demonstrate PLC I/O testing. Include a PC with sufficient software tools to allow visual demonstration of each digital/analog input status/value and be capable of forcing digital and analog outputs. Coordinate effort with PLC programmer if required (reference Specification Section 13451).

   c. Utilize dummy I/Os to verify proper operation.

   d. Demonstrate that all PLC hardware is fully functional.

   e. Allow for Owner and/or Engineer representatives to witness the shop test. Provide a minimum of 15 days notice prior to test.

   f. Do not ship the system prior to successful completion of this testing.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install PLC control system in accordance with manufacturer's written instructions.

B. Test, verify and demonstrate access to and functionality of PLC system.

***** END OF SECTION *****

SECTION 16920

HMI HARDWARE AND SOFTWARE PROCUREMENT

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section consists of hardware and software procurement of Human Machine Interface (HMI) computers and associated support devices used for the SCADA system.

For HMI programming requirements, reference specification 13452.

1.2 RELATED WORKS SPECIFIED ELSEWHERE

Section	Item
01300	Submittals
13451	PLC Programming
13452	HMI Programming
16050	Basic Electrical Materials and Methods
16910	PLC Hardware and Software Procurement

1.3 SYSTEM REQUIREMENTS

A. Provide all HMI hardware and peripheral support devices as described herein. Include all required connectors, adapters, chargers, and cables for a complete operational system.

B. Provide all software packages, licenses, and drivers required for a complete operational system

1.4 DEFINITIONS

Reference Specification Section 16050.

1.5 SUBMITTALS

A. Submit under the provisions of Specification Section 01300.

B. PRODUCT DATA

1. Manufacturer’s information for hardware.

2. Manufacturer's information for software components including specific versions or release numbers for each program, module, driver, or similar software.

3. Licensing and tag counts for HMI software.

C. OPERATION AND MAINTENANCE MANUALS

1. Provide specific information including:

a. Information for obtaining assistance from the manufacturer.

1.6 SEQUENCING AND SCHEDULING

A. COMPUTER DELIVERY

1. Sequence the shipping of the HMI computer hardware and software to the HMI System Programmer within 60 days of award of Contract.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Provide products by the following manufacturers.

1. Computer Hardware

a. Dell, or equal.

2. Printer Hardware

a. Dell, or equal.

3. Computer Software

a. HMI Software Package: Factory Talk SE

b. Alarm Dialer Software: Win-911 or equal

c. Remote access software for operator remote view of the system.

4. Computer OS: Windows 11

2.2 COMPONENTS

A. HMI COMPUTER(S)

Provide the following components and performance values for the HMI Computer:

1. Software

All software licenses provided shall be licenses to the Owner within 60 days of award of contract.

a. HMI Software and Licenses

Factory Talk SE licenses as required to complete the requirements of 13451 and 13452.

b. Alarm Software

i. Win-911 Bundle, or equal.

2. Hardware, HMI Tower PC

Provide one HMI tower PC, Dell precision tower or equal.

Processor, memory, and graphics shall meet software(s) manufacturer recommended hardware, minimum hardware requirements are not acceptable.

a. Keyboard

b. Mouse

i. Two button optical with scroll.

c. Monitor

Provide two monitors as follows:

i. 21 inches.

ii. Digital flat panel.

iii. 20.1-inch viewable screen.

B. UNINTERRUPTABLE POWER SUPPLY (UPS)

Each computer shall be provided with a UPS as follows:

1. The battery for each UPS shall be sufficient to supply power for 15 minutes to the computer and the monitor specified above. The printer will not be powered from a UPS.

2. Supply any cables and software needed to allow the UPS to communicate status to the computer.

3. Manufacturer shall be APC or approved alternate.

C. PRINTER

Brother color laser printer, no other manufacturers.

1. Provide all necessary cables, power adapters, etc. needed to connect printer to the computer.

PART 3 EXECUTION

3.1 COMPUTER CONFIGURATION

A. If listed under software, install MSOffice if not preinstalled. Test for basic operation.

B. HMI and related software shall be installed by the HMI Programmer (reference Specification Section 13542).

***** END OF SECTION *****

SECTION 16940

CONTROL PANELS

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section includes control panels and custom field assemblies not provided as part of a manufacturer's system. Manufacturer's systems may also be required to meet the requirements of this section if their Division 11 specification states so.

1.2 RELATED WORKS SPECIFIED ELSEWHERE

Section	Item
01300	Submittals
16910	PLC Hardware and Software Procurement
Division 16	Electrical

1.3 DEFINITIONS

A. CONTROL PANELS

Reference Section 16050.

B. CONTROL POWER

Control power is considered electrical power at either 120 VAC or 24 VDC that powers control or instrumentation devices. Control power circuits are less than 150 VAC and less than or equal to 20 Amps.

Examples:

1. 120 VAC or 24 VDC device power to instruments such as flow meters, chlorine analyzers, dissolved oxygen transmitters, and etc.

2. 120 VAC or 24 VDC device power to control devices such as PLCs, radios, network switches, and etc.

3. 120 VAC power to control devices such as motor operated valves, metering pumps (even when through dedicated receptacles), lighting circuits (controlled within a lighting control panel), and etc.

1.4 REFERENCES

Reference	Title
NEMA	National Electrical Manufacturers Association
ICS-1	General Standards for Industrial Control and Systems
ICS-4	Terminal Blocks for Industrial Use
ICS-6	Enclosures for Industrial Controls and Systems
Publication No. 250	Enclosures for Electrical Equipment (1000 V maximum)
NFPA	National Fire Protection Association
NEC	National Electric Code
JIC-EMP-1	Joint Industrial Council

1.5 SYSTEM DESCRIPTION

A. CONTROL PANELS

1. Reference Section 16050, Definitions.

2. Control panels shall be fabricated similar to those shown on the Plans. With the exception of the discrete and analog I/O terminal blocks, the exact dimensions and component layout is not critical.

3. The system includes new control panels for control of process equipment. Some of the control panels are provided under Division 16. Some panels are provided under other Divisions with equipment specified in those Divisions. Control panels, whether provided under Division 16 or other Divisions, shall meet the requirements of this Section.

1.6 SUBMITTALS

A. SHOP DRAWINGS

1. See Section 01300.

2. Dimensioned or to-scale panel layout drawings.

3. Materials of construction.

4. Drawings showing conduit and wiring access locations.

5. Elementary wiring diagrams and terminal block drawings, differentiating between panel and field wiring.

6. Bill of Materials describing the reference name or number, quantity, complete English language description, manufacturer, model number, local supplier, and wiring or piping reference. Information shall include manufacturer name, catalog descriptions, wiring and piping diagrams, dimensional plans, anchoring details, installation instruction, and test results.

7. Loop diagrams with all components connected per ISA standards.

8. Nameplate text.

9. Heat calculations and relationship to enclosure fan, heater, air conditioner.

10. UPS system loading and resulting back-up run time.

B. OPERATION AND MAINTENANCE MANUALS

1. See Section 01300.

2. Provide manufacturer's operating and maintenance manuals for each device or item provided.

3. Recommended spare parts stocking list.

C. CONTRACTOR CERTIFICATION

1. If the submitted panel(s) are to be labelled and listed with an agency other than UL, submit proof of certification as a panel shop by that agency. For UL listed panels, the Contractor fabricating panels shall submit proof of certification as a UL 508A and/or UL 698A (if required) panel shop upon request.

1.7 QUALITY ASSURANCE

A. Make shop drawings available prior to placement of conduits in slabs to ensure placement is coordinated with panel access locations.

B. Test panels prior to shipment to project site.

1. The entire assembled panel shall be tested to be free from grounds and shorts.

2. Controllers, circuits, and interlocks shall be rung out and tested to assure that they function correctly before the panel is shipped.

Prior to placement of conduit feeds, assure approved control panel layouts are available.

C. Panels supplied under this Section are provided by a single manufacturer.

D. Provide panels labeled by a recognized testing laboratory acceptable to the State of Washington Department of Labor and Industries meeting the requirements of Article 409 of the NEC.

E. Revise all drawings upon completion of the work to show "as shipped" condition of the panel.

1.8 STORAGE AND HANDLING

A. After completion of shop assembly and testing, enclose panels in heavy-duty polyethylene envelopes or secured sheeting to provide complete protection from dust and moisture. Place dehumidifiers inside the polyethylene covering.

B. Skid-mount the equipment for final transport. Show shipping weight on shipping tags, together with instructions for unloading, transporting, storing, and handling on job site.

1.9 EXTRA MATERIALS

Reference Specification Section 16050 for spare parts.

PART 2 PRODUCTS, MATERIALS

2.1 CONTROL PANEL ENCLOSURES

A. ENCLOSURE BODIES

Control panel enclosures are factory listed and labeled enclosures fabricated of stretcher leveled steel welded into a rigid, self-supporting structure. Control panels shall be completely enclosed, welded construction, self-supporting, and gasketed dust-tight.

1. Panels mounted outdoors or in below-ground vaults shall be NEMA 4X 316L stainless steel.

Exception:

- *Unless indicated otherwise in the Plans.*

2. Panels mounted indoors shall be NEMA 1 gasketed.

Exception:

- *Unless indicated otherwise in the Plans.*

B. HINGES AND HINGE PINS

1. Provide full length (continuous) piano hinges rated for 1.5 times the weight of the door plus all door-mounted instruments.

2. Hinges shall be welded to all surfaces and shall match the metallurgy of the enclosure.

3. Hinge pins shall be 316L stainless steel on all panels.

C. MOUNTING FEET

If called for, mounting feet shall be the height indicated on the Plans and shall be made of the same material as the enclosure body that it supports.

2.2 CONTROL PANEL POWER DEVICES

A. FUSES

1. Power Circuit Fusing

Reference Specification 16410, Enclosed Switches, Fuses, and Circuit Breakers.

2. Control Power Fusing

Control power fuses are FRN for ratings above 10 amperes and FNQ for 10 amperes and below. FRN fuses are mounted in phenolic blocks with a fuse puller mounted adjacent to them. FNQ fuse holders are DIN-rail mounted type, 12A, 300 V minimum, hinged to disconnect and replace fuse, with blown fuse indicating light. Label all fuseholders with fuse identification number and fuse size and type. Provide five spare fuses of each type and size in each panel. Provide box mounted on panel interior marked "SPARE FUSES" to hold the spares.

3. PLC I/O Field Connection Fusing

a. 24 VDC Fusing

i. Fuses for 24 VDC circuits shall be 5 x 20 mm, glass body, fast acting, 250 VAC, sized by the integrator unless specifically called in the Plans or Specifications.

ii. Fuse holders for 24 VDC circuits shall be DIN-rail mounted type, provided in fusible terminal blocks, for 5 x 20 mm fuses, black, hinged to open, 10-57 VAC/VDC, with red LED blown fuse indicators, #30 AWG - #12 AWG, 15A.

b. 120 VAC Fusing

i. Fuses for 120 VAC circuits shall be 1/4" x 1-1/4", glass body, time-delay, 250 VAC, sized by the integrator unless specifically called in the Plans or Specifications.

ii. Fuse holders for 120 VAC circuits shall be DIN-rail mounted type, provided in fusible terminal blocks, for 1/4" x 1-1/4" fuses, black, 100-300 VAC, with neon blown fuse indicators, #30 AWG - #12 AWG, 15A.

B. CIRCUIT BREAKERS

1. Power Circuit Breakers

Reference Specification 16410, Enclosed Switches, Fuses, and Circuit Breakers.

2. Control Power Circuit Breakers

Control power circuit breakers shall be DIN-rail mounted type, miniature, 240 VAC, single pole, 10 kAIC (minimum) @ 240 VAC, “C” curve (inductive) trip characteristics, 1,500 VAC dielectric strength (minimum), #14 to #12 AWG 75 degrees C line and load screw terminals, UL 489, CSA 22.2 No. 5.1; Allen Bradley Bulletin 1492-SPU Series A or equal.

C. DISCONNECT SWITCHES AND ACTUATORS

1. For Power Circuits > 30 Amps

Reference Specification 16410, Enclosed Switches, Fuses, and Circuit Breakers.

2. For Power Circuits <= 30 Amps

a. For Single Phase Circuits

Load disconnect switches shall be 2-position, OFF-ON, 90 degree, 600 VAC, 20 A or 32 A rating, single pole, front door installation; Allen Bradley 194L-E **aa**-1751 or equal, where **aa** = 20 for 20 A unit and **aa** = 32 for 32 A unit.

Associated switch actuators shall be OFF-ON, 90 degree, front/door installation, IP66 rated, 22.5 mm central hole mount, square, red/yellow handle with padlock provision, 48 mm x 48 mm; Allen Bradley 194L-HC4L-175I or equal.

b. For Three Phase Circuits

Load disconnect switches shall be 2-position, OFF-ON, 90 degree, 600 VAC, 20 A or 32 A rating, 4-pole, front door installation; Allen Bradley 194L-E **aa**-1754 or equal, where **aa** = 20 for a 20 A unit and **aa** = 32 for a 32 A unit.

Load disconnect switch actuators shall be OFF-ON, 90 degree, front/door installation, IP66 rated, 22.5 mm central hole mount, square, grey/black handle with padlock provision, 64 mm x 64 mm; Allen Bradley 194L-HC6E-175I or equal.

When being used as a 3 PH motor safety disconnect switch, reference Specification 16410, Enclosed Switches, Fuses, and Circuit Breakers.

D. SURGE PROTECTIVE DEVICES

1. For Power Circuits > 150 VAC and > 30 A

Reference Plans

2. For Control Power Circuits

Control power SPDs shall protect L-N, L-G and N-G and have a minimum peak surge current of 40kA, shall have terminals that accept a #12 AWG conductor, shall be rated for the voltage shown in the Plans, shall be listed, and shall have a terminal configuration with separate Line, Neutral, and Ground connections.

Control power SPDs shall meet Mil-Std-220 for maximum EMI/RFI attenuation.

Control power SPDs shall be DIN-rail mounted, 1-inch wide maximum.

Control power SPDs shall be Cooper Bossman #BSPMA1_S2GR or equal.

3. For Telecommunications

All incoming phone and internet services shall be provided with surge protection.

a. Intermatic IG2TM or equal for twisted pair copper.

b. Intermatic IG4TM or equal for coaxial cable.

E. UPS SYSTEMS

1. 24 VDC UPS Systems

24 VDC UPS Systems shall include the 24 VDC power supplies, the converters, batteries, and redundancy modules as described herein. Each of these devices shall be DIN-rail mounted, industrial rated, packaged, and listed. Custom built circuits boards and loose electronic devices shall not be allowed. Provide a minimum of 30 minutes of backup time or that shown on the Plans, whichever is the greater.

a. A dual (paralleled) 24 VDC UPS systems shall include, as a minimum, the following devices:

i. 2x 24 VDC Power Supplies;

ii. 2x 24/12 VDC UPS Controllers;

iii. 2x 12 VDC Backup Batteries;

iv. 1x 24 VDC DC Redundancy Module.

The minimum DC UPS system shall be capable of providing 10 Amps at 24 VDC continuously. The specifications listed below are for a minimum system. Increase the system ampacity as called on the Plans.

b. 24 VDC Power Supplies

24 VDC power supplies shall be 120 VAC input, 24 VDC output, 10 A minimum, with +/- 1 percent voltage regulation from no-load to full-load. Process power supplies shall be sized by the integrator and increased in size as required. Provide the power supply sizing calculations with the product submittal.

i. 10 A: PULS #QS10.241 or equal.

c. 24 VDC UPS Controllers

DC UPS controllers shall be 24-28 VDC normal input, 12 VDC battery input with a 24 VDC, 10 A output (minimum) and a 12 VDC, 5 A output, with indicating LEDs. The unit shall monitor the battery and provide a dry contact output to indicate that the battery should be replaced.

i. 24 VDC @ 10 A, 12 VDC @ 5A: PULS #UB10.245 or equal.

d. 12 VDC Backup Batteries

Batteries shall be fully sealed gel type. Batteries shall be rated for 12 Ah (minimum) and rated to operate between -40 degrees C to 60 degrees C.

e. DC Redundancy Module

DC Redundancy Modules provide parallel connectivity of two separate 24 VDC systems and are required on all dual 24 VDC supply systems.

Provide DC Redundancy module, 24 VDC/24 VDC input, 24 VDC output, 20 Amp; PULS YR2.DIODE or equal.

F. PHASE MONITOR RELAYS (PMRS)

1. PMRs shall only be used on 3 phase power systems and shall be compatible with the voltage configuration as shown on the Plans. For 240 VAC 3 phase systems, the high leg shall be phase B.

2. PMRs shall monitor the following conditions and provide the ability to adjust trip values and time delays as described below:

a. Phase Loss

i. Trip not adjustable

ii. Time delay not adjustable, fixed at 100 msec.

b. Phase Reversal

i. Trip not adjustable

ii. Time delay not adjustable, fixed at 100 msec.

c. Phase Unbalance

i. Trip adjustable, set at 10 percent

ii. Time delay not adjustable, fixed at 2 seconds.

d. Under voltage

i. Trip adjustable, set at 80 percent of nominal voltage

ii. Time delay adjustable, set at 5 seconds.

e. Overvoltage

i. Trip not adjustable, fixed at 110 percent of nominal voltage

ii. Time delay not adjustable, fixed based on inverse time.

3. PMRs shall be provided with 1x SPDT (Form C) dry isolated contact that transitions when thresholds are exceeded for time delays described above.

4. PMRs shall be: Automation Direct, Prosense, PMRU-1C-480A or equal.

G. MOTOR START COUNTERS/MOTOR RUN TIME (ELAPSED TIME) METERS

When the control panel contains motor starters, start counter and run time meter shall be a combination electromechanical device. Eaton CEC-55PM-406 or equal. Battery backed LCD displays shall not be used. Refer to Specification 16420, Motor Controllers.

H. CURRENT TRANSFORMERS

Current transformers are 1 percent accuracy at burden and lead length as installed. G.E., Midwest, Westinghouse or Hawkeye.

I. AMMETERS

Ammeters are ±2 percent accuracy, 2-1/2-inch size GE, Simpson, Weston, or Crompton.

J. ANALOG CURRENT TRANSMITTERS

Loop powered 4-20 mA solid core current transducer for currents up to 200 A. Hawkeye H721 Series or equal.

2.3 CONTROL PANEL CONTROL DEVICES

A. PILOT LIGHTS

1. Pilot lights shall be heavy duty, Class 9001, Type J, NEMA 4 (watertight) and NEMA 13 (oil-tight), metal collar, push-to-test, multi-segmented LED with red, green, amber, blue, clear, white, or yellow colored caps as shown on the Plans.

a. Allen-Bradley

b. Cutler-Hammer

c. General Electric

d. Siemens

e. Square D

B. PUSH BUTTONS

1. Push buttons shall be heavy duty, Class 9001, Type K, UL Types 4 and 13, NEMA 4 (watertight) and NEMA 13 (oil-tight), metal collar, non-illuminating, with full button guard. Contact block shall be provided with 1 N.O. and 1 N.C. contacts minimum with the ability to stack additional blocks. Provide additional blocks as required.

Pushbutton actuators may be standard, mushroom head, recessed (flush collar), or deep recessed (deep collar) as required.

a. Allen-Bradley

b. Cutler-Hammer

c. General Electric

d. Siemens

e. Square D

C. SELECTOR SWITCHES

1. On-Off Selector Switches

ON-OFF selector switches shall be Class 9001, Type K, UL types 4 and 13, NEMA 4 (watertight) and NEMA 13 (oil-tight), metal collar, non-illuminating push button contact blocks with 2-position operators and standard knob. Contact block shall be provided with 2 N.O. and 2 N.C. contacts minimum with the ability to stack additional blocks. Provide additional blocks as required.

The 2-position operator shall be manual rotation to left and manual rotation to right. Two contact block stacks shall be provided. In both contact block stacks, one set of contacts is closed in the left position and open in the right position. In both contact block stacks, one set of contacts is closed in the right position and open in the left position.

a. Allen-Bradley

b. Cutler-Hammer

c. General Electric

d. Siemens

e. Square D

2. Hand-Off-Auto (HOA) Selector Switches

HOA selector switches shall be Class 9001, Type K, UL types 4 and 13, NEMA 4 (watertight) and NEMA 13 (oil-tight), metal collar, non-illuminating push button contact blocks with 3-position operators and standard knob. Contact block shall be provided with 2 N.O. and 2 N.C. contacts minimum with the ability to stack additional blocks. Provide additional blocks as required.

The 3-position operator shall be manual rotation to left and right from center and manual return back to center. Two contact block stacks shall be provided. In both contact block stacks, one set of contacts is closed in the left position and open in the center and right positions. In both contact block stacks, one set of contacts is closed in the right position and open in the center and left positions.

a. Allen-Bradley

b. Cutler-Hammer

c. General Electric

d. Siemens

e. Square D

3. Reset-Off-On Selector Switches

RESET-OFF-ON selector switches shall be Class 9001, Type K, UL types 4 and 13, NEMA 4 (watertight) and NEMA 13 (oil-tight), metal collar, non-illuminating push button contact blocks with 3-position operators and standard knob. Contact block shall be provided with 2 N.O. and 2 N.C. contacts minimum with the ability to stack additional blocks. Provide additional blocks as required.

The 3-position operator shall be manual rotation to left and right from center, spring return from left to center and manual return from right to center. Two contact block stacks shall be provided. In both contact block stacks, one set of contacts is closed in the left position and open in the center and right positions. In both contact block stacks, one set of contacts is closed in the right position and open in the center and left positions.

a. Allen-Bradley

b. Cutler-Hammer

c. General Electric

d. Siemens

e. Square D

D. RELAYS

Regardless of the technology of a relay's control (from simple to programmable), the relay's output technology shall be the electro-mechanical type. Electronic outputs (triacs, thyristors, transistors, etc.) shall not be allowed.

Exceptions:

- *Unless specifically shown otherwise on the Plans.*
- *Unless approved in writing by the Engineer.*

1. Contactor relays

Contactor relays for switching 120 VAC power circuits including, but not limited to, lighting, solenoid valves, and small motors shall be electro-mechanical machine tool, heavy-duty type, NEMA rated, with 120 VAC/24 VDC coils and double-break contacts rated at 20 A at 250 VAC. Equip relays with surge suppressers. IEC rated relays are not permitted.

2. Control relays

Control relays for logic control circuits shall be permitted to be miniature “ice cube” type DPDT or 4PDT with 24V or 110-120V AC/DC coils with a mechanical life of 20 million operations minimum and an electrical life of 1 million operations minimum at 1 amp. The dielectric strength between the coil and contacts shall be 2,000 VAC for 1 minute. Contacts shall be rated at 10A at 250 VAC, 10A at 30 VDC. Relays shall have a maximum pickup and release time of 25 milliseconds and a minimum drop voltage of 30 percent of the rated voltage. Relays shall include non-polarized LED coil indictors. Relays shall be IDEC, P&B/Tyco or equal.

3. Alternating relays

Alternating relays shall have 24 VDC or 120 VAC coils as required for the application.

a. Duplex Alternating Relays

2-state alternating relays shall be DPDT with the transition between states occurring on loss of power to the coil.

4. Time delay relays

Time delay relays shall be electronic, programmable, multifunction type with a minimum of two Form C (DPDT) contacts rated at 10 A into resistive loads. Timers shall have a selectable timing range from 0.05 seconds to 999 hours. The following features shall be provided on the front of the timer for easy and clear adjustability:

a. Function selection (type of delay function);

b. Time setting (3 digits);

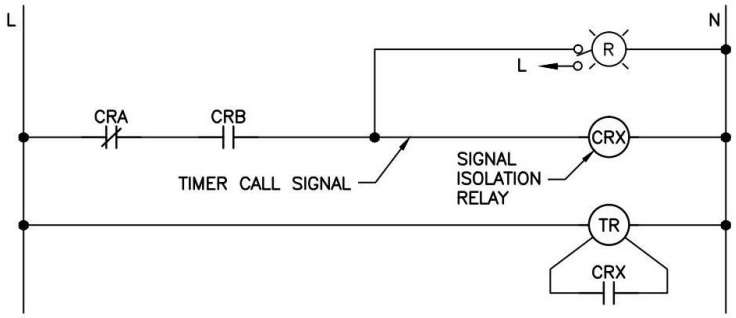
c. Timing range (seconds, minutes, hours);

d. Table showing the selectable functions;

e. LED indicator that indicates timing mode and time out condition.

On-delay timers (TDAE, Time Delay After Energization) shall be 8-pin octal socket style with 120 VAC or 24 VDC coils; Macromatic #TD-70222 and #TD-70228 respectively.

Off-delay timers (TDAD, Time Delay After De-energization) shall be 11-pin socket style with 120 VAC or 24 VDC coils, requiring an isolated trigger (see figure below); Macromatic #TD-71622 and #TD-71628, respectively.



5. PLC 24 VDC Output Buffer Relays

PLC 24 VDC output buffer relays shall be miniature DIN-rail DPDT type with silver-nickel alloy contacts rated at 8 amps @ 250 VAC/30 VDC (resistive load), 4 amps @ 250 VAC/30 VDC (inductive load), and 100,000 operations at full rated load with a dielectric strength between contacts of 1,000 VAC for 1 minute.

The relay coil shall be 24 VDC, with a mechanical life of 50 million operations and a dielectric strength between the coil and contacts of 5,000 VAC for 1 minute. Relays shall have a maximum pickup time of 15 milliseconds and release time of 10 milliseconds and a minimum drop voltage of 10 percent of the rated voltage.

Relays shall include a non-polarized LED coil indicator.

Relays shall include a DIN-rail mounting socket, 0.625-inch wide maximum with finger-safe screw terminals and replacement locking lever. DPDT relays and sockets shall be stackable at 0.625 inch.

Relays shall be IDEC RJ2S-CL-D24 or exact equal.
Sockets shall be IDEC SJ2S-07L or exact equal.

6. PLC 120 VAC - to - 24 VDC Input Buffer Relays

PLC 120 VAC input buffer relays shall be miniature DIN-rail DPDT type with silver-nickel alloy contacts rated at 8 amps @ 250 VAC/30 VDC (resistive load), 4 amps @ 250 VAC/30 VDC (inductive load), and 200,000 operations at full rated load with a dielectric strength between contacts of 1,000 VAC for 1 minute.

The relay coil shall be 120 VAC, with a mechanical life of 30 million operations and a dielectric strength between the coil and contacts of 5,000 VAC for 1 minute. Relays shall have a maximum pickup time of 15 milliseconds and release time of 10 milliseconds and a minimum drop voltage of 30 percent of the rated voltage.

Relays shall include a non-polarized LED coil indicator.

Relays shall include a DIN-rail mounting socket, 0.625-inch wide maximum with finger-safe screw terminals and replacement locking lever. DPDT relays and sockets shall be stackable at 0.625 inch.

Relays shall be IDEC RJ2S-CL-A120 or exact equal.
Sockets shall be IDEC SJ2S-07L or exact equal.

E. LEVEL INDICATOR/SETPOINT CONTROLLERS (LICs)

For processes using setpoint controllers for level control, such as wet wells and reservoirs, the following specifications shall apply.

1. 120 VAC or 24 VDC power (as shown on the Plans).

2. 4-20 mA or 0-10 VDC analog input (as shown on the Plans).

3. 16-point scaling for non-linear processes.

4. Four setpoint outputs, each with its own separate “SET” and “RESET” setoints.

5. Panel mount configuration.

6. LICs shall be Red Lion PAXP Process Input Panel Meters with PAXCDS Quad Setpoint Relay Output Card or equivalent.

F. THERMAL SETPOINT CONTROLLERS/TRANSMITTERS

1. Motor Winding Temperature Monitoring and Alarming Thermal Setpoint Controllers shall be:

   a. 2-wire, 3-wire, and 4-wire Ni100 and Pt100 RTD compatible;

   b. B, E J, K, N, R, S, T (ITS 90/IEC 584), L (DIN 43710) thermocouple compatible;

   c. Provide a linearized 4-20 mA isolated output;

   d. Provide an adjustable over- and under- temp Form A, 250 VAC, 500 VA (2 A) output contact;

   e. Provide line monitoring for sensor wire-break and short circuit;

   f. Capable of operating between 20 and 250 VAC input power;

   g. Provide galvanic separation of input circuits, output circuits, and power supply;

   h. Provide no more than 0.2 mA of sensor current;

   i. Provide galvanic separation of input circuits, output circuits, and power supply;

   j. Turck Interface Module, Ex-Temperature Measuring Amplifier, 1-Channle; Part Number IM34-12EX-RI or equal.

G. INTRINSICALLY SAFE BARRIERS

1. Intrinsically Safe Barriers, Analog (ISBAs)

   a. ISBAs shall be single-channel, 4-20 mA input, 2-wire, 4-20 mA output, loop powered with an ungrounded field circuit; R. Stahl P/N 9002/13-280-110-001, no exceptions.

   b. ISBAs shall provide electrical isolation between the input circuit, the output circuit, and the supply voltage.

c. ISBAs shall transfer 4-20 mA or 0-10 VDC input signals without attenuation (1:1 throughput).

2. Intrinsically Safe Barriers, Digital (ISBDs)

a. ISBDs shall be contact input, 2-channel, 2 x SPST, 2 Amp rated output (configurable N.O. or N.C.), universal supply voltage 20-250 VAC/20 – 125 VDC, UL-913 listed: Turck IM1-22Ex-R, PR Electronics 5202B2 or equivalent.

b. ISBDs shall provide electrical isolation between the input circuit, the output circuit, and the supply voltage.

c. ISBDs shall have programming switches to select if the output will operate in normally closed, normally open, or short circuit/wire break modes (fault detection mode). Disable the wire-break and short-circuit monitoring when using mechanical contacts as the input.

d. ISBDs shall have an LED on the front cover to indicate the switching status of the digital device.

H. ETHERNET SWITCHES

Ethernet switches shall be industrial grade, 10/100 MB, DIN-rail mounted type, 24 VDC powered, 8-port; N-Tron 300 series or equal.

Exceptions:

- *If the requirement shown on the Plans is greater than 8 ports, then provide the higher value.*

- *Non-DIN-rail acceptable if over 16 channels.*

I. FIREWALL

Provide hardware firewall with integral VPN services. Firewall may be 120VAC or 24VDC. Firewall may be installed in telemetry rack, reference plans, or in [01 CP 01] at integrator's discretion.

Coordinate provisioning of firewall with access and programming requirements of Specifications Sections 13451 and 13452.

2.4 CONTROL PANEL ANCILLARY DEVICES

A. RECEPTACLES MOUNTED IN CONTROL PANELS

120 VAC power to convenience and device receptacle in control panels shall not be derived from the same panelboard circuit as that used for process control devices (PLC, flow meters, autodialers, DC power supplies, etc.).

1. Convenience Receptacles

Convenience receptacles in control panels are not dedicated and are intended for providing 120 VAC convenience power for non-motor-operated equipment.

Convenience receptacles shall be GFCI, 15 Amp, 125 VAC, duplex, white, in a DIN-rail mount, cast aluminum box. Stamped steel boxes shall not be used.

2. Device Receptacles

Device receptacles are dedicated for communication and control devices operating within the control panel on a continuous basis. These include devices with 120 VAC power packs like VPNs, Fiber-To-Voice Converters, Data-To-Voice Converters, and etc.

Device receptacles shall be non-GFCI, 15 Amp, 125 VAC, duplex, white, in a DIN-rail mount, cast aluminum box. Stamped steel boxes shall not be used.

On Communication Patch Panels, these receptacle circuits can be extended with surge- and load-protected power strips.

3. Combination Port

The combination port shall consist of a simplex 120 VAC receptacle and a Category 5e ethernet port mounted on a single bulkhead.

The simplex receptacle shall have a placard stating “For Computer Use Only” along with the current rating. The current rating shall not be less than 3 A. If the receptacle rating is less than 15 A, the combination port shall have an integrated circuit breaker, operable without opening the enclosure, allowing the receptacle to be wired to an ordinary 15 A circuit.

The Category 5e ethernet port shall be a female RJ-45 connector, allowing an operator to connect a computer to the PLC over ethernet without opening the enclosure.

The bulkhead shall be a listed assembly. The bulkhead shall be installed in a manner that preserves the environmental rating of the enclosure. The bulkhead shall have a hinged cover that protects the combination port when not in use.

B. PANEL LIGHTING

For all panels so designated on the Plans, provide an LED lighting package, under cabinet style, hardwired, 120 VAC, with integral door-activated ON/OFF switch.

120 VAC power to the panel light shall not be derived from the same Panelboard circuit as that used for process control devices (PLC, flow meters, autodialers, DC power supplies, etc.).

C. PANEL HEATER

Provide a panel heater with thermostat in each outdoor control panel and all panels so designated on the Plans. Each heater shall include a DIN-rail mounted disconnect breaker and associated feedthrough and grounding terminals for connection to external 120 VAC line, neutral, and ground conductors. The heater and thermostat shall be prewired to these terminals and breaker.

The wattages shown below are minimum values. The Contractor shall size the panel heaters based on enclosure size, internal load heat generation, minimum operating temperature of devices in the enclosures, and minimum ambient temperature. Contractor shall include panel heating calculations with control panel submittals.

For panels with a front surface area less than 11 square feet, provide a semiconductor type, 30 watt minimum, 120 VAC, DIN-rail panel heater. Provide a N.C., DIN-rail heater thermostat with 15 Amp contacts at 120 VAC.

120 VAC power to panel heaters shall not be derived from the same Panelboard circuit as that used for process control devices (PLC, flow meters, autodialers, DC power supplies, etc.).

D. PANEL COOLING FANS

Provide a panel cooling system in enclosures that contain motor starters, drives, PLCs, RTUs, and other electronic devices that can generate heat and have maximum operating temperature limits unless specifically shown otherwise in the Plans. The panel cooling system shall include one or more fans with a thermostat as a minimum. The cooling system shall be sufficiently sized to maintain an internal enclosure temperature below the maximum operating temperature of all internal devices.

Provide a thermostat for cooling, N.O. contact, adjustable setpoint range 32 to 140 degrees F, 15 Amp-rated contact at 120 VAC.

Cooling fans shall be configured to exhaust air. Vents shall be provided for supply air. Layout fans and vents in such a manner as to:

1. Maximize cooling of critical components;

2. Minimize air flow restriction;

3. Eliminate entry of water or dust particles into the enclosure.

Provide vent covers over fan and vent openings to eliminate rain and moderate washdown for all outdoor panels and all panels so designated on the Plans

Provide a “washdown filter” fan set, capable of eliminating sprayed water entry, stainless steel, 120 VAC, 310 CFM, 3.8 Amps max., 18" x 10" x 5".

120 VAC power to panel fans shall not be derived from the same panelboard circuit as that used for process control devices (PLC, flow meters, autodialers, DC power supplies, etc.).

E. TERMINAL BLOCKS

1. For Power Circuits > 30 Amps

Terminations for power circuits greater than 150 V to ground or greater than 30 A shall be made using 600 VAC, listed, screw type, Power Distribution Blocks.

2. For Non-Fused Control, Instrumentation, and Power Circuits < 30 VDC, < 150 VAC, and <= 30 Amps

Provide standard feed-through DIN-rail type IEC terminal blocks, single circuit, screw terminal type, #22 - #10 AWG, rated 600 V AC/DC at 30 A, white or grey; Allen Bradley Bulletin 1492-J4 series or equal.

Exceptions:

- *For equipment/chassis grounded circuits*

  Provide DIN-rail type IEC grounding blocks, single circuit, screw terminal type, #22 - #10 AWG, rated 600 V AC/DC at 30 A, green/yellow in color; Allen Bradley Bulletin 1492- WG6 or equal. These ground blocks shall be inherently connected to the din rail.

- *For instrumentation cable shield terminations (reference Section 3.1.E)*

  Provide standard feed-through DIN-rail type IEC terminal blocks, single circuit, screw terminal type, #22 - #10 AWG, rated 600 V AC/DC at 30 A, blue; Allen Bradley Bulletin 1492-J4-B or equal.

5. Terminals used for digital and analog I/O field connections shall be grouped as shown in Section 3.1.E, FABRICATION, FIELD CONNECTIONS TO PLC I/O.

F. PANEL WIRING PRODUCTS

1. Power Circuit Wiring; Reference Specification 16120.

2. Control Circuit Wiring; Reference Specification 16120.

3. Analog PLC I/O Wiring

Signal cables connected completely inside control panels between analog input and output field terminal groupings and their associated PLC analog cards shall be #22 AWG, stranded, tinned copper, twisted pair, 300 V, 100 percent overall foil shielded cable with #22 AWG tinned copper drain wire; Belden #8451 or equal.

2.5 CONTROL PANEL ACCESSORIES

A. PANEL NAMEPLATES AND IDENTIFICATION

1. Identify each item on the control panel with rectangular nameplates.

2. Provide nameplates of rigid phenolic plastic laminate with engraved lettering or engraved metal plate with filled lettering. Use black background with white lettering.

3. Minimum letter height is 1/2 inch for instrument description and 1/4-inch height for instrument tag number.

4. Provide each panel with a 2-inch by 10-inch (minimum) nameplate with 1-inch-high lettering with panel identification.

5. Abbreviations are not permitted unless approved by the Owner or specifically shown on the nameplates, schedules, or plans.

6. Install nameplates plumb and parallel to the lines of doors or structure to which they are attached. Attach to the sheet metal structure by a thin coat of adhesive and sheet metal screws. Make adhesive and screw applications in such a manner as to avoid nameplate buckling or distortion due to use of excessive adhesive or over tightening of screws.

PART 3 INSTALLATION

3.1 FABRICATION

A. GENERAL

1. Control panels are factory or shop fabricated units completely assembled, wired, and tested before shipment to the job site.

2. Panel construction, in general, meets JIC EMP-1 standards and applicable NEMA and IEEE standards.

Exception:

- *Where open penetrations are required, such as for fans and vents, the NEMA rating of the panel may be modified to meet the intent of the design and fit the environment of the*

application. Verify the change of a panel's NEMA rating with the Engineer.

3. The panels shall be constructed in accordance with Article 409 of the NEC and electrical testing laboratory standards and shall be so labeled (the standards of a recognized electrical testing laboratory).

4. Size panels for enclosed equipment and available space for mounting of panel or as shown on the Plans.

5. Panels shall be descaled, cleaned, and primed in preparation for painting. Painting shall consist of one coat of flat white enamel in the interior and two coats of hard finish exterior enamel, gray in color. Paint shall be suitable for field touch-up. Spare paint (1 quart) shall be provided for touch-up purposes.

   Exceptions:

   - *If the panel is to be used in eastern Washington, then the final outer coating shall be high gloss white.*

   - *Unless shown otherwise in the Plans stainless steel enclosures shall not be painted.*

6. Panel material, penetrations, and etc. shall be verified for proper operation in their intended locations. Issues and concerns shall be brought to the attention of the Engineer prior to fabrication within or on the panel.

B. FREE-STANDING PANELS

1. Welded construction

2. Completely enclosed, self-supporting, and gasketed dust-tight.

3. Seams and corners welded and ground smooth.

4. Furnish doors with keyed alike locking handles and three point catch.

5. Provide each panel with lifting eyebolts. Furnish stainless steel base channels.

6. Slotted bolt holes in base, 1-1/2 long for field adjustment.

C. COMPONENT INSTALLATION

1. Minimize welding to panel fronts and avoid distortion of panel metal.

2. Reinforce around areas of the enclosure weakened by openings or mounting of heavy equipment/components.

3. Accurately and cleanly cut or nibble cutouts, and finish free of sharp edges or burrs. Make cutouts plumb, level, and on-line vertically or horizontally within 1/32 of an inch where components are in rows or columns.

4. Provide minimum 1-5/8-inches spacing between horizontal rows of externally mounted components; 1-1/2 inches minimum between vertical columns of components.

5. The distance from the bottom row of components to the floor shall be not less than 36 inches, unless specifically shown as less. In general, all indicating lights, pushbuttons, etc., shall be mounted in accordance with the sequence of operation from left to right and top to bottom.

6. Provide minimum 1/4-inch spacing between components mounted on the panel sub-plate, Provide minimum spacing between the component and the wire duct of 1-1/2 inches above, and 1 inch below.

7. Components mounted in the interior shall be fastened to an interior subpanel using machine screws plus adhesive to insure vibration-free attachment.

8. Interior component mounting and wiring shall be grouped as much as possible by function and then by component type. Interiors shall be so arranged that control relays, terminal blocks, fuses, etc., can be replaced or added without disturbing adjacent components.

9. AC UPS systems and associated batteries shall be mounted on a shelf specifically sized and braced for the UPS system. This rack shall assure that the UPS system is not resting on the bottom of the Control Panel and that no part of the UPS system blocks, or in any other way interferes with devices, terminals, or wireways that are not specifically a part of the UPS system. The shelf shall have a raised lip around all sides that are not in contact with a wall. The bottom of the shelf shall be at least 4 inches above the bottom of

the enclosure (this provides a free flow of cables and conductors from conduits entering the bottom of the panel). Straps shall be provided to secure the UPS to the shelf.

If insufficient room is available on the panel's backplane, then mount the shelf to the inside of the door. When mounted on the door, secure all cables to the door in such a manner that assures:

a. Highly reliable secured connections to the UPS (not affected by movement of the door),

b. Free and unencumbered door movement,

c. Door movement that does not stress the cables.

10. Open batteries provided to support DC UPS systems shall be mounted on 316L stainless steel shelves and provided with non-conducting bracing straps to firmly hold the battery in place. The shelves shall have a raised lip around all sides that are not in contact with a wall. The bottom of the shelf shall be at least 4 inches above the bottom of the enclosure.

Batteries provided with manufacturer's mounting systems do not require the additional stainless steel shelving.

D. PANEL WIRING METHODS

1. Provide panel wiring sizes and colors per Specification 16120.

2. Provide PLC analog and digital input and output circuit field terminations and wiring methods per Section 3.1.E.

3. Field wiring terminations to control panel terminal strips shall be connected as shown on the Plans. Cable shields or "drain" wires shall be terminated as per manufacturer's recommendations.

4. Provide a chassis-connected equipment ground bus at the bottom of PLC control panels.

5. Provide an isolated ground bus, dedicated solely for analog shield connections, adjacent to the equipment ground bus. Provide a separate and dedicated #10 AWG minimum green-insulated ground wire from the Panelboard ground bus to the isolated ground bus.

6. Provide raceways for panel wiring.

    a. Size raceways per the requirements of NEC.

    b. Provide panel wireways between each row of components, and adjacent to each terminal strip.

    c. Wireways are a minimum of 1-inch wide and 3-inches deep with removable snap-on covers and perforated walls for easy wire entrance. Wireways shall be constructed of non-metallic materials with a voltage insulation in excess of the maximum voltage carried therein Panduit type LG, Panel Channel or equal

7. Run wires neatly in wiring duct tied and bundled with tie wraps or similar materials.

8. Provide wire bending space per NEMA ICS 6.

9. Label wiring within the panel with wire numbers using the same number on both ends of the wire. Identify each wire termination, including long jumpers, with wire markers. Arrange wire labels to permit reading of identification when installed.

10. Connect wiring internal to the panel to one side, leaving the opposite side for field terminations. Connect no more than two wires to any one control terminal point.

11. Arrange wiring inside the panel to separate instrumentation cables, conductors, and terminals at least 12 inches from 120 VAC power and control circuits.

12. Connect electrical equipment grounds to the chassis grounding bus.

13. Provide necessary power supplies for control equipment.

E. WIRE TERMINATION METHODS

1. Power conductors terminated on Power Distribution Blocks shall be covered with the block manufacturer’s transparent cover and a caution sticker stating the voltage and available bolted fault current.

2. Terminate one end of all instrumentation cable shields to blue isolated-ground terminals (reference Section 2.4.E).

3. Provide fused terminals as shown on the Plans or defined herein. Reference Section 2.2 for materials

4. Terminals used for 4-20 mA analog input and output circuits shall be grouped as shown herein. This grouping shall be provided for each analog input and output connected to a PLC, whether assigned or unassigned (spare).

5. Provide terminal strips for the termination of panel wiring not directly connected to panel mounted devices.

6. Terminals shall facilitate wire sizes as follows:

   a. 120 VAC applications: Wire size 12 AWG and smaller.

   b. Other: Wire size 14 AWG and smaller.

7. Tag each I/O terminal to indicate tag number of the connected device or wire.

8. Provide 20 percent excess terminals (minimum) for future expansion.

9. Provide a minimum of 1.5 inches between terminal strips and wireways or between terminal strips.

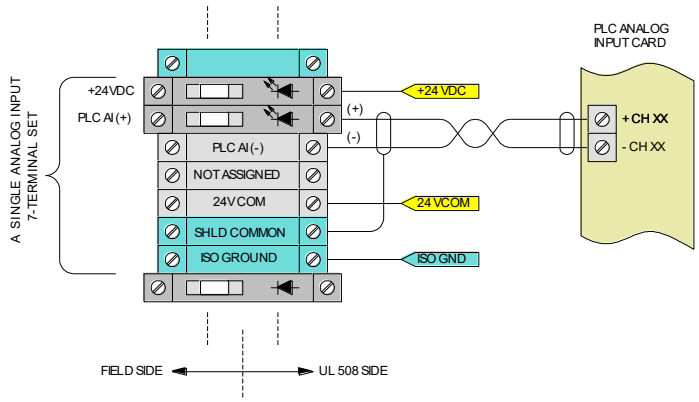
F. FIELD CONNECTIONS TO PLC I/O

1. Analog Input, Termination and Connectivity

   Each 4-20 mA PLC analog input shall be connected to a 7-terminal grouping as shown below and as detailed on the Analog Loop Diagrams on the Plans whether the input channel is assigned or unassigned (spare) and whether the input is single-ended, differential, or isolated. No chassis-grounded terminals shall be used. Reference table below.

7-Terminal Analog Input Grouping, Terminal Assignments

Internal Panel Connections	Clarification	Terminal Type and Color
+24VDC	+ 24 VDC Power	Fused, Black
PLC AI (+)	PLC Analog Input, +	Fused, Black
PLC AI (-)	PLC Analog Input, -	Feedthrough, Gray
NOT ASSIGNED	2-Device Connection	Feedthrough, Gray
24VCOM	24 V Common	Feedthrough, Gray
SHLD COMMON	Shield Common	Feedthrough, Blue
ISO GROUND	Isolated Ground	Feedthrough, Blue



All connections on the UL 508 side are the same, regardless of the type of field connection.

Bundle all analog input terminal groups in the same sequence as the analog input cards and channels.

Maintain a minimum of 12 inches between analog terminal groups and AC power circuits.

The shields shall be connected at the terminal block-end only. Shields shall not be connected at the PLC cards.

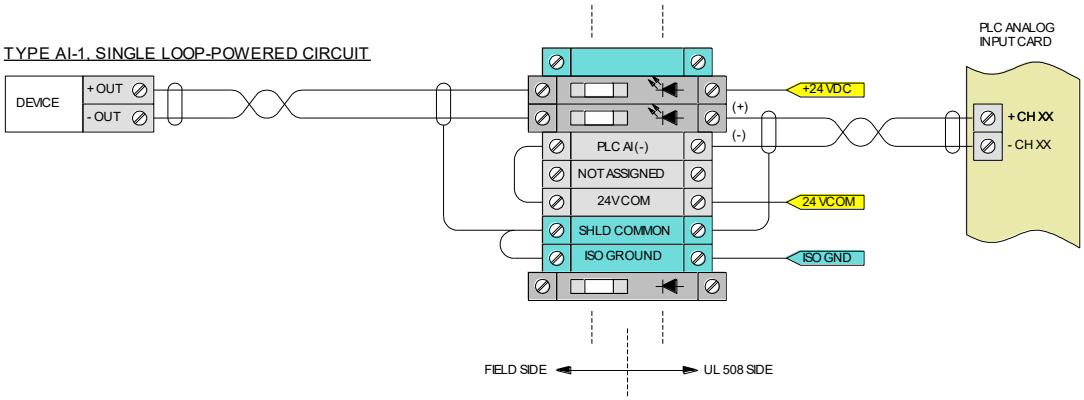
No additional 24 VDC fusing is to be provided.

For cable type between terminal groupings and analog input PLC cards, reference Section 2.4.F.

2. Analog Input, 7-Terminal Connection Methods

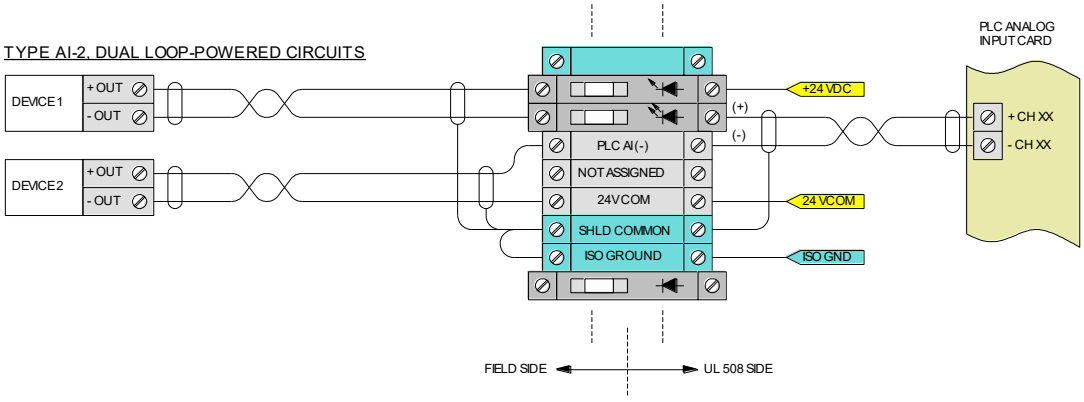
a. Field Connection **TYPE AI-1**, connection to a single loop-powered field device

The Figure below shows the method of connecting a PLC analog input to a single loop-powered field device using a 7-terminal standard analog input terminal group.



b. Field Connection **TYPE AI-2**, connection to two loop-powered field devices

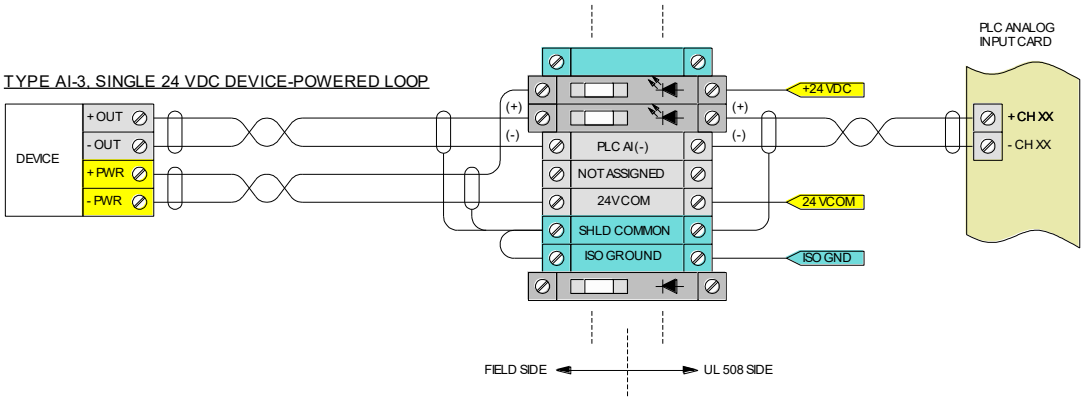
The Figure below shows the method of connecting a PLC analog input to two loop-powered field devices using a 7-terminal standard analog input terminal group.



c. Field Connection **TYPE AI-3**, connection to a single 24 VDC device-powered field device

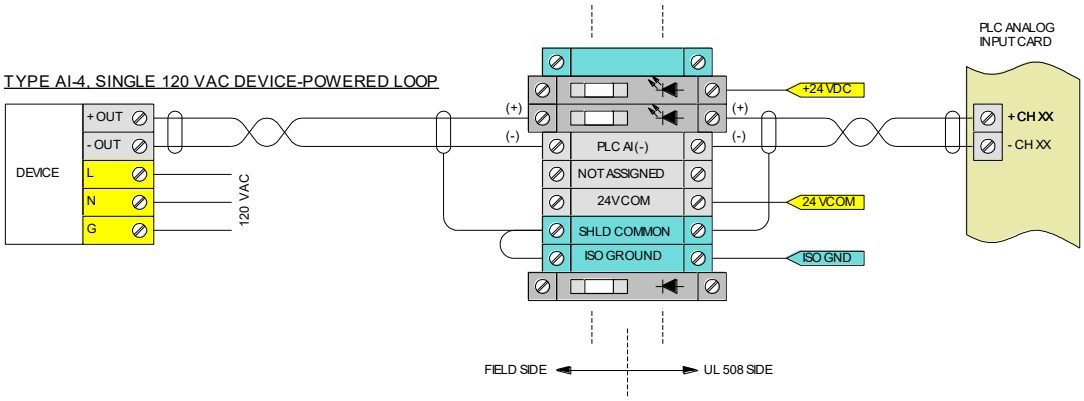
The Figure below shows the method of connecting a PLC analog input to a single 24 VDC device-powered field

device using a 7-terminal standard analog input terminal group. Device power is provided by the control system power.



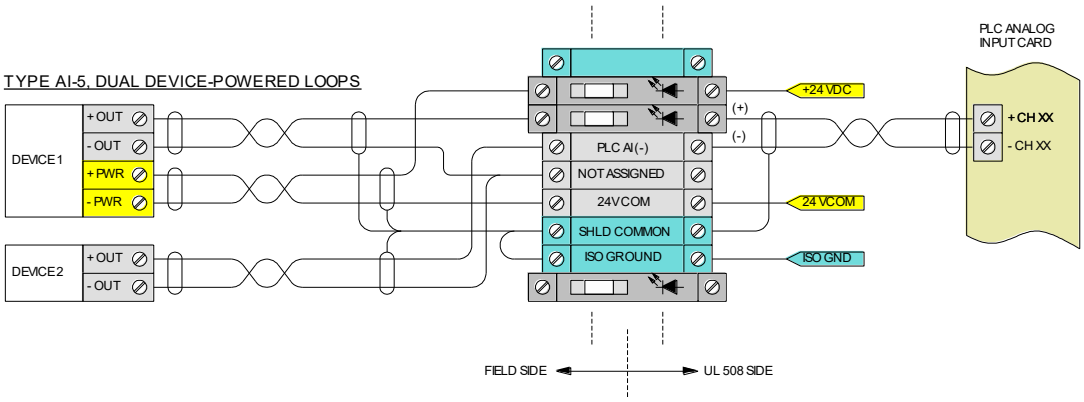
d. Field Connection **TYPE AI-4**, connection to a single 120 VAC device-powered field device

The Figure below shows the method of connecting a PLC analog input to a single 120 VAC device-powered field device using a 7-terminal standard analog input terminal group.



e. Field Connection **TYPE AI-5**, connection to a set of 24 VDC device-powered and loop-powered field devices

The Figure below shows the method of connecting a PLC analog input to two field devices, with at least one requiring 24 VDC device power using a 7-terminal standard analog input terminal group. Device power is provided by the control system power.

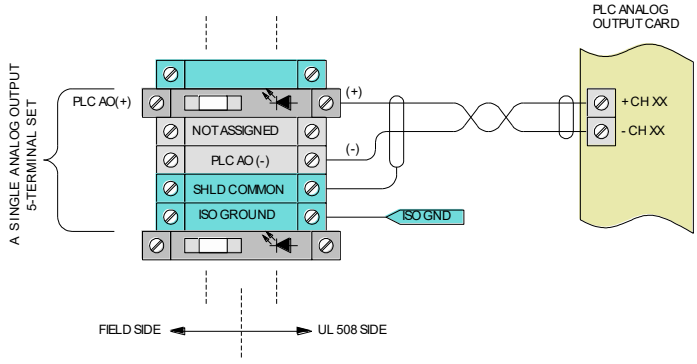


3. Analog Output, Termination and Connectivity

Each 4-20 mA PLC analog output channel shall be connected to a 5-terminal grouping as shown below and as detailed on the Plans whether the input channel is assigned or unassigned and whether the output is isolated or not. No chassis-grounded terminals shall be used. Reference table below.

5-Terminal Analog Input Grouping, Terminal Assignments

Internal Panel Connections	Clarification	Terminal Type and Color
PLC AO(+)	PLC Analog Output, +	Fused, Black
NOT ASSIGNED	2-Device Connection	Feedthrough, Gray
PLC AO(-)	PLC Analog Output, -	Feedthrough, Gray
SHLD COMMON	Shield Common	Feedthrough, Blue
ISO GROUND	Isolated Ground	Feedthrough, Blue



All connections on the UL 508 side are the same, regardless of the type of field connection.

Bundle all analog output terminal groups in the same sequence as the analog output cards and channels.

Maintain a minimum of 12 inches between analog terminal groups and AC power circuits.

The shields shall be connected at the terminal block-end only. Shields shall not be connected at the PLC cards.

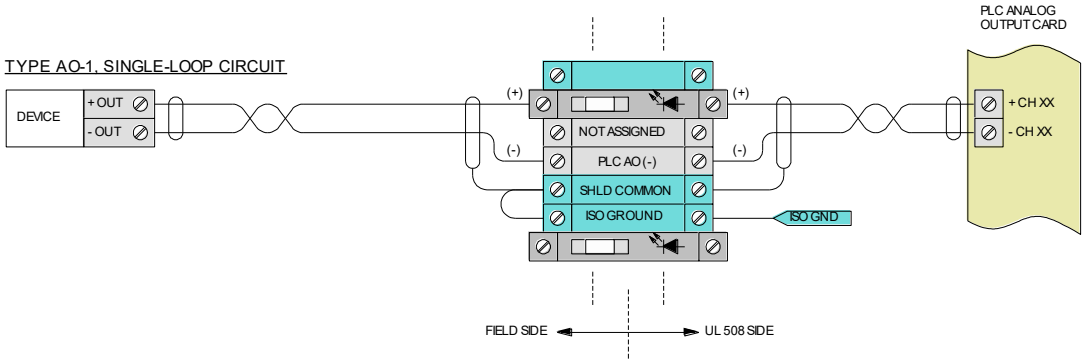
No additional 24 VDC fusing is to be provided.

For cable type between terminal groupings and analog input PLC cards, reference Section 2.4.F.

4. Analog Output, 5-Terminal Connection Methods

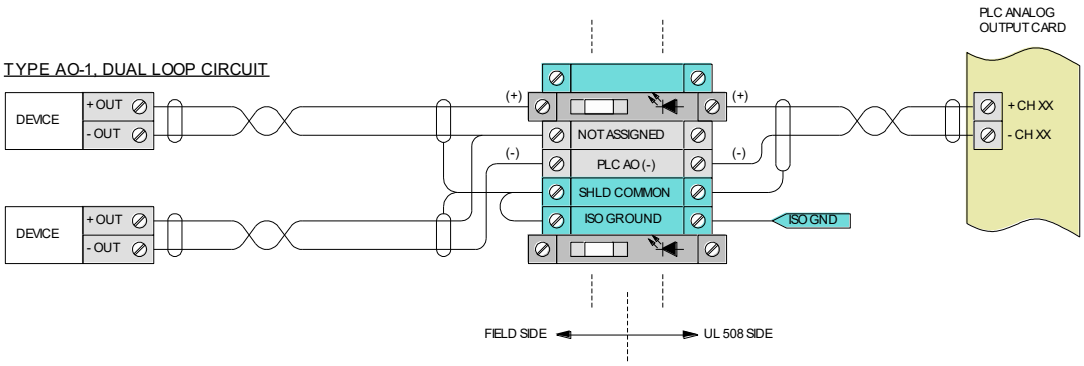
a. Field Connection **TYPE AO-1**, connection to a single field device

The Figure below shows the method of connecting a PLC analog output to a single field device using a 5-terminal standard analog output terminal group.



b. Field Connection **TYPE AO-2**, connection to two field devices

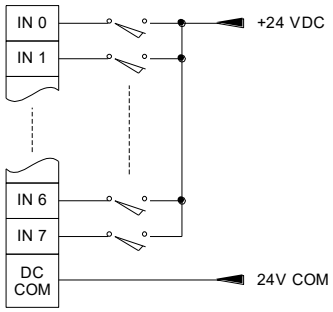
The Figure below shows the method of connecting a PLC analog output to two field devices using a 5-terminal standard analog output terminal group. These devices can be loop-powered or device powered.



5. Digital Input, Termination and Connectivity

a. Digital Input Type

All digital inputs shall be the "sinking" type as shown below. Reference Specification Section 13450, Programmable Logic Controller (PLC) Hardware.



1/2 OF 24 VDC, 16 CHANNEL PLC
DIGITAL SINKING INPUT CIRCUIT

b. Digital Input Fusing to Field Circuits

Provide fusing for each field-connected digital input. A single fuse shall be used for a group of field inputs from a common remote panel providing that the inputs are connected to the same input card. A common fuse shall not be used for separate cards.

Separate fuses shall be provided for field inputs that are not terminated in a common remote panel.

Provide a separate fuse for each set of 4 unassigned (spare) Digital Inputs.

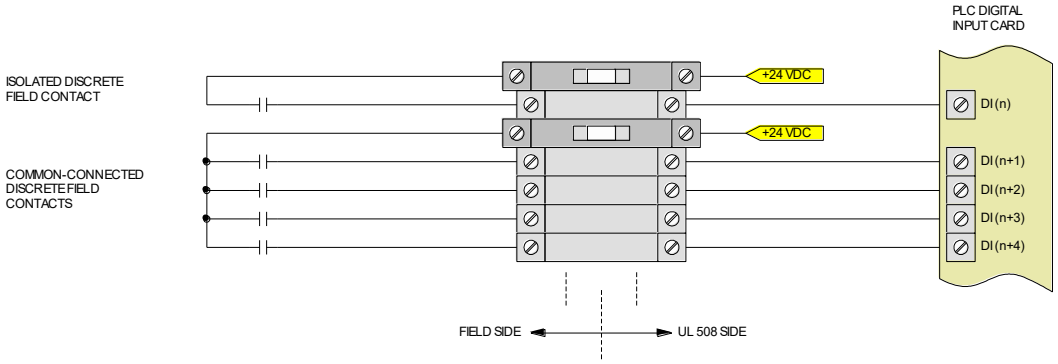
Fuses shall be 0.5 Amp.

Provide a separate gray feedthrough terminal for each digital input channel whether the input channel is assigned or unassigned.

c. Digital Input Connection Methods

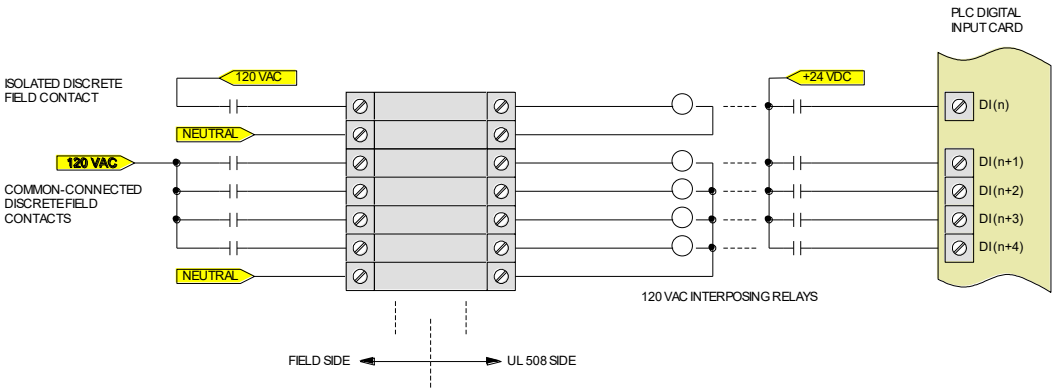
i. Connections to “Dry” Field Contacts

Discrete input field devices with dry Form A or Form B contacts sharing a common cabinet or piece of equipment may be combined into a group sharing a single +24 VDC fused common as shown below.



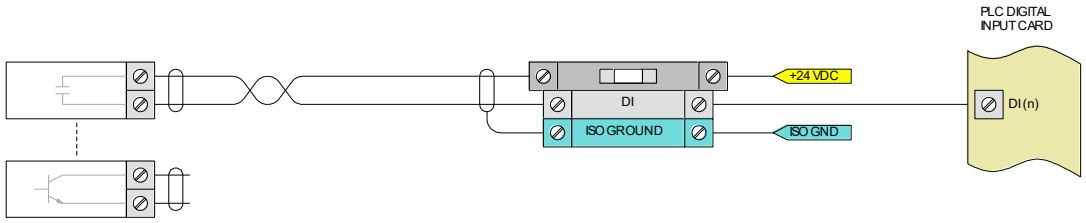
ii. Connections to “Hot” (wet) 120 VAC Field Circuits

Digital inputs derived from 120 VAC "hot" circuits shall be buffered through interposing relays inside the PLC control panel prior to connection to the 24 VDC Digital Input PLC cards in a manner shown in the Figure below. Reference “PLC 120 VAC - to - 24 VDC Input Buffer Relays” in Section 2.2 for relay product type.



iii. Digital Pulse Inputs

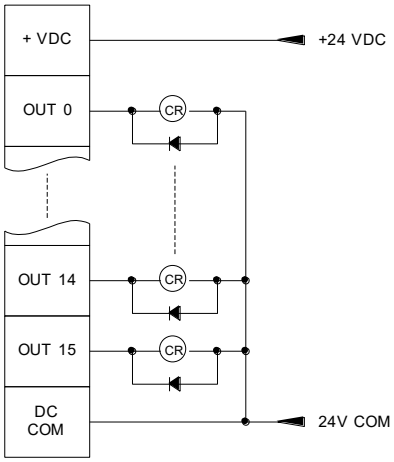
Digital pulse inputs shall be either dry Form A or Form B contacts or active open-collector circuits as shown in the Figure below. The +24 VDC power shall be provided by the 24 VDC control system power and shall be separately fused.



6. DIGITAL OUTPUT, Termination and Connectivity

a. Digital Output Type

All digital outputs shall be the "sourcing" type as shown below. Reference Specification 13450, Programmable Logic Controller (PLC) Hardware.



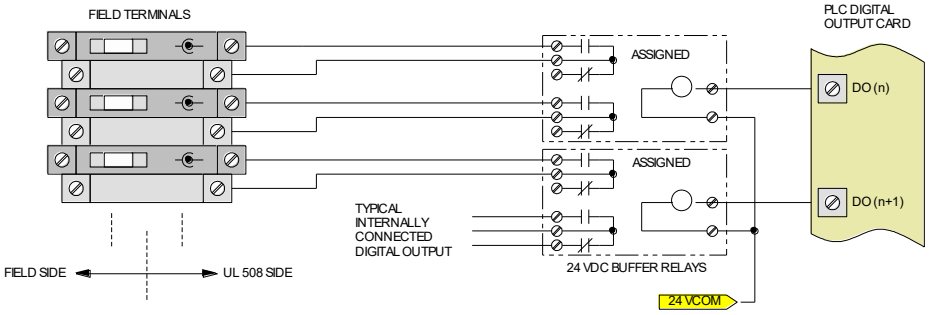
24 VDC, 16 CHANNEL PLC
DIGITAL SOURCING OUTPUT CIRCUIT

b. Digital Output Buffer Relays

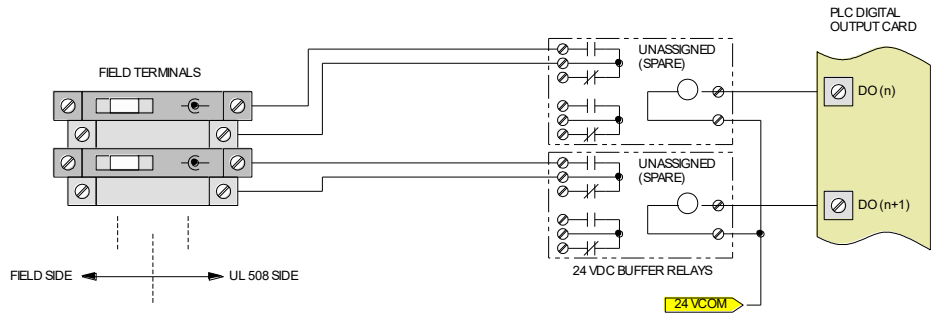
All 24 VDC digital outputs, even if unassigned (spare), shall be buffered through a DPDT (minimum) interposing relay prior to being connected to other internal circuits or field terminals. 4PDT relays shall be provided where shown on wiring diagrams. Reference "PLC 24 VDC Output Buffer Relays" in Part 2 for product type.

Internally connected buffered outputs shall not be fused.

Assigned digital outputs shall be assigned to single or double fused output terminal pairs as shown in the Figure below.



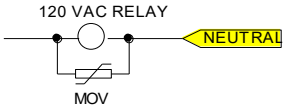
All unassigned digital outputs shall be buffered to a single fused output terminal pair as shown in the Figure below.



G. RELAY COIL SURGE SUPPRESSION

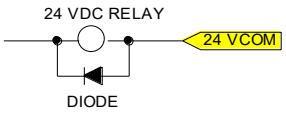
1. 120 VAC Coil Surge Suppression

All 120 VAC coils shall be paralleled by a Metal Oxide Varistor (MOV) type surge suppressor as shown in the Figure below. The suppressor shall be connected directly across the relay socket coil terminals with short wire leads.



2. 24 VDC Coil Surge Suppression

All 24 VDC coils shall be paralleled by a reverse-connected shunt diode as shown in the Figure below. The diode shall be connected directly across the relay socket coil terminals with short wire leads. The diode shall be rated at 1A, 100 PIV minimum.



3.2 SOURCE QUALITY CONTROL

A. Submit a shop test plan indicating how the test will be conducted, and how the system will be verified.

B. Revise all plans upon completion of the work to show the “as shipped” condition of the panel.

C. Allow for the owner and Engineer to witness the shop test. Provide a minimum of 15-days notice prior to the test.

D. Provide a shop test after factory completion and prior to shipment.

1. Test Documentation

a. Provide a testing procedure and submit to the Engineer at least 1 week prior to the shop test.

b. Document all required corrections, even those that may be remedied during the shop test.

c. Issue a copy of the test procedures and necessary corrections to the General Contractor and the Engineer.

d. Make all necessary corrections before shipping any panels, equipment, or devices to the job site.

e. Issue a final signed document verifying that each correction has been made.

2. PLC Control Test

a. Conduct a burn-in period (minimum of 2 days) where the system is operated continuously and checked for proper operation.

b. Utilize simulated I/Os to verify proper operation. Demonstrate the operation of each digital and analog I/O point.

c. Demonstrate compete connectivity and data transfer over the process control network. Verify the operation of all motor starters and remote devices monitored and controlled over the network.

d. Provide a computer and the software required for testing such that the owner may view the simulation of operator entries of field parameters such as set points and alarm values during the test.

3. Relay and Process Controller Test

a. Demonstrate the complete operation of the relay logic, backup logic, process controllers, and etc.

4. Motor Starter Test

   a. Demonstrate the complete operation of all motor starters. Connect a portable motor to each starter and operate the motor in HAND, OFF, and AUTO modes. Demonstrate the proper operation of all motor safety interlocks.

   b. Preprogram all motor starter Human Interface Modules (HIMs) for compliance with motor manufacturer's protection criteria and compliance with the design engineer's control requirements.

5. Other Tests

   a. Provide normal operating voltage to all equipment. Demonstrate the operation of all equipment while under power.

   b. The entire assembled panel shall be tested to be free from grounds and shorts.

   c. Controllers, circuits and interlocks shall be rung out and tested to assure that they function correctly before the panel is shipped.

3.3 INSTALLATION

A. Install freestanding panels on concrete housekeeping pads.

B. Anchor panels rigidly in place with approved anchorage devices. If mounting details are shown on the Plans, then these methods shall be used.

***** END OF SECTION *****

PART 8

APPENDICES

APPENDIX A

CONTRACT PROVISIONS FOR PROCUREMENT OF MEMBRANE EQUIPMENT AND SERVICES

TAYLOR BAY BEACH CLUB HOA

PIERCE COUNTY **WASHINGTON**

TAYLOR BAY
BEACH CLUB

CONTRACT PROVISIONS

for

PROCUREMENT OF MEMBRANE EQUIPMENT SYSTEM AND SERVICES

G&O #22848.01
JANUARY 2025

Gray & Osborne, Inc.
CONSULTING ENGINEERS

TAYLOR BAY BEACH CLUB HOA

PIERCE COUNTY **WASHINGTON**

TAYLOR BAY
BEACH CLUB

CONTRACT PROVISIONS

for

PROCUREMENT OF MEMBRANE EQUIPMENT SYSTEM AND SERVICES



1/28/2025

G&O #22848.01
JANUARY 2025

Gray & Osborne, Inc.
CONSULTING ENGINEERS

ADVERTISEMENT FOR BIDS

TAYLOR BAY BEACH CLUB HOA
LONGBRANCH, WA
PROCUREMENT OF MEMBRANE SYSTEM AND SERVICES

General Notice

Taylor Bay Beach Club HOA (Owner) is requesting Bids for the construction of the following Project:

Procurement of Membrane Equipment System and Services
G&O# 22848.01

Bids for the Project will be received electronically by QuestCDN – Quest eBidDoc™ #9401967, until **11:00 a.m** local time on **Tuesday, February 18, 2025**. At that time the Bids received will be opened and displayed on the QuestCDN website.

The Project includes the following Work:

Preconstruction services, equipment supply, construction services and post-construction services for the membrane equipment for a new wastewater treatment facility.

Bids are requested for the following Contract: **Procurement of Membrane Equipment System and Services**

Owner anticipates that the Project's total bid price will be approximately $**700,000 - $1,000,000**. The Membrane Equipment System must be delivered by the Seller to the General Contractor no late than June 1, 2026, as specified in Sections 01110 and 11500. The Project has an expected duration of **3 years**.

Obtaining the Bidding Documents

Information and Bidding Documents for the Project can be found at the following designated website:

www.questcdn.com #9401967

Bidding Documents may be downloaded from the designated website. Prospective Bidders are urged to register with the designated website as a plan holder. The designated website will be updated periodically with addenda, lists of registered plan holders, reports, and other information relevant to submitting a Bid for the Project. All official notifications, addenda, and other Bidding Documents will be offered only through the designated website. Neither Owner nor Engineer will be responsible for Bidding Documents, including addenda, if any, obtained from sources other than the designated website.

Owner as "Buyer" **will execute** a procurement contract with **the seller** for the procurement of goods and special services for **procurement of membrane equipment system and services**. The materials and equipment to be provider through the procurement contract are to be furnished and delivered to the Site for installation by Contractor as part of the Wastewater Treatment Facilities Upgrade Project. Owner will assign said procurement contract to Contractor as set forth in the Agreement. Contractor will accept the assignment, as Buyer (Contractor/Assignee), and will be responsible to Owner for the performance of obligations by Seller, which will become a Subcontractor or Supplier to Contractor.

EJCDC® C-111, Advertisement for Bids for Construction Contract.
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Modified to include RD edits from RUS Bulletin 1780-26 (6/16/2020).

Instructions to Bidders.

For all further requirements regarding bid submittal, qualifications, procedures, and contract award, refer to the Instructions to Bidders that are included in the Bidding Documents.

American Iron and Steel

Section 746 of Title VII of the Consolidated Appropriations Act of 2017 (Division A - Agriculture, Rural Development, Food and Drug Administration, and Related Agencies Appropriations Act, 2017) and subsequent statutes mandating domestic preference applies an American Iron and Steel requirement to this project. All iron and steel products used in this project must be produced in the United States. The term "iron and steel products" means the following products made primarily of iron or steel: lined or unlined pipes and fittings, manhole covers and other municipal castings, hydrants, tanks, flanges, pipe clamps and restraints, valves, structural steel, reinforced precast concrete, and Construction Materials.

The following waivers apply to this Contract:
***De Minimis*,**
Minor Components,
Pig Iron and Direct Reduced Iron

This project is subject to the Build America, Buy America Act (BABAA) requirements under Title IX of the Infrastructure Investment and Jobs Act (IIJA), Pub. L. 117-58, §§ 70901-70953. Absent an approved waiver, all iron, steel, manufactured products, and construction materials used in this project must be produced in the United States.

The following waivers apply to this Contract:
BABAA De Minimis, Small Grants, and Minor Components

This Advertisement is issued by:

Owner: **Taylor Bay Beach Club HOA**
By: **Mitzi McCart**
Title: **President**
Date: **Tuesday, February 4, 2025**

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CONTRACT PROVISIONS

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TAYLOR BAY BEACH CLUB HOA

PROCUREMENT OF MEMBRANE EQUIPMENT SYSTEM AND SERVICES

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PART 1

INSTRUCTIONS TO BIDDERS

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INSTRUCTIONS TO BIDDERS FOR PROCUREMENT CONTRACT

ARTICLE 1—DEFINED TERMS

1.01 Terms used in these Instructions to Bidders will have the meanings indicated in the General Conditions and Supplementary Conditions. Additional terms used in these Instructions to Bidders have the meanings indicated below.

A. *Issuing Office*—The office from which the Procurement Bidding Documents are to be issued and where the bidding procedures are to be administered.

ARTICLE 2—PROCUREMENT BIDDING DOCUMENTS

2.01 Bidder may obtain complete sets of the Procurement Bidding Documents for a fee from the following QuestCDN website: www.questcdn.com #9401967. Bidders must obtain a complete set of the Procurement Contract Documents as listed in the Procurement Agreement.

2.02 Bidder must use a complete set of the Procurement Bidding Documents in preparing the Bid; neither Buyer nor Engineer assumes any responsibility for errors or misinterpretations resulting from the use of incomplete sets of Procurement Bidding Documents.

2.03 Buyer and Engineer make copies of Procurement Bidding Documents available on the above terms only for obtaining Bids for furnishing Goods and Special Services, and do not authorize or confer a license for any other use.

ARTICLE 3—QUALIFICATIONS OF BIDDERS

3.01 Buyer may at any time conduct such investigations as Buyer deems necessary to establish the responsibility, qualifications, and financial ability of Bidder, and after the opening of Bids may require a Bidder to submit documentation of its qualifications, including but not limited to financial data and documentation of previous experience providing goods and services comparable to the specified Goods and Special Services.

3.02 Bidder is to carefully review those portions of the Bid Form requiring Bidder's representations and certifications.

3.03 Deleted.

3.04 Bidders shall provide an installation list with the bid of at least five successful full-scale membrane bioreactor installations at Publicly Owned Treatment Works (including Tribal Casino facilities), not pilot or demonstration plants, with design flow rates greater than 100,000 gal/day each operating for at least 3 years, per Specification Section 11500-1.4, for which the Seller has provided equipment and services of similar scope as this contract, to include membranes, permeate pumps, air scour blowers, automatic valves, chemical feed systems, instruments, control panels and control programming.

3.05 Bidder shall submit evidence of valid license to do business in the state of Washington.

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ARTICLE 4—SITE VISIT; PRE-BID CONFERENCE

4.01 Buyer recommends that Bidder visit the Point of Destination and the site where the Goods are to be installed and Special Services will be provided, taking into account observable local and site conditions that may affect the delivery, cost, progress, and furnishing of the Goods and Special Services. Arrangements for such a visit may be made through Engineer.

4.02 A pre-bid conference will not be held for this procurement.

4.03

ARTICLE 5—INTERPRETATIONS AND ADDENDA

5.01 All questions about the meaning or intent of the Procurement Bidding Documents are to be submitted to Engineer in writing via the QuestCDN website.

5.02 Interpretations or clarifications considered necessary by Engineer in response to such written questions will be issued by Addenda via the QuestCDN website. Questions received less than 10 days prior to the date for opening of Bids will not be answered. Only answers in the Addenda will be binding. Oral statements, interpretations, and clarifications may not be relied upon in the preparation of a Bid, and will not be binding or legally effective.

5.03 Addenda may be issued to clarify, correct, or change the Procurement Bidding Documents as deemed advisable by Buyer or Engineer.

ARTICLE 6—BID SECURITY

6.01 A Bid must be accompanied by Bid security made payable to Buyer in an amount of **five** percent (5%) of Bidder's maximum Bid price (determined by adding the base bid and all alternates) and in the form of a Bid bond issued by a surety meeting the requirements of Paragraph 5.01 of the General Conditions. Such Bid bond will be issued in the form included in the Procurement Bidding Documents. Bid security must be at least 5% of the Bidder's maximum Bid price.

6.02 The Bid security of the apparent Successful Bidder will be retained until Buyer (Project Owner) awards the Procurement Contract to such Bidder, and such Bidder has executed the Procurement Contract, furnished the required contract security, and met the other conditions of the Notice of Award, whereupon the Bid security will be released. If the Successful Bidder fails to execute and deliver the Procurement Contract and furnish the required contract security within 15 days after the Notice of Award, Buyer (Project Owner) may consider Bidder to be in default and annul the Notice of Award, and the Bid security of that Bidder will be forfeited, in whole in the case of a penal sum bid bond, and to the extent of Buyer's damages in the case of a damages-form bond. Such forfeiture will be Buyer's exclusive remedy if Bidder defaults.

6.03 The Bid security of other Bidders that Buyer believes to have a reasonable chance of receiving the award may be retained by Buyer until the earlier of 7 days after the Effective Date of the Procurement Contract or 61 days after the Bid opening, whereupon Bid security furnished by such Bidders will be released.

6.04 Bid security of other Bidders that Buyer believes do not have a reasonable chance of receiving the award will be released within 7 days after the Bid opening.

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ARTICLE 7—PROCUREMENT CONTRACT TIMES

7.01 See applicable provisions in the Procurement Agreement.

ARTICLE 8—LIQUIDATED DAMAGES

8.01 Any provisions for liquidated damages, such as those for Seller's failure to attain a specified Milestone such as the delivery of the Goods, are set forth in the Procurement Agreement.

ARTICLE 9—CONFIDENTIALITY OF BID INFORMATION

9.01 Confidential information is information in the Bid, or in documents submitted by Bidder with the Bid or submitted subsequent to the opening of Bids in support of the Bid, that Bidder clearly and prominently labels in writing to be a trade secret, proprietary, or confidential. Bids will be opened and accompanying documents, if any, will be maintained in a manner that endeavors to avoid disclosing confidential information to third parties, to the extent allowed by Laws and Regulations.

9.02 Bidder shall clearly and prominently mark confidential information with the word "CONFIDENTIAL" on each page or sheet or on the cover of bound documents. Place "CONFIDENTIAL" stamps or watermarks so that they do not obscure any of the required information on the document, either in the original or in a way that would obscure any of the required information in a photocopy of the document.

9.03 If Buyer is requested to disclose confidential information, becomes legally compelled to disclose confidential information, or is required by a regulatory body, governing agency, or controlling authority to disclose confidential information, or make any other disclosure that is prohibited or otherwise constrained by these Procurement Bidding Requirements, Buyer will provide Bidder with prompt notice so Bidder may seek a protective order or other appropriate remedy. Bidder will be solely responsible for submitting to the regulatory body, governing agency, or controlling authority any arguments, briefs, memoranda, motions, authorities, or other information in opposition to disclosure.

9.04 Buyer's obligations with respect to confidential information are nullified by the following exceptions:

A. Confidential information becomes a part of the public domain through publication or otherwise, through no fault of the Buyer;

B. Buyer can demonstrate through suitable documentation that the confidential information was already in the Buyer's possession, and not previously marked as confidential, or was otherwise publicly available prior to the date of Bid submittal;

C. The confidential information is subsequently and independently disclosed to the Buyer by a third party who has a lawful right to disclose such information;

D. Buyer concludes in good faith that the information is not confidential, or that disclosure is required or justified; or

E. Buyer is required to disclose the confidential information by court order or by applicable Laws and Regulations.

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9.05 Notwithstanding any other provision of the Procurement Bidding Documents, it is stipulated and agreed that by accepting a Bid, Buyer has not and does not waive its legal immunity (if any) from suit or liability.

ARTICLE 10—"OR-EQUAL" ITEMS

10.01 Deleted.

10.02 The Procurement Contract, if awarded, will be based on materials and equipment specified or described in the Procurement Bidding Documents. Bidders may propose "or equal" materials and equipment, which if approved by Engineer will be identified by Addendum. The materials and equipment described in the Procurement Bidding Documents establish a standard of required type, function, and quality to be met by any proposed "or-equal" item. No item of material or equipment will be considered by Engineer as an "or-equal" unless written request for approval has been submitted by Bidder and has been received by Engineer no later than 15 days after the advertisement or invitation to bid is first issued. Each such request shall conform to the requirements of Paragraph 7.04 of the General Conditions. Each such request shall include the Manufacturer's Certification for Compliance with BABAA. Refer to the Manufacturer's Certification form provided in these construction Contract Documents. The burden of proof of the merit of the proposed item is upon Bidder. Engineer's decision of approval or disapproval of a proposed item as an equal will be final. Bidders shall not rely upon approvals unless set forth in an Addendum. Send requests to QuestCDN website. Substitutes may be proposed by Seller in accordance with Paragraphs 7.05 and 7.06 of the General Conditions after the Effective Date of the Contract. Each such request shall include Manufacturer's Certification letter to document compliance with Domestic Preference requirements. Refer to Manufacturer's Certification Letter provided in these Contract Documents.

ARTICLE 11—PREPARATION OF BID

11.01 The Bid Form is included with the Procurement Bidding Documents. Additional copies of Procurement Bidding Documents may be obtained from the Issuing Office.

11.02 All blanks on the Bid Form must be completed and the Bid Form must be signed by an individual authorized to act on behalf of the Bidder. Alterations must be initialed by an individual authorized to act on behalf of the Bidder. A Bid price must be indicated for each item in the Bid Form. In the case of optional alternates, the words "No Bid" may be entered.

11.03 Bidder must acknowledge all Addenda by filling in the number and date of each Addendum in the Bid Form and sign where indicated to verify that the Addenda were received. A Bid that does not acknowledge receipt of all Addenda may be considered non-responsive.

11.04 Bidder shall:

A. Sign the Bid Form as indicated in the Bid Form.

B. Include evidence of authority to sign.

C. Provide information on the individual to be contacted for any communications regarding the Bid.

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D. Provide evidence of the Bidder's authority and qualification to do business in the locality of the Project, to the extent required, or indicate the ability to obtain such authority and qualification prior to award of the Procurement Contract.

11.05 The responsibilities of each Bidder submitting a Bid are described in the Bidder's representations and certifications set forth in Article 6 of the Bid Form.

ARTICLE 12—BASIS OF BID; COMPARISON OF BIDS

12.01 *Base Bid with Alternates*

A. The "Base Bid" is the sum stated in the Bid for which the Bidder offers to furnish the Goods and Special Services described in the Procurement Bidding Documents as the base, **to which work may be added** for sums stated in Alternate Bids. An "Alternate Bid" (or Alternate) is an amount stated in the Bid to be **added to** the amount of the Base Bid if the corresponding change in the Goods and Special Services, as described in the Procurement Bidding Documents, is accepted.

B. As set forth in the Bid Form, Bidder shall enter an amount for the Lump Sum Base Bid, and enter a separate amount for each Alternate Bid described in the Procurement Bidding Documents.

C. Award will be made to the responsible Bidder that provides the lowest Bid amount for any combination of Base Bid plus selected additive Alternate Bids which Buyer determines provides the most beneficial combination of alternatives within the funds available.

ARTICLE 13—SUBMITTAL OF BID

13.01 Bidder shall refer to the **advertisement** for specific identification of the date, time, and place where Bids are to be submitted.

13.02 Bidder must submit one copy of the completed Bid Form, and, if required, the Bid Security and the other documents required to be submitted under the terms of Article 4 of the Bid Form.

13.03 A Bid must be submitted no later than the date and time prescribed on the QuestCDN website. Enclose the Bid security and other documents required to be submitted with the Bid as listed in the Bid Form. If a Bid is sent by mail or other delivery system, the sealed envelope containing the Bid shall be enclosed in a separate package plainly marked on the outside with the notation "BID ENCLOSED."

13.04 Complete bids must be submitted with each of the following:

A. Bid Proposal Attachment A – Seller MBR Experience: Provide an installation list of at least five successful full-scale membrane bioreactor installations at Publicly Owned Treatment Works (including Tribal Casino facilities), not pilot or demonstration plants, with design flow rates greater than 100,000 gal/day each operating for at least 3 years, per Specification Section 11500-1.5, for which the Seller has provided equipment and services of similar scope as this contract, to include membranes, permeate pumps, air scour blowers, automatic valves, chemical feed systems, instruments, control panels and control programming. Attach additional sheets if needed.

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B. Bid Proposal Attachment B – Scope of Supply Components That Do Not Comply With BABA Requirements: Provide a list of components in the proposal scope of supply which do not comply with Build America, Buy America (BABA) Act requirements, including the cost of each item to be included in the summation of items for the BABA De Minimus waiver.

C. Bid Proposal Attachment C – Ancillary Equipment: Provide the required information for major pieces of ancillary equipment in the table provided including all motor driven equipment with a motor size of 0.5 hp or greater.

D. Bid Proposal Attachment D – Bid Proposal Submittal: The Bid Proposal submittal shall be submitted to the QuestCDN portal as PDF documents bookmarked to provide navigation links to each section of the submittal. The Bid Proposal submittal shall be arranged with sections numbered 1 through 9 listed below.

Bid submittals shall be complete in all respects and shall be suitable for the Buyer to evaluate the proposed design and equipment. Bidders shall provide all submittals listed herein with the bid package. The cost for preparation of the bid submittals shall not be included in the bid price, nor will the bidders be compensated for the bid submittals at a later date. Drawings submitted by the Bidder or System Seller shall clearly delineate the supplied equipment. All drawings shall clearly indicate all required external connection points to the provided equipment.

Bidders are advised to include as much detail as possible to facilitate the evaluation process. Missing, incomplete, or inaccurate information and details may affect evaluation scoring. Partial, incomplete, or illegible submissions may disqualify the bidder.

The following information shall be submitted with the bid submittal:

1. A list of requested deviations from the specifications including exceptions to the pretreatment and operating conditions described in Specification Sections 01110 and 11500. The list shall be organized by specification section and referenced by its specific subsection and page. The requested specification deviation list shall contain a detailed description of the requested deviation from the specifications and a detailed written explanation of the reasons for requesting the deviation. The Buyer shall be the final authority for determining acceptability of requested deviations.

2. Simplified process and instrumentation diagrams (P&IDs). The simplified P&IDs shall include all flows, pipe sizes, instruments and automated valves. P&IDs shall clearly identify equipment, pipes, conduit, conductors, electrical components, and instrumentation. The P&IDs shall show all equipment required for a complete and operational system and shall clearly indicate which equipment items, piping, conduit, conductors, and electrical connections are not included in the Seller's bid price.

3. A scope of supply list. The scope of supply list shall include a detailed list of all mechanical and electrical equipment items, including all pumps, blowers, compressors, motors, instrumentation, programmable logic controller, operator interface, and gauges that are included in the Seller's bid. The scope of supply list shall include the equipment manufacture's name and model, electrical

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requirements and connected loads, motor size and type, and features and accessories.

4. Process control narratives, including, but not limited to, start-up and shut-down procedures, cleaning procedures, and recommended maintenance procedures.

5. Proposed net, instantaneous and minimum flux rates at maximum day flow and peak equalized flow, corrected for the range of wastewater temperatures in the Technical Specifications.

6. Documentation that the membrane equipment has been recognized by the California Department of Public Health as being acceptable for compliance with the treatment requirements of the State of California Recycled Water Criteria (Title 22).

7. Mechanical Information

a. Plans and sections of the equipment in its proposed location.

b. Plan view of each major component and/or skid.

c. All four section views of each major component and/or skid. Plan and section views of submerged membrane units, permeate pumps, and air scour blowers in both PDF and AutoCad format.

d. Manufacturer's data, including catalog cut, materials of construction, identifying trade name and model designation, and equipment weight.

e. Information on codes to which the equipment conforms.

f. Location and weight of all membrane cassette frames, pumps, motors, and equipment weighing over 100 pounds, which will require hoisting equipment to be supplied by the General Contractor, for removal and maintenance. Note: Actual locations for pumps and blowers will be determined during the design phase and in coordination with the Buyer's Engineer.

8. Electrical Information

a. List of all equipment requiring variable frequency drives (VFDs) including information indicating VFDs to be provided by the General Contractor. For VFDs to be provided by the General Contractor, include information required to select the size, type, and ratings for the VFDs. Provide an indication of the manufacturer, type, and model recommended by the seller. Indicate whether the driven equipment requires any specialized ratings, equipment, or settings to operate correctly with standard 6-pulse pulse-width-modulated (PWM) drives similar to Allen-Bradley

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Powerflex 750 Series. Indicate whether additional equipment including filters or inductors are recommended for use with the driven equipment.

b. Motor data shall be supplied as specified for the scope of supply list.

c. Equipment list of power loads at 480V and 120V with the number of phases, ampacity, and hp ratings shall be included on scope of supply list.

d. Location and approximate footprint and height of electrical system control panels.

e. Control system component vendor, type and models for all PLC, OIU, and network components.

9. Seller warranty stating full compliance with the requirements of Specification Section 11500-1.6 and containing the complete terms and conditions to be included with the Contract.

E. Required Bid security in the form prescribed in the Instructions to Bidders.

F. Evidence of authority to do business in the state of the Project; or a written covenant to obtain such authority within the time for acceptance of Bids.

G. If Bid amount exceeds $10,000, signed Compliance Statement (RD 400-6). Refer to specific equal opportunity requirements set forth in the Supplementary Conditions of the Construction Contract (EJCDC P-800).

H. If Bid amount exceeds $25,000, signed Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lower Tier Covered Transactions (AD-1048).

I. If Bid amount exceeds $100,000, signed RD Instruction 1940-Q Exhibit A-1, Certification for Contracts, Grants, and Loans.

J. Bid Signature Form.

ARTICLE 14—MODIFICATION OR WITHDRAWAL OF BID

14.01 A Bid may be modified or withdrawn by a document duly signed in the same manner that a Bid must be signed and delivered to the place where Bids are to be submitted prior to the date and time for the opening of Bids.

14.02 If, within 24 hours after Bids are opened, any Bidder files a duly signed written notice with Buyer and promptly thereafter demonstrates to the reasonable satisfaction of Buyer that there was a material and substantial mistake in the preparation of its Bid, that Bidder may withdraw its Bid, and the Bid security will be returned.

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ARTICLE 15—OPENING OF BIDS

15.01 Bid Proposals will be opened and displayed shortly after the time and date stated on the advertisement. An abstract of the amounts of the Base Bids and Alternate Bids, if any, will be made available to Bidders after Bids have been opened and reviewed by the Buyer.

ARTICLE 16—BIDS TO REMAIN SUBJECT TO ACCEPTANCE

16.01 All Bids will remain subject to acceptance for the period stated in the Bid Form, but Buyer may, in its sole discretion, release any Bid and return the Bid security prior to the end of this period.

ARTICLE 17—EVALUATION OF BIDS AND AWARD OF PROCUREMENT CONTRACT

17.01 Buyer reserves the right to reject any and all Bids, including without limitation, nonconforming, nonresponsive, unbalanced, or conditional Bids. Buyer also reserves the right to waive all informalities not involving price, time, or changes in the Goods and Special Services.

17.02 Buyer will reject the Bid of any Bidder that Buyer finds, after reasonable inquiry and evaluation, to not be responsible.

17.03 In evaluating Bids, Buyer will consider whether the Bids comply with the prescribed requirements, and such alternates, unit prices, and other data as may be requested in the Bid Form or may be requested from Bidders prior to a Notice of Award.**The undersigned agrees that the Buyer reserves the right to Award the Contract to the lowest responsible, responsive bidder whose Proposal is in the best interest of the Buyer. The Buyer will determine at the time of Award of the Contract which alternate bid items will be included in the Contract.**

The Proposal must include a bid for all items, including the Base Bid and Alternates A, B, and C.

Pass/Fail Criteria

Proposals must meet all the pass/fail criteria listed below and described in Table 1 in order to be considered responsive:

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TABLE 1

Pass/Fail Evaluation Criteria

Criteria	Description	Bid Requirement
Warranty Terms and Conditions	Warranty Terms and Conditions.	Warranty terms and conditions must meet requirements specified in Specification Section 11500-1.6.
Title 22 Certification	Membrane equipment has been recognized by the California Department of Public Health as being acceptable for compliance with the treatment requirements of the State of California Recycled Water Criteria (Title 22).	Title 22 acceptance documentation.
Flux Rates	Proposed Net Flux Rates.	The proposed net flux rates shall meet the requirements as listed in Section 11500-1.3.

ARTICLE 18—BONDS AND INSURANCE

18.01 Article 5 of the General Conditions and Article 5 of the Supplementary Conditions set forth Buyer's requirements as to performance and payment bonds and insurance. When the Successful Bidder delivers the signed Procurement Agreement to Buyer, it must be accompanied by such bonds and acceptable evidence of insurance.

ARTICLE 19—SIGNING OF PROCUREMENT AGREEMENT

19.01 When Buyer issues a Notice of Award to the Successful Bidder, it will be accompanied by the unsigned counterparts of the Procurement Agreement along with the other Procurement Contract Documents identified in the Procurement Agreement. Within 15 days thereafter, Successful Bidder must execute and deliver the required number of counterparts of the Procurement Agreement and any bonds and insurance documentation required to be delivered by the Procurement Contract Documents to Buyer. Within 10 days thereafter, Buyer will deliver one fully executed counterpart of the Procurement Agreement to Successful Bidder, together with printed and electronic copies of the Procurement Contract Documents as stated in Paragraph 2.02 of the General Conditions.

ARTICLE 20—NOT USED

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ARTICLE 21—PROCUREMENT CONTRACT TO BE ASSIGNED

21.01 Bidder's attention is directed to the provisions of Article 5 of the Procurement Agreement which provide for the assignment of the Procurement Contract to a construction contractor designated by the Buyer to construct the **Wastewater Treatment Facility Upgrade**. Successful Bidder (Seller) will be required to perform the Procurement Contract after it has been assigned to the construction contractor (Contractor Assignee) in accordance with the provisions in the Procurement Contract. Timing of the assignment is addressed in the Procurement Agreement. Forms documenting the assignment of the Procurement Contract and for the agreement of the Seller's surety to such assignment are included as attachments to the Procurement Agreement.

ARTICLE 22—FEDERAL REQUIREMENTS

22.01 Federal requirements at Article 16 of the Supplementary Conditions apply to this Contract.

22.02 Build America, Buy America Act requirements apply to this project.

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PART 2

BID DOCUMENTS

BID FORM FOR PROCUREMENT CONTRACT

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BID FORM FOR PROCUREMENT CONTRACT

The terms used in this Bid with initial capital letters have the meanings stated in the Instructions to Bidders, the General Conditions, and the Supplementary Conditions.

ARTICLE 1—BUYER AND BIDDER

1.01 This Bid is submitted to:

QuestCDN (website to be added prior to bid)

Taylor Bay Beach Club HOA

8215 175th Avenue KPS

Longbranch, Washington 98351

1.02 The undersigned Bidder proposes and agrees, if this Bid is accepted, to enter into a Procurement Contract with Buyer in the form included in the Procurement Bidding Documents, and to furnish the Goods and Special Services as specified or indicated in the Procurement Bidding Documents, for the prices and within the times indicated in this Bid, and in accordance with the other terms and conditions of the Procurement Bidding Documents.

ARTICLE 2—BASIS OF BID

2.01 *Lump Sum Bids*

A. Bidder will furnish the Goods and Special Services in accordance with the Procurement Contract Documents for the following Procurement Contract Price(s):

1. Lump Sum Bid Price (Base Bid and Alternates)

1 Lump Sum Bid Price for Base Bid Item 1: Preconstruction Services	$ $220,000.00
2 Lump Sum Bid Price for Base Bid Item 2: Membrane Equipment System Supply, Construction Services, and Post-Construction Services	$660,000.00
Subtotal (Base Bid)	$880,000.00
Washington State Sales Tax (8.1%)	$71,280.00
Total Base Bid Cost	$951,280.00
Alternate A **[Add] – Lump Sum Bid Price for Guaranteed Membrane Module replacement cost for all modules supplied with this contract**	$90,000.00
Washington State Sales Tax (8.1%)	$7,290.00
Total Alternate A Cost	$97,290.00

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Alternate B **[Add] – Lump Sum Bid Price for Extended Warranty for Submerged Membrane Units**	$ $0.00
Washington State Sales Tax (8.1%)	$0.00
Total Alternate B Cost	$0.00
Alternate C **[Add] Lump Sum Bid Price for 10-Year Membrane System Supplier Service Contract**	$ $0.00
Washington State Sales Tax (8.1%)	$0.00
Total Alternate C Cost	$0.00

ARTICLE 3— *NOT USED*TIME OF COMPLETION

3.01 Bidder agrees that the furnishing of Goods and Special Services will conform to the schedule of Procurement Contract Times set forth in Article 2 of the Procurement Agreement.

3.02 Bidder accepts the provisions of the Procurement Agreement as to liquidated damages.

ARTICLE 4—ATTACHMENTS TO THIS BID

4.01 The following documents are attached to and made a condition of this Bid:

A. Bid Proposal Attachment A – Seller Experience.

B. Bid Proposal Attachment B – Scope of Supply Components That Do Not Comply With BABA Requirements.

C. Bid Proposal Attachment C – Ancillary Equipment.

D. Bid Proposal Attachment D – Bid Proposal Submittal

E. Required Bid security in the form prescribed in the Instructions to Bidders.

F. Evidence of authority to do business in the state of the Project; or a written covenant to obtain such authority within the time for acceptance of Bids.

G. If Bid amount exceeds $10,000, signed Compliance Statement (RD 400-6). Refer to specific equal opportunity requirements set forth in the Supplementary Conditions of the Construction Contract (EJCDC P-800).

H. If Bid amount exceeds $25,000, signed Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lower Tier Covered Transactions (AD-1048).

I. If Bid amount exceeds $100,000, signed RD Instruction 1940-Q Exhibit A-1, Certification for Contracts, Grants, and Loans.

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ARTICLE 5—BIDDER'S ACKNOWLEDGMENTS

5.01 Bidder has examined and carefully studied the Procurement Bidding Documents, the related data identified in the Procurement Bidding Documents, and the following Addenda, receipt of which is hereby acknowledged:

Addendum No.	Addendum Date

ARTICLE 6—BIDDER'S REPRESENTATIONS AND CERTIFICATIONS

6.01 *Bidder's Representations*

A. In submitting this Bid, Bidder represents that:

1. Bidder has examined and carefully studied the Procurement Contract Documents.
2. If in Bidder's judgment, any observable local or site conditions may affect the delivery, cost, progress, or furnishing of the Goods and Special Services, then Bidder has visited the Point of Destination and site where the Goods are to be installed or Special Services will be provided (as applicable) and become familiar with and is satisfied as to the observable local and site conditions that may affect delivery, cost, progress, and furnishing of the Goods and Special Services.
3. Bidder is familiar with and is satisfied as to all Laws and Regulations that may affect the cost, progress, and performance of Seller's obligations under the Procurement Contract, including all Domestic Preference requirements.
4. Bidder has carefully studied, considered, and correlated the information known to Bidder with respect to the effect of such information on the cost, progress, and performance of Seller's obligations under the Procurement Contract.
5. Bidder has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder has discovered in the Procurement Contract Documents, and the written resolution (if any) thereof by Engineer is acceptable to Bidder.
6. The Procurement Contract Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performance of Seller's obligations under the Procurement Contract.
7. The submission of a Bid will constitute an incontrovertible representation by Bidder that Bidder has complied with every requirement of the Bidding Requirements, that without exception the Bid (including all Bid prices) is premised upon furnishing the Goods and Special Services as required by the Procurement Contract Documents.

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6.02 *Bidder's Certifications*

A. Bidder certifies that:

1. This Bid is genuine and not made in the interest of or on behalf of any undisclosed individual or entity and is not submitted in conformity with any collusive agreement or rules of any group, association, organization, or corporation;

2. Bidder has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid;

3. Bidder has not solicited or induced any individual or entity to refrain from bidding; and

4. Bidder has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for the Procurement Contract. For the purposes of this Paragraph 6.02.A.4:

   a. "corrupt practice" means the offering, giving, receiving, or soliciting of anything of value likely to influence the action of a public official in the bidding process;

   b. "fraudulent practice" means an intentional misrepresentation of facts made (a) to influence the bidding process to the detriment of Buyer, (b) to establish bid prices at artificial non-competitive levels, or (c) to deprive Buyer of the benefits of free and open competition;

   c. "collusive practice" means a scheme or arrangement between two or more Bidders, with or without the knowledge of Buyer, a purpose of which is to establish bid prices at artificial, non-competitive levels; and

   d. "coercive practice" means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process.

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This Bid is offered by:

Bidder: KUBOTA Water and Environment U.S.A. Corporation
(typed or printed name of organization)

By: _____
(individual's signature)

Date: 2/18/2024
(date signed)

Name: Diego Ayala
(typed or printed)

Title: President
(typed or printed)

(If Bidder is a corporation, a partnership, or a joint venture, attach evidence of authority to sign.)

Attest: _____
(individual's signature)

Title: Notary Public
(typed or printed)

Address for giving notices:

19910 N Creek Pkwy, Suite 100 Bothell, WA 98011

Designated Representative:

Name: Tamami Konishi
(typed or printed)

Title: Notary Public
(typed or printed)

Address:

19910 M Creek Pkway, Suite 100, Bothell, WA 98011

Phone: 425-287-8113

Email: tamami.konishi@kubota.com

License No.: 155619

Classification: Notary Public State of Washington

Limitation: Commission expires 1/24/2028

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ATTACHMENT A

SUPPLIER MBR EXPERIENCE

Provide an installation list of at least four successful full-scale membrane bioreactor installations at Publicly Owned Treatment Works (including Tribal Casino facilities), not pilot or demonstration plants, with design flow rates greater than 100,000 gal/day, each operating for at least 3 years, per Specification Section 11500-1.5, for which the Supplier has provided equipment and services of similar scope as this contract, to include membranes, permeate pumps, air scour blowers, automatic valves, chemical feed systems, instruments, control panels and control programming. Attach additional sheets if needed.

Facility Name/Address	Description and Size of Facility	Month and Year Commissioned	Net Flux Rate at Design Max. Day Flow Rate[1] (gfd)	Contact Name	Phone No.	Email
Winlock	28 RW400 SMU Total Membrane Surface Area: 174,807 sq ft Design Max Monthly Flow: 1.0 MGD	2010	Max Monthly Design Flow/Flux: 1.0 MGD/11.4 gfd Peak Day Flow/Flux: 2.0 MGD/22.9 gfd Peak Hour Flow/Flux: 2.5 MGD/28.6 gfd	Rodney Cecil Superintendent	360-785-3811	winws@cityofwinlock.com
La Center	10 RW400 SMU Total Membrane Surface Area: 62,437 sq ft Design Max Monthly Flow: 0.76 MGD	May 2010	Max Monthly Design Flow/Flux: 0.76 MGD/12.7 gfd Peak Day Flow/Flux: 1.10 MGD/17.62 gfd	Deb Houdeshell	360-281-5613	deb.houdeshell @cantonohio.gov
Cowlitz	8 RM200 SMU Total Membrane Surface Area: 24,972 sq ft Design Max Monthly Flow: 0.195 MGD	2017	Max Monthly Design Flow/Flux: 0.195 MGD/7.81 gfd Peak Day Flow/Flux: 0.360 MGD/14.42 gfd Peak Hour Flow/Flux: 0.590 MGD/23.63 gfd	Amber Mummert Superintendent	360-887-6708	amummert@ilaniresort.com

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Facility Name/Address	Description and Size of Facility	Month and Year Commissioned	Net Flux Rate at Design Max. Day Flow Rate[1] (gfd)	Contact Name	Phone No.	Email
Nisqually	8 RM200 SMU Total Membrane Surface Area: 24,976 sq ft Design Max Monthly Flow: 0.20 MGD	May 2010 Replaced Microdyne Membrane Operation with Kubota SMU	Max Monthly Design Flow/Flux: 0.20 MGD/8.01 gfd Peak Day Flow/Flux: 0.39 MGD/15.62 gfd Peak Hour Flow/Flux: 0.57 MGD/22.83 gfd	Chris Clardy Superintendent	209-602-7379	clardy.chris@nisqually-nsn.gov
Alderwood	84 RW400 SMU Total Membrane Surface Area: 524,422 sq ft Design Max Monthly Flow: 6.2 MGD	February 2011	Max Monthly Design Flow/Flux: 4.1 MGD/11.7 gfd Peak Day Flow/Flux: 4.7 MGD/13.4 gfd Peak Hour Flow/Flux: 8.8 MGD/25.2 gfd	Joe Carter Wastewater Manager	425-478-5968	jcarter@awwd.com

(1) Net flux rate shall be temperature corrected for 20 degrees C, and shall have been field verified. The design net flux rates used shall be reasonable and consistent with design net flux rates at existing full-scale U.S. facilities by the membrane manufacturer. The Supplier shall provide an attached sheet with a list of three installations in the U.S. using flux rates equal to or less than the proposed design flux rates, with the contact information for the facility operations personnel and design annual average, maximum month, peak day, and peak hour flux rates and flow rates, design temperature, and membrane pore size and SMU models used for those installations.

Lummi Tribe WWTP	6 RM150 SMU Total Membrane Surface Area: 14,047 Design Max Monthly Flow: 0.16 MGD	2022	Max Monthly Design Flow/Flux: 0.16 MGD/11.39 GFD Peak Day Flow/Flux: 0.21 MGD/14.81 GFD	Daniel Jeffries	360 461 6059	Danj@ltswd.com

Referenced required information in note 1 is provided in the above table for all plants. All Kubota Membranes referenced come with a design average membrane pore size of 0.2 micron.

Two additional MBR References in which Kubota Replaced Competitors:
Pluris North Topsail: https://www.plurisusa.com/resources/pluris-news/2021/december-2021-01
Pluris Hampstead: https://www.plurisusa.com/resources/pluris-news/2021/december-2021

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ATTACHMENT B

SCOPE OF SUPPLY COMPONENTS THAT DO NOT COMPLY WITH BABA REQUIREMENTS

Part Identification (Name)	Equipment Description and Type	Manufacturer	Number of Units	Total Lump Sum Equipment Cost for Line Item
Kubota SMU Equipment	FS150 SMU Units + Associated Lifting Tool	Kubota	4 SMUs 1 Lifting Tool + Chains	$80,400.00
SMU Basin Associated Endress + Hauser Instrumentation	1. Air Pressure Transmitters 2. Blower Flow Meters 3. Permeate Flow Meter 4. Pump Pressure Transmitter 5. Level Transmitter	Endress + Hauser	Type 1 - QTY 3 Type 2 - QTY 2 Type 3 - QTY 1 Type 4 - QTY 2 Type 5 - QTY 2	$33,896.00
SMU Basin Hach Instrumentation	1. Air Pressure Transmitters 2. Blower Flow Meters 3. Permeate Flow Meters	Hach	Type 1 - QTY 1 Type 2 - QTY 1 Type 3 - QTY 1	$12,633.00
Kubota Standard CIP System	Kubota CIP system based around Mazzei injector, rotometer and flow control valve	Various	1 System of Supply	$18,500.00
PVC Isolation Valves + Check Valves	3 inch PVC Ball Valves 3 inch PVC Check Valves	Asahi	11 Ball Valves 3 Check Vavles	$11,072.00

Kubota will continue to explore and offer alternatives to decrease Non-BABA inclusions

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ATTACHMENT C

ANCILLARY EQUIPMENT

Please see attached Scope of Supply Sheet which supplies the above information in a similar format.

Part Identification (Name)	Equipment Description and Type	Manufacturer	Number of Units	Material of Construction	Size or Capacity	Motor Horsepower	VFD? (yes/no)

Please see attached Scope of Supply Sheet which supplies the above information in a similar format.

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1. Scope of Supply

The following proposed items will be supplied by Kubota Membrane. We are flexible in terms of scope of supply though, and are happy to adjust our scope to fit the project's needs.

2. Major Equipment and Instrumentation Per System

Table 1: Kubota Major MBR Scope of Supply

Equipment Category	Type	Required Capacity/Units	Material	Manufacturer	Model/ Specification	Motor HP	Voltage	QTY
MBR Equipment								
MBR SMU	Flat Plate		304SS	KUBOTA	FS150			4
MBR SMU Lifting Tool	Lifting Tool		CS, SS	KUBOTA	TG150			1
MBR Diffuser Cleaning Valve	Modulating Butterfly	4.0 inch	CI		AUMA Actuated Bray Valve		120 VAC	2
MBR Air Isolation Valve	Manual Butterfly	3.0 inch	Duct Iron	Bray	S30			8
MBR PRMT Isolation Valve	Manual Ball	3.0 inch	PVC	Asahi	Type 21			4
MBR Level Switch	Float		PU	Conery				4
MBR Level Sensor	Hydrostatic	ft	SS	Endress & Hauser	Waterpilot FMX21			2
MBR SMU Guide & Stabilizer + Seismic Bracing								4
MBR SMU Fasteners			304SS					40
MBR In-Basin Pipe&Supports (Permeate Drop Pipe)			PVC					4
MBR In-Basin Pipe&Supports (Air Drop Pipe)			304SS					8
Permeate (PRMT) Control Equipment								
PRMT Pump	Rotary Lobe – VFD Required, provided by others	45.0 gpm		Boerger	AN 70	5.0	460 VAC	3
PRMT Flow Control Valve	Modulating Butterfly	3.0 inch	SS	Bray	AUMA Actuated Bray Valve		120 VAC	1
PRMT Pump Pressure Gauge								6
PRMT Pump Pressure Transmitter	Diaphragm	psi		Endress & Hauser	Cerabar PMC21			2
PRMT Flow Meter	Electromagnetic	3.0 inch	PU	Endress & Hauser	Promag W 400		120 VAC	1

Equipment Category	Type	Required Capacity/Units	Material	Manufacturer	Model/ Specification	Motor HP	Voltage	QTY
PRMT Turbidity Meter	Laser	NTU		HACH	TU5300sc		120 VAC	2
PRMT Turbidity Transmitter				HACH	SC4500		120 VAC	1
Turbidity Meter Maintenance Kit				HACH				1
Valves		3.0 inch	PVC	Asahi	Type 21/Check Valves			3 PVC Check Valves 7 PVC Type 21 Ball Valves
MBR Blower								
MBR Blower	Positive Displacement (VFDs Required, By Others)	114 scfm	CI	Aerzen	GM 4S DN 80	5.0	460 VAC	3
MBR Blower Flow Meter	Thermal Mass	3.0 inch	PU	Endress & Hauser	t-mass I 500		120 VAC	2
MBR Blower Pressure Transmitter	Diaphragm	psi		Endress & Hauser	Cerabar PMP51B			3
Manual Isolation Valves		3.0		Bray	S30			5
Clean-In-Place Equipment								
SMU CIP System		3.0 inch		KUBOTA				1
System Control Equipment								
Control Panel	OIT	See Below for Details						1

3. Controls Detail

I. PLC Control Panel Features

- NEMA 4/12, 72" x 72" x 18" floor mount enclosure (estimated size)
- Allen Bradley 1769-L36ERM PLC (Non-BABA version)
- Allen Bradley 1756-L81E PLC (BABA-Version)
- Redundant 24 VDC power supply for field devices
- Allen Bradley Stratix or Cisco Lightly managed Ethernet Switch, sized as needed
- All I/O points wired to terminal blocks
- Fuses for power distribution to all instruments
- 15% spare IO for all types
- LED Panel Lights
- Convenience power outlet
- Panel fed by three separate 120VAC circuits (Spec requirement)
- 3-point latching door handle

- DC UPS controller provided to provide power through power outage to emergency generator startup
- Fabricated and listed per UL 508a requirements
- Complete, documented control panel functionality test, including point-to-point testing of all I/O channels.
- Detailed panel drawings and loop interconnects
- Submittals as required

II. IO Count

Based upon our reading of the supplied P&IDs, we estimate the following I/O count:

I/O Type	Qty	# I/O Cards	Spare Channels	Spare Percentage
DI	23	2	9	28%
DO	11	1	5	31%
AI	15	5	5	25%
AO	6	2	2	25%

III. SCADA System Hardware and Software:

- Siemens Simatic IPC427D industrial computer
- Hope Industrial 23.9" touchscreen operator interface
- Wonderware Intouch 3000 Tag Runtime with I/O SCADA software, licensed to owner
- Rockwell Software Studio 5000 PLC Programming software (spec requirement)
- Two licensed copies of RSLinx communication driver software (Spec requirement)

IV. PLC and HMI Programming:

- PLC Programming following Kubota control narratives using PLC programming standards
- HMI Programming following Kubota control narratives using HMI Programming standards
- PLC/HMI programming FAT at Control Engineers office in Boise, Idaho or remotely witnessed
- Incorporation of HMI Programming into owner's master SCADA system (spec requirement)

V. Engineering:

- Control panel design, drawings, and wiring schematics in AutoCAD
- Loop wiring (point-to-point) drawings in AutoCAD
- Control Narrative and HMI manual based upon process description provided by Kubota
- Submittal documents
- 100% design documentation
- As-delivered documentation
- As-built documentation

4. Clarifications to Kubota's Scope of Supply

- As permitted in Section 11500-20 Part 2.8F, Kubota is proposing manual isolation valves to enable switching between Air Scour Blowers and Permeate Pumps. Should the automatic system also referenced be desirable, Kubota is happy to adjust it's scope.

- In Kubota's research, it was discovered that the specified PVC valve manufacturers were unable to meet BABA requirements. Because of the relatively minimal cost for these valves in the scope of Kubota's proposal, it was decided to submit the specified non-BABA Asahi valves in the interest of adhering to the written specification. However, should a BABA alternative be of interest, Kubota identified some options that may be suitable in this application.
- As stated in Section 1, Kubota is proposing using the Allen Bradley ControlLogix system due to its BABA compatibility. However, if it is more desirable to stick to the specified CompactLogix PLC, Kubota can supply the CompactLogix system instead.
- Kubota has included vendor startup support in this cost for the major equipment suppliers as written in the specification.
- As stated in Section 1, the Chemical Injection system is included as a Mazzei injector system to pull direct from the chemical totes, as the chemical requirements both per clean and annually are relatively minor in comparison to the scope of the work entire.

5. Exclusions to Kubota Scope of Supply

The following items are not currently included in the Kubota scope of supply:

- **Professional Liability Insurance.**
- **Equipment unloading, handling, storage, and installation.**
- **Any equipment or services not expressly listed above.**
- **Civil works including installation of equipment, piping, and wiring.**
- **Fine screening equipment.**
- **Pretreatment/Headworks (grit removal, DAF, etc.).**
- **Flow equalization system (TBD).**
- **Electrical system (main electrical, generators, etc.).**
- **Solids handling equipment and digesters.**
- **Disinfection System (TBD).**
    - **KWU can supply this equipment at an additional cost.**
- **Tanks, building construction.**
- **All piping that is outside of the MBR tanks, including permeate, air scour and diffuser cleaning headers.**
- **Wall pipe, link seal, sleeve, and any kind of penetration seal.**
- **Chemical storage tanks.**
- **Chemicals, seed sludge, and other consumables.**
- **Heat tracing (A separate power supply will also be required).**
- **Flow conditioners for flow meters.**
    - **All flow meters will include a compact mounted housing (i.e., mounted directly on the meter). The scope of supply assumes piping configurations can provide the manufacturer recommended straight pipe run upstream and downstream from the meter. If these requirements cannot be met, flow conditioners will be required which can be provided by KWU at an additional cost.**
- **MCC, VFDs, motor starters.**
- **Motor heaters**
- **Equipment lifts or hoists except for Kubota SMU.**
- **Seismic bracing for equipment, if needed.**

- Any systems for operation in a classified area. All supplied systems will be "unclassified" in accordance with NFPA Standard 820.
- Surge protection for analog input, analog output, discrete input, discrete output signals and instrument power in the MBR PLC.
- Surge protection for field devices at the field device location, including signal and power circuits.
- Thread rod anchor bolts for SMU guide rail and/or SMU diffuser case to floor and wall are supplied by Kubota. All other anchor bolts are excluded. Epoxy or glue for anchor bolts is supplied by others.

For Earth, For Life

Kubota

Bid Proposal for

Taylor Bay, Washington

Kubota

MBR Treatment Facility

February 18, 2025



Prepared By:

Kubota Water and Environment
19910 N Creek Pkwy, Suite 100
Bothell, WA 98011
425-898-2858

Local Representation By:

Goble Sampson
Doug Allie
425-392-0491
dallie@goblesampson.com

February 18th, 2025

Taylor Bay Beach Club HOA representatives,

Kubota Water and Environment (KWU) is pleased to present our budgetary proposal for the Taylor Bay Beach Club HOA Membrane System and Services. Kubota Water and Environment is a company with a strong history in the U.S., backed by Kubota Corporation's extensive wastewater experience worldwide. The Kubota MBR system has unique features that will save your client time through simple and reliable operation.

A compelling feature of the Kubota MBR system is the simplicity of daily operations and periodic maintenance. Both the membrane unit and the MBR system are designed for the operator's convenience. Cleaning is performed in place, with no routine membrane unit removal required. Cleaning events are performed two to four times per year, and each event can be completed in a matter of hours. Also, because the Kubota MBR System uses a flat sheet membrane, it offers straightforward troubleshooting and easy replacement in the unlikely event that problems arise.

Kubota Water and Environment offers first class service. Our technicians have operational experience and are well trained in wastewater analysis and membrane inspection. This sets us apart from other membrane manufacturers who do not design, build, or operate treatment plants, and system integrators who do not manufacture parts or operate plants. We are responsive to operator concerns and knowledgeable about the Kubota MBR System from top to bottom.

With the Kubota name comes a long history of excellence in MBR wastewater treatment. We are happy to put you in touch with operators and engineers who can share their experience with our product. If you have any questions regarding our proposal, please feel free to contact us or our local representative, Doug Allie of Goble Sampson Associates Inc., at 425-392-0491 or dallie@goblesampson.com.

Best regards,

Hiro Kuge

Regional Manager | KUBOTA Membrane USA Corporation

Cell: +1-425-919-3308

Email: hiroo.kuge@kubota.com

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Introduction

Kubota Water and Environment would like to thank you for the opportunity to present the enclosed proposal to supply a Membrane Bioreactor System (MBR) system and associated components for the Project Name project. Included in this proposal is some background information about Kubota and Kubota MBR systems, followed by an overview of the proposed design, Kubota's scope of supply, and budgetary price.

Company Background

History

Kubota Corporation has been designing and building wastewater treatment plants since the early 1960s. Long before building wastewater treatment plants, the company became involved with water engineering projects in 1893 as a manufacturer of iron piping, which was used for clean water distribution. As the largest engineering contractor for wastewater treatment plants in Japan, Kubota has the capability to design, build and operate municipal and industrial wastewater treatment plants.

In the 1980s, Kubota developed its own MBR technology using an external tubular type of ultrafiltration membrane. After the initial installation of these membranes in a soil treatment plant in Japan, Kubota realized these membranes lacked energy efficiency, had short life spans, and required frequent maintenance. This prompted Kubota to find an alternative to the external tubular membranes. In 1989, Kubota pioneered the energy-efficient, long-lasting, and easy-to-use flat sheet membrane with its Submerged Membrane Unit. Kubota's Submerged Membrane Unit was designed specifically for wastewater treatment applications and is currently installed in wastewater treatment plants around the world, making Kubota a leader in the flat sheet MBR technology market.

The first installation of the Kubota flat sheet Submerged Membrane Unit was for a mechanical tool equipment manufacturer in Hiroshima in 1990. Kubota has refined and improved the membrane product for over 25 years (Figure 1). Kubota membranes were first introduced to the U.S. in 2002. Today, MBR systems using the Kubota membrane have been installed all over the world for numerous applications in addition to sewage treatment, such as brewery, dairy, food processing, pharmaceutical and chemical, laundry, leachate, and electrical industry wastes, as well as for sludge liquor treatment and water reuse.

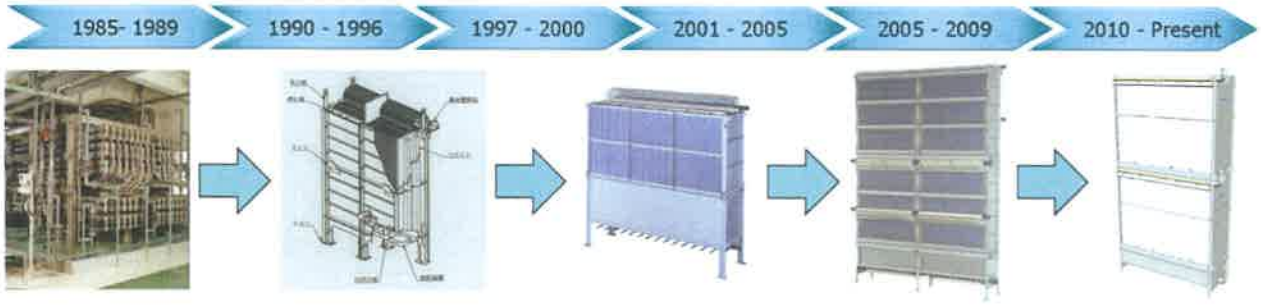


Figure 1: Progression of the Kubota membrane, from the tubular type to the most recent SP600

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Design Support and After-Sales Service

Kubota Water and Environment has technical staff in Washington State and Ohio who can help the customer with any design or operational needs of this project. Kubota staff members are available to provide technical support to consultants, WWTP operators, and WWTP owners.

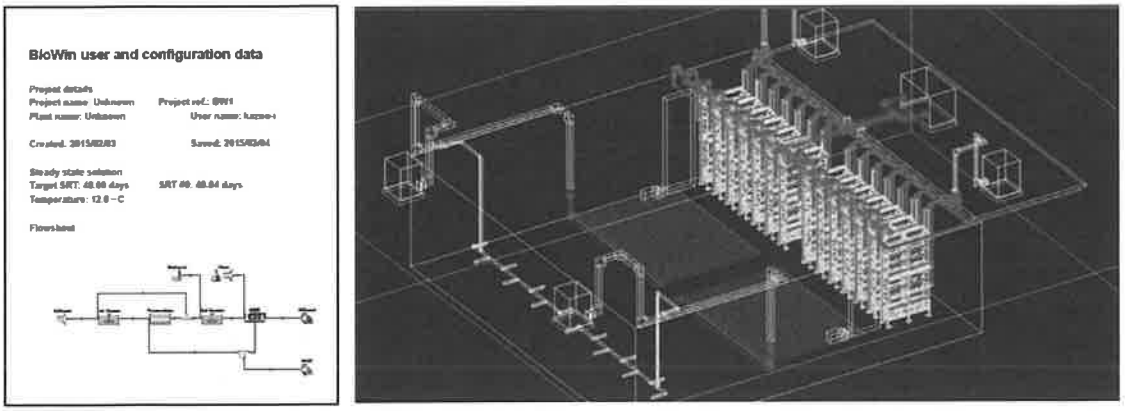


Figure 2: Examples of Kubota's Design Support Capabilities

Kubota provides a staff on a regular basis for service and support of construction activities and throughout the warranty period. The service provided includes delivery inspection, installation certification, training, commissioning and ongoing technical support. Kubota will also provide operation and maintenance manuals and 24/7 customer support.

Kubota Industrial Equipment in the state of Georgia has five certified operators who operate the industrial MBR system for the factory's wastewater. Additionally, Kubota has a Research and Development Center in Canton, OH, which focuses on optimizing the design and performance of Kubota membrane systems for the North American market.

Kubota's Experience

Kubota has extensive experience in all parts of an MBR system project including designing, building, and operating MBR systems. Kubota has over 300 Design-Build projects, operates over 30 plants, and has over 300 maintenance contracts. Kubota also designed, operates, and maintains the 80,000 GPD MBR treatment facility for the Kubota Tractor Factory in Georgia, USA.

As of 2022, Kubota MBR systems have been installed at over 7,300 facilities worldwide, making Kubota the top supplier in the world. Even prior to the first U.S. MBR installations, Kubota had already been designing, building, and operating MBR systems around the world for many years.

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Table 1: Kubota Submerged Membrane Unit Installations Worldwide as of December 2022

Region	Number of Installations
North America	525
Europe & Africa	756
Middle East	148
Asia (Except Japan) & Oceania	836
Japan	5,062
Total MBR Plants	**7,327**

Membrane Product Information

For this project, we have prepared a preliminary design based around the FS150 Submerged Membrane Unit (SMU). The FS series was launched in 1991. For over 25 years, it has provided simple and reliable treatment in a compact and robust package. Ideal for smaller facilities, the FS model offers high quality effluent with simple maintenance and operation. A basic overview of the FS series of Submerged Membrane Units and of the Kubota membrane cartridge is included in the figure below.

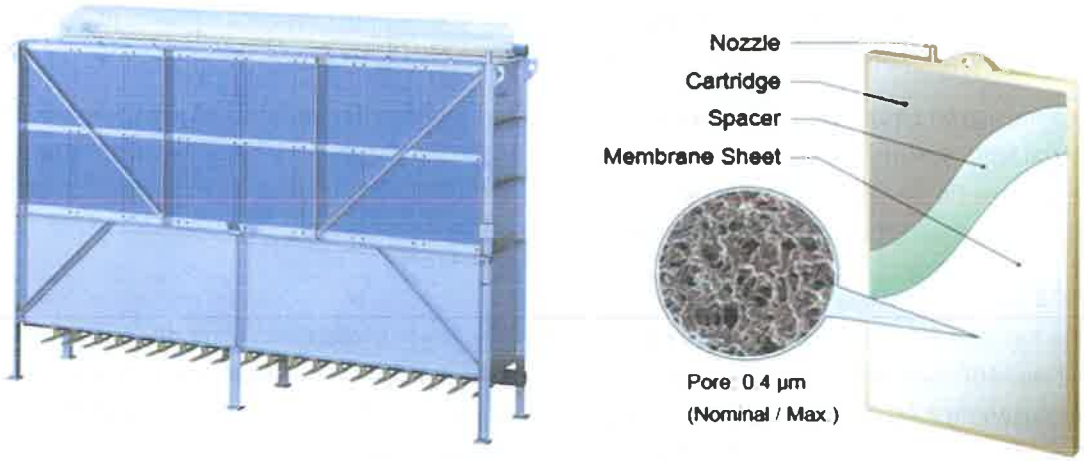


Figure 3: Kubota FS Series Unit Structure (left) and Membrane Cartridge Structure (right)

MBR Process Description

The MBR treatment process is capable of meeting strict nutrient removal requirements while still maintaining a small footprint. MBR is the combined process of activated sludge (secondary treatment) and membrane filtration (tertiary treatment). Membrane units are installed in the activated sludge reactor, where sludge and treated water are separated by means of physical filtration. Other treatment processes, such as conventional activated sludge, require gravity sedimentation through the use of final

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clarifiers. MBRs eliminate the need for gravity sedimentation, thereby eliminating the need for final clarifiers.

Additionally, the Kubota MBR tank using FS150 can operate at a mixed liquor concentration up to 13,000 mg/L, which is much higher than that of a conventional activated sludge basin. This reduces the required aeration volume and the volume of waste sludge produced, and also gives the system increased ability to withstand influent load fluctuations.

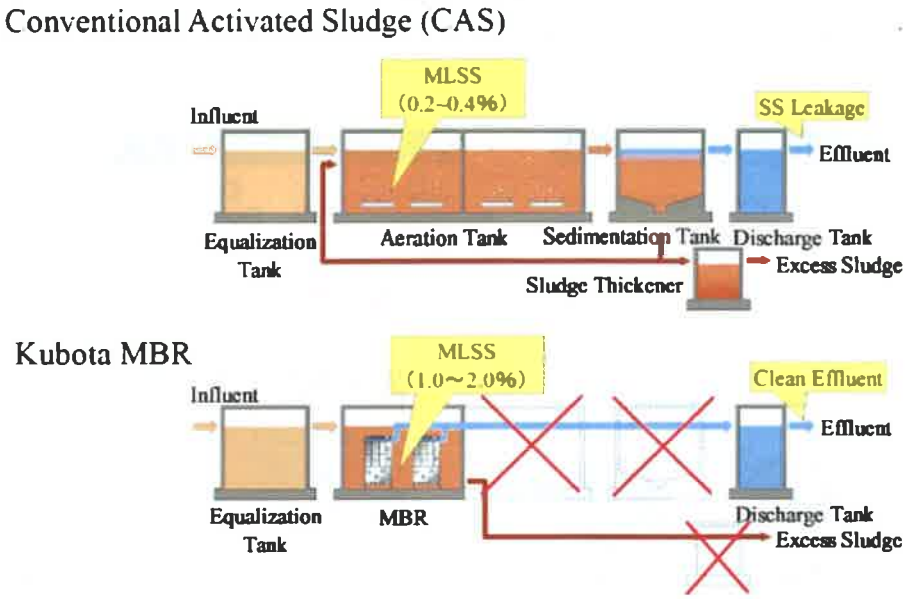


Figure 4: Typical CAS Process (top) vs. Kubota MBR Process (bottom)

Operation and Maintenance

The primary method of membrane cleaning for the Kubota MBR system is the air scour provided by the diffusers at the base of the membrane units. The chemical cleaning system, utilized much less often, is based on a venturi mixing valve that feeds the cleaning solution through the permeate piping into the membrane units and allowing that solution to soak in the membrane units for 2 to 4 hours. If the residual chemical cannot be discharged from the system, it can be sent back to the raw water inlet or to the bioreactor in order to neutralize the chemical. The venturi system is compact and can be wall mounted. **No neutralization or back pulse is required with Kubota membranes.**

Organic fouling can be cleaned with a 0.5% sodium hypochlorite (NaClO) solution, which is typically needed two to four times per year. Inorganic fouling such as iron or aluminum can be cleaned by a 0.5% to 1% oxalic or citric acid solution which is typically needed once a year or less.

The annual maintenance cleaning chemical usage cost estimation is based on the following assumptions:

- Sodium hypochlorite used for organic fouling removal and is done two-four times every year. Below is calculated based on three CIP cleaning events per year.
- Citric acid is used to address inorganic fouling and would typically be needed once per year or less. In organic fouling does not occur at every facility so some facilities never require this. However,

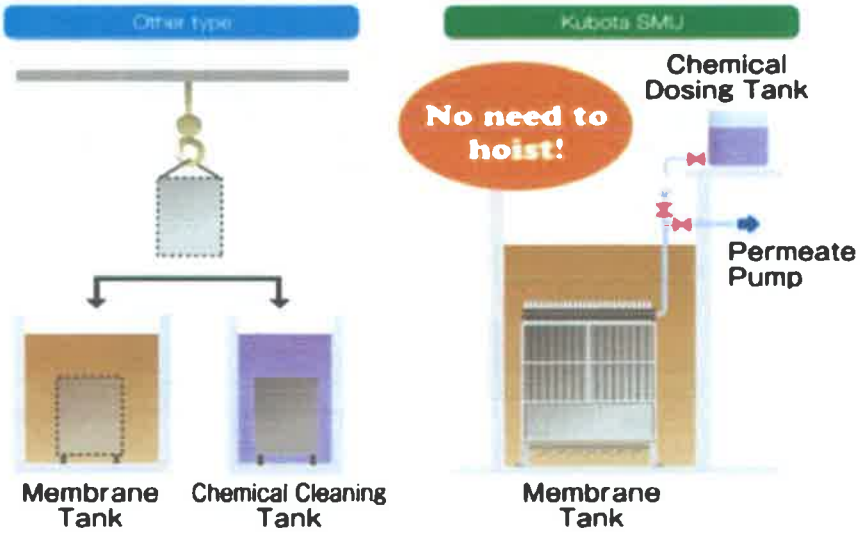
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due to the water treatment residuals in this system, we have calculated the acid usage below based on one CIP cleaning event per year.

- Sodium Hydroxide is used if silica is present in the wastewater.

The Kubota MBR system was developed in 1990 to be low-maintenance and easy to operate. Since then, Kubota MBR package plants have been installed in many remote communities to treat small flows. Many of these plants run without constant operator attention and are visited only once every two weeks. This illustrates the ease of operation and reliability of the Kubota MBR system.

Kubota takes pride in the simplicity of our MBR systems, and we strive to build long-term relationships with our customers. We are committed to the U.S. market, and will provide excellent support through all phases of our proje



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Section 1:Requested Deviations from Specifications

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The following list denotes Kubota's requested deviations from the given specification. Our intent is to meet the intent of the design in its entirety and supply a safe, effective MBR treatment system for the Taylor Bay project. We believe the requested deviations will aid the delivery of that system.

Items to note:

- Lead Time of Items – Section 01110-11
  - Due to the BABA requirements, some of the equipment associated with the system was quoted to have extended lead times.
- CIP system – Section 11500-18, Paragraph D-2
  - Use of mazzei injector system to dose chemical directly from tote vs. Large chemical tank
    - Kubota proposes that the chemicals required for the clean in place process be injected via Mazzei injector system directly from the chemical totes in which they come. Kubota's designed CIP system brings the stock chemical solution to the desired concentration, and given the low and infrequent dosage required to operate the MBR facility, Kubota would propose that the CIP system Bulk Storage tanks for the Sodium Hydroxide and Citric Acid are not necessary in this use case. This will have the added benefit of saving space for the facility for other uses. If the tank is important to the evaluation committee, we are happy to discuss bringing it back into the scope.
    - Small volume of chemical required for clean makes tote system advantageous.
- Control System Model – Section 11500-21 Paragraph 2.10 – 16910-4 Part 2.1
  - During research with Kubota's preferred controls partner, it was found that the specified control system, Alen Bradley CompactLogix, is not BABA compliant. However, Allen Bradley's ComputLogix is. Because of the high cost associated with the controls portion of the project, Kubota is moving forward with a Computlogix in our proposal submission.

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Section 2:Simplified Process and Instrumentation Diagrams (P&IDs

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P&ID

Within the zip file included in the Bid proposal is our drafted P&ID which shows Kubota's scope listed on the relevant pages and highlighted in red to demark what is included in our proposal. We are happy to change and develop this scope further as the project develops..

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Section 3:Scope of Supply List

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Scope of Supply

The following proposed items will be supplied by Kubota Membrane. We are flexible in terms of scope of supply though, and are happy to adjust our scope to fit the project's needs.

Major Equipment and Instrumentation Per System

Table 2: Kubota Major MBR Scope of Supply

Equipment Category	Type	Required Capacity/Units	Material	Manufacturer	Model/ Specification	Motor HP	Voltage	QTY
MBR Equipment								
MBR SMU	Flat Plate		304SS	KUBOTA	FS150			4
MBR SMU Lifting Tool	Lifting Tool		CS, SS	KUBOTA	TG150			1
MBR Diffuser Cleaning Valve	Modulating Butterfly	4.0 inch	CI		AUMA Actuated Bray Valve		120 VAC	2
MBR Air Isolation Valve	Manual Butterfly	3.0 inch	Duct Iron	Bray	S30			8
MBR PRMT Isolation Valve	Manual Ball	3.0 inch	PVC	Asahi	Type 21			4
MBR Level Switch	Float		PU	Conery				4
MBR Level Sensor	Hydrostatic	ft	SS	Endress & Hauser	Waterpilot FMX21			2
MBR SMU Guide & Stabilizer + Seismic Bracing								4
MBR SMU Fasteners			304SS					40
MBR In-Basin Pipe&Supports (Permeate Drop Pipe)			PVC					4
MBR In-Basin Pipe&Supports (Air Drop Pipe)			304SS					8
Permeate (PRMT) Control Equipment								
PRMT Pump	Rotary Lobe – VFD Required, provided by others	45.0 gpm		Boerger	AN 70	5.0	460 VAC	3
PRMT Flow Control Valve	Modulating Butterfly	3.0 inch	SS	Bray	AUMA Actuated Bray Valve		120 VAC	1
PRMT Pump Pressure Gauge								6
PRMT Pump Pressure Transmitter	Diaphragm	psi		Endress & Hauser	Cerabar PMC21			2
PRMT Flow Meter	Electromagnetic	3.0 inch	PU	Endress & Hauser	Promag W 400		120 VAC	1

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Equipment Category	Type	Required Capacity/Units	Material	Manufacturer	Model/ Specification	Motor HP	Voltage	QTY
PRMT Turbidity Meter	Laser	NTU		HACH	TU5300sc		120 VAC	2
PRMT Turbidity Transmitter				HACH	SC4500		120 VAC	1
Turbidity Meter Maintenance Kit				HACH				1
Valves		3.0 inch	PVC	Asahi	Type 21/Check Valves			3 PVC Check Valves 7 PVC Type 21 Ball Valves
MBR Blower								
MBR Blower	Positive Displacement (VFDs Required, By Others)	114 scfm	CI	Aerzen	GM 4S DN 80	5.0	460 VAC	3
MBR Blower Flow Meter	Thermal Mass	3.0 inch	PU	Endress & Hauser	t-mass I 500		120 VAC	2
MBR Blower Pressure Transmitter	Diaphragm	psi		Endress & Hauser	Cerabar PMP51B			3
Manual Isolation Valves		3.0		Bray	S30			5
Clean-In-Place Equipment								
SMU CIP System		3.0 inch		KUBOTA				1
System Control Equipment								
Control Panel	OIT	See Below for Details						1

Controls Detail

I. PLC Control Panel Features

- NEMA 4/12, 72" x 72" x 18" floor mount enclosure (estimated size)
- Allen Bradley 1769-L36ERM PLC (Non-BABA version)
- Allen Bradley 1756-L81E PLC (BABA-Version)
- Redundant 24 VDC power supply for field devices
- Allen Bradley Stratix or Cisco Lightly managed Ethernet Switch, sized as needed
- All I/O points wired to terminal blocks
- Fuses for power distribution to all instruments
- 15% spare IO for all types
- LED Panel Lights
- Convenience power outlet
- Panel fed by three separate 120VAC circuits (Spec requirement)
- 3-point latching door handle

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- DC UPS controller provided to provide power through power outage to emergency generator startup
- Fabricated and listed per UL 508a requirements
- Complete, documented control panel functionality test, including point-to-point testing of all I/O channels.
- Detailed panel drawings and loop interconnects
- Submittals as required

II. IO Count

Based upon our reading of the supplied P&IDs, we estimate the following I/O count:

I/O Type	Qty	# I/O Cards	Spare Channels	Spare Percentage
DI	23	2	9	28%
DO	11	1	5	31%
AI	15	5	5	25%
AO	6	2	2	25%

III. SCADA System Hardware and Software:

- Siemens Simatic IPC427D industrial computer
- Hope Industrial 23.9" touchscreen operator interface
- Wonderware Intouch 3000 Tag Runtime with I/O SCADA software, licensed to owner
- Rockwell Software Studio 5000 PLC Programming software (spec requirement)
- Two licensed copies of RSLinx communication driver software (Spec requirement)

IV. PLC and HMI Programming:

- PLC Programming following Kubota control narratives using PLC programming standards
- HMI Programming following Kubota control narratives using HMI Programming standards
- PLC/HMI programming FAT at Control Engineers office in Boise, Idaho or remotely witnessed
- Incorporation of HMI Programming into owner's master SCADA system (spec requirement)

V. Engineering:

- Control panel design, drawings, and wiring schematics in AutoCAD
- Loop wiring (point-to-point) drawings in AutoCAD
- Control Narrative and HMI manual based upon process description provided by Kubota
- Submittal documents
- 100% design documentation
- As-delivered documentation
- As-built documentation

Clarifications to Kubota's Scope of Supply

- As permitted in Section 11500-20 Part 2.8F, Kubota is proposing manual isolation valves to enable switching between Air Scour Blowers and Permeate Pumps. Should the automatic system also referenced be desirable, Kubota is happy to adjust it's scope.

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- In Kubota's research, it was discovered that the specified PVC valve manufacturers were unable to meet BABA requirements. Because of the relatively minimal cost for these valves in the scope of Kubota's proposal, it was decided to submit the specified non-BABA Asahi valves in the interest of adhering to the written specification. However, should a BABA alternative be of interest, Kubota identified some options that may be suitable in this application.
- As stated in Section 1, Kubota is proposing using the Allen Bradley ControlLogix system due to its BABA compatibility. However, if it is more desirable to stick to the specified CompactLogix PLC, Kubota can supply the CompactLogix system instead.
- Kubota has included vendor startup support in this cost for the major equipment suppliers as written in the specification.
- As stated in Section 1, the Chemical Injection system is included as a Mazzei injector system to pull direct from the chemical totes, as the chemical requirements both per clean and annually are relatively minor in comparison to the scope of the work entire.

Exclusions to Kubota Scope of Supply

The following items are not currently included in the Kubota scope of supply:

- **Professional Liability Insurance.**
- **Equipment unloading, handling, storage, and installation.**
- **Any equipment or services not expressly listed above.**
- **Civil works including installation of equipment, piping, and wiring.**
- **Fine screening equipment.**
- **Pretreatment/Headworks (grit removal, DAF, etc.).**
- **Flow equalization system (TBD).**
- **Electrical system (main electrical, generators, etc.).**
- **Solids handling equipment and digesters.**
- **Disinfection System (TBD).**
  - **KWU can supply this equipment at an additional cost.**
- **Tanks, building construction.**
- **All piping that is outside of the MBR tanks, including permeate, air scour and diffuser cleaning headers.**
- **Wall pipe, link seal, sleeve, and any kind of penetration seal.**
- **Chemical storage tanks.**
- **Chemicals, seed sludge, and other consumables.**
- **Heat tracing (A separate power supply will also be required).**
- **Flow conditioners for flow meters.**
  - **All flow meters will include a compact mounted housing (i.e., mounted directly on the meter). The scope of supply assumes piping configurations can provide the manufacturer recommended straight pipe run upstream and downstream from the meter. If these requirements cannot be met, flow conditioners will be required which can be provided by KWU at an additional cost.**
- **MCC, VFDs, motor starters.**
- **Motor heaters**
- **Equipment lifts or hoists except for Kubota SMU.**
- **Seismic bracing for equipment, if needed.**

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- Any systems for operation in a classified area. All supplied systems will be "unclassified" in accordance with NFPA Standard 820.
- Surge protection for analog input, analog output, discrete input, discrete output signals and instrument power in the MBR PLC.
- Surge protection for field devices at the field device location, including signal and power circuits.
- Thread rod anchor bolts for SMU guide rail and/or SMU diffuser case to floor and wall are supplied by Kubota. All other anchor bolts are excluded. Epoxy or glue for anchor bolts is supplied by others.

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Other Inclusions to Scope of Supply

The following table shows other items that Kubota routinely includes in its scope of supply for various projects across the globe. KWU is dedicated toward ensuring the success of each project it takes on.

Table 3: Other Inclusions to Kubota Scope

Other Inclusions	
Design Support Submittal	Preliminary Design
	Design Calculation
	Selection of Equipment
	Review of 30/60/90/100% Design
	Design Meeting
	Submittal
	Construction Guidelines & Installation Specification
O&M Manual	O&M Manual for the MBR Systems including HMI
Delivery and Construction SV	Delivery Inspection
	Construction Supervisor
Startup	Dry Check, Wet Check, Control Program check
Membrane Warranty	Performance and Defect
Equipment Warranty (Excluding Membrane)	Defect
Control Warranty	Performance and Defect

Direct Services

The following services are included in Kubota's scope of supply:

Design Support

- Support during preliminary and final design.
- One (1) day on-site design meeting.
- Construction submittals including shop drawings.
- Preparation and submittal of a system O&M manual for Kubota supplied systems and equipment.
- Equipment delivery coordination with the contractor.
- On-site delivery inspection of Submerged Membrane Units.

Commissioning

- On-site installation inspection, start-up, and commissioning including dry and wet equipment checks, clean water testing, and support during seeding and start-up.
- On-site performance testing.
- Additional days are available as needed.

Training

- Two (2) days of on-site, hands-on operator training using a mix of classroom and field time. See Table 4 below for list of training topics.

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Table 4: Training and Workshops Included in Kubota's Scope of Supply

Training/Workshop	Brief Summary
PLC and HMI	1. Navigation of all HMI screens and menus. 2. Review of automatic operations and controls. 3. Changing process set points. 4. Overriding controls from the HMI. 5. Manual operation of the system in the event of a power failure.
CIP training	1. Navigation of CIP (Clean-In-Place), in-situ maintenance chemical cleaning. 2. Control from HMI and operation of manual valve. 3. Adjust set points of chemical flow.
Troubleshooting	1. Case study of troubleshooting 2. Recovery from trouble 3. "Fish bone" approach
Daily testing	1. Filterability test 2. Viscosity measurement

Workshop/Additional Training Available (No Charge)

Operator Workshops

Kubota also organizes yearly Operator Workshops in US. These workshops are a unique resource for new MBR operators to gain firsthand knowledge and troubleshooting from experienced operators at the presenting operator's own Kubota MBR facility. Our workshops are offered free of charge and focus on operator chosen topics, under the direction of Kubota engineers with years of hands-on experience. In the last five years we have given workshops in Atlanta, GA; Alderwood, WA; Pocatello, ID; Dallas, TX; Vancouver, WA and twice at Spirit Mountain Casino, OR as well as online workshop in 2020 and 2021. In 2022, operator workshop was held in City of Grapevine TX and Auburn CA.

- In June 2023 we had operator workshop in Cowlitz Casino WA. Multiple Cities, Counties, tribes, and districts came to these 2 days workshop. CEU credit was given to the attendees.
- This is just one of the many ways Kubota supports each of our MBR installations and continues operator training to ensure the highest level of performance for our MBR plants possible. We have not seen any other MBR suppliers provide these workshops every year.



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- The biggest benefit of these operator workshop is that you get to know other Kubota MBR plant operators. We are happy to put you in touch with operators and engineers who can share their experience with our product across the country. We would be happy to help arrange tours of local installations using the Kubota membrane if desired.

Kubota Design Build Operate Experience

Given the size and in-depth experience of the Kubota MBR team, we can provide complete solutions. Facilities in Asian Countries, industrial facilities in US and in some small package plant projects, we have delivered a turnkey solution. We not only provided all of the plant MBR equipment, we also provided facility design, full construction services, commissioning and startup, as well as operations. We do not know of another major MBR system supplier that has demonstrated this level of experience. Our unique capabilities in design build projects provides real value to the design build team.

Kubota Quality Assurance Support Team from the Factory

In addition to our US based support group, Kubota utilizes a well experienced quality assurance team to support and trouble shoot issues as required. Resume information on each support person can be provided on request to demonstrate experience and knowledge of MBR products and systems.

Table 5: Kubota Quality Assurance Team Resources

Quality Assurance Team		
Shinichiro Fukuhara	Shingo Kubo	Yuji Otsuka
Ryuji Yamamoto	Kimihiro Ishikawa	Ken Yoshizaki
Yusuke Oi	Yuki Kawashima	Yoshitaka Murakami
Hiroyuki Takatori	Tadao Shinkai	Motonobu Nakaya
Yukako Morita	Ken Tanaka	Hitoshi Yanase

Piedmont, SC Diffuser Issue Resolved by Kubota Quality Assurance Team

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A primary mission of our quality assurance team is to provide support where needed anywhere in the world. While we have local based support in all countries, some issues are best suited with a team support effort. Case in point is Piedmont, SC. This facility has been operational for about 8 years and has performed flawlessly. There are 72 SP400 membrane modules installed total, with 18 membranes modules in each of 4 MBR zones. In August of 2017, we discovered a crack on the scour air PVC drop pipe manifold coupling on 2 of the 72 total units. This crack was allowing a portion of the scour air to escape prior to the diffusers, reducing scouring efficiency on these two particular membrane modules. The coupling assembly itself is a pretty small component, but the labor required to replace all of these would have been substantial to the relatively small operations staff at the Piedmont facility. Although only two SP400 units showed a crack on this header, we proactively chose to replace this component on **all 72 SP400 units installed.** This is the Kubota way and is reflective of our dedication and commitment to our customers.





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ReWa
renewable water resources

(O) 864.846-0007 • (C) 864.419-5490

561 Mauldin Rd. • Greenville, SC 29607
www.ReWaonline.org

To: Damone Supica

I wanted to thank you guys again (Kubota Corporation) for the continued support you have shown us out here at the Piedmont Regional WRRF since start-up in 2012. Kubota Corporation's technical staff and their impressive MBT & MBR knowledge have allowed us to be proactive in performing adjustments and keeping the membrane equipment in optimal shape. Additionally, you guys have stood behind your products in supporting the warranty, and made any needed repairs in a quick manner. I look forward to continuing our working relationship with you guys into the future.

Sincerely,

Dana Green

WRRF Operations Supervisor

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In Pigeon Forge, TN, near the Great Smoky Mountains, Kubota supplied membranes for the City's membrane thickener and digestion system. Veolia Water operates this facility and provided the following communication after some recent service provided by Kubota Membrane USA.

VEOLIA
WATER

March 30, 2020

Damone Supica
Regional Manager
Kubota Membrane USA Corporation
11807 North Creek Parkway, Suite B-109
Bothell, WA 98011

Damone,

I just wanted to drop a note of thanks for the support you have given the Pigeon Forge WWTP staff over the last 6 months. Every suggestion you have made related to improving Pad-K permeate rates and TMP has made a dramatic improvement in the performance of this process. We now seem to be on the way to meeting the original design specifications in the number one unit. I will keep you up to date as we collect additional data.

Last but not least, we want to thank Hiro and Taz for the on-site support (at no charge no less!) that they gave during each of our PM projects over the last 6 months. The knowledge and hands-on effort that these two technicians gave us is the most valuable support we have received from any equipment vendor to-date! They made what could have been a tough and time consuming project both enjoyable and a great learning experience. We will have no trouble completing the PM on the #2 unit on our own.

Make sure to give us a call the next time you are in the area. Lunch will always be on us!

Sincerely,

Pigeon Forge WWTP Staff

Martin Cross
Gary Carr
Jerald Sawyers
Larry Parton
Tim Helton
Gary L. Sweeney
Brian Eckley

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In Chino Valley AZ located slightly north of Prescott, Kubota supplied membranes for their wastewater treatment system in 2004. The plant has been operating for 19 years, but in year 2022, the plant faced some foreign substance coming into the plant and caused some issues. Mike Bovee, the Utilities Manager of Town of Chino Valley provided following communication after Kubota provided some service work.

For Earth, For Life
Kubota

Kuge, Hiroo <hiroo.kuge@kubota.com>

Chino Valley Service

1 message

Mike Bovee <mbovee@chinoaz.net> Tue, May 10, 2022 at 3:35 PM
To: "diego.ayala@kubota.com" <diego.ayala@kubota.com>
Cc: Hiro Kuge <hiroo.kuge@kubota.com>, ROSSCO BOOKER <rossco.booker@kubota.com>, "amy.clingman@kubota.com" <amy.clingman@kubota.com>, Dan Bertschman <dbertschman@goblesampson.com>

Hello Diego,

I wanted to take the time to express our gratitude for the service that we have received from Kubota this past month. Your team of professionals have been instrumental in helping us through some troubling times. As you probably know, we were hit with a foreign substance at the end of March which caused filterability issues with our plant. Rossco came out here quickly to assist us in identifying the substance and plan the best course of action. He was quite helpful. We are still having some issues, but it is much better. We were also having issues with our membranes being impacted, so Rossco and Hiro arranged for the membrane cleaning machine to be delivered to us and Rossco stayed another week helping us clean and inspect the membranes. Rossco was very informative and taught my crew a lot, especially on how to identify failures in the membranes. We were short on replacement membranes and Hiro assisted us in expediting shipment of replacement membranes, twice, so that we could complete the job in a timely manner. There was one day that Amy showed up. My crew was very impressed with her attitude, knowledge and willingness to get the job done. She harnessed up and went into the basins along with Rossco and my crew as we were pulling SMU's. Good job Amy!

Again, I wanted to give a big thank you to Hiro, Rossco and Amy for their professionalism and outstanding customer service, they are welcome here anytime.

Michael Bovee

Utilities Manager

Public Works Dept.

Town of Chino Valley

1982 Voss Drive

Chino Valley, Arizona 86323

928 636-7140 X1218

mbovee@chinoaz.net

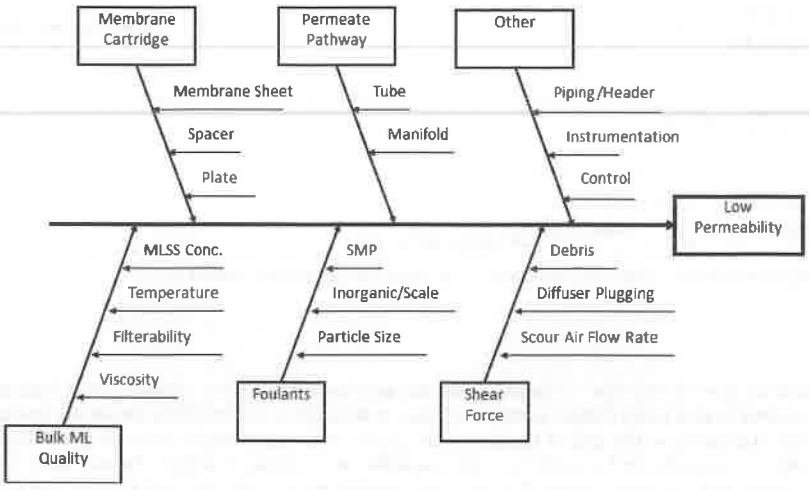
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Customized Operator Training

- Customized individual on-site operator training is available upon request (Free). Please see table below to find examples of training.

*Technique applied for finding the solution - developed at our plant in Alderwood, WA

Fish Bone Approach



Membrane Inspection

- Kubota will provide a free membrane inspection using our technical strength and general ability as a membrane manufacturer. Simply ship back membrane cartridge, we will diagnose it and provide a report for you with useful information.

  Example of diagnosis menu and equipment:
  - Clean Water Flux Test
  - Flow Rate Test
  - Chemical Recovery Test
  - Tensile Strength Test
  - SEM (Scanning Electric Microscope)
  - Digital Microscope
  - ICP-AES (Inductively Coupled Plasma - Atomic Emission Spectrometry) Analysis
  - Zetasizer

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Regarding Line Item Alternate C on Bid From- Ten Year Membrane Service Contract

Kubota acknowledges the presence of Alternate C on the bid form in reference to a ten year full service contract, which is to include six site visits per year, unlimited 24/7 phone service, annual membrane inspection with inspection report and unlimited technical assistance via remote access. Kubota's main headquarters and proximity to the location in question make it an ideal partner to excel for this performance contract, and if it is deemed necessary by the selection committee, would honor the technical support of the facility as outlined free of charge.

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Section 4: Process Control Narratives

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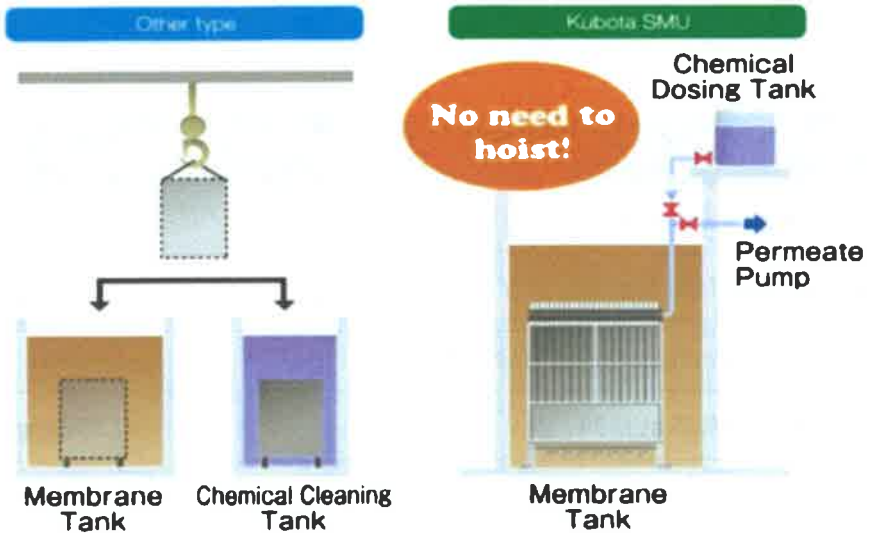


Figure 5: Chemical Cleaning for Other Manufacturers (left) vs. Kubota Membrane Units (right)

Design Overview

The MBR system was designed based on the following influent data.

Influent Design Flow Per System

The following flow conditions were used to design the capacity of the proposed MBR system.

Table 6: Design Flow Conditions

Condition	Design Flow
Average Daily Flow	24,200 gpd
Maximum Monthly Flow	37,700 gpd
Peak Daily Flow	61,900 gpd
Peak Hourly Flow	117,000

The wastewater characteristics used for design are listed in the table below.

Table 7: Influent Characteristics

Constituent	Influent Concentrations at Average Annual Flow	Influent Concentrations at Maximum Monthly Flows
BOD	25 lb/day	72 lb/day
TSS	38 lb/day	74 lb/day
TKN	7 lb/day	11 lb/day

Effluent Requirements

Kubota understands the effluent requirements to be that the system is required to provide effluent turbidities that do not exceed a monthly average of 0.2 NTU and shall never exceed 0.5 NTU.

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MBR Specifications Per System

Specifications for the proposed membrane equipment are provided in the tables below.

Table 8: Membrane Equipment Specifications.

Component	Specifications
Membrane Model	FS150
Membrane Surface Area per Unit	1291.67 sq ft
Total Number of Submerged Membrane Units	4 units
Design MLSS at MBR	10,000 mg/L
Total Number of Treatment Trains	1
Total Number of MBR Tanks	2
Job Site Elevation	80 feet above sea level
Assumed Minimum Water Temperature	10 degrees Celsius

Process Flow Diagram and Tank Sizing

Pre-screened raw influent will first be directed into the Anoxic zone (AX). Feed forward pumps will then carry the mixed liquor to the pre-aeration zone to continue the biological process. Gravity will then carry liquor into the MBR tank. In the MBR tanks, permeate will be extracted through the membranes via the permeate pumps, while sludge also flows by gravity back to the pre-anoxic zone. Wasting occurs in this this tank as needed via external Boerger pumps

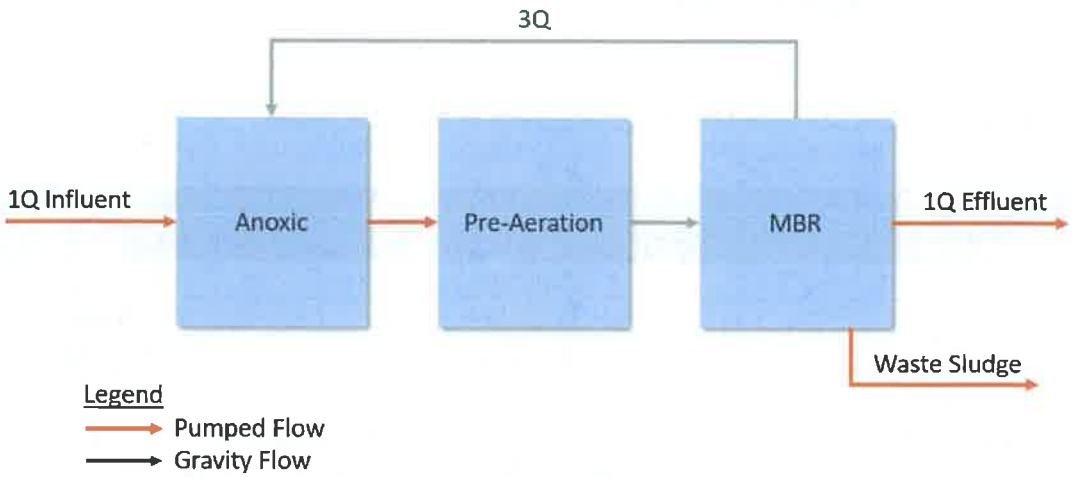


Figure 6: Process Flow Diagram

Kubota Water and Environment 2025
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Chemical Cleaning Requirements

Table 9: Estimated Chemical Clean Requirements

	Chemical Type	Unit	Sodium Hypochlorite	Citric Acid
1	Stock Conc.	%	12.5%	50.0%
2	Dose Conc.	%	0.5%	1.0%
3	Assumed Chemical Cost	$/Gal at Stock Concentration	$0.60	$2.35
3	CIP Volume per Unit	Gal	119	119
4	Stock Chemical Volume per Unit	Gal	4.76	2.38
5	Nos. of Units in Each Tank	#	2	2
6	Total Stock Chemical Volume per Tank per Cleaning	gal	38.04	4.76
7	Nos. of Cleaning Per Year Per Tank	#	4	1
8	Total Stock Chemical Volume Required in a Year	gal	38.04	4.76
9	Unit cost of Chemical	$	$45.65	$22.35
10	Total Annual Cost	$		$68.01

The above table shows the Kubota's estimated annual chemical usage for the plant for both Sodium Hypochlorite and Citric Acid cleans. As outlined later on in the CIP mode, this process is very operator friendly and effective and managing membrane thickness.

Membrane Control Strategy

KMU will supply an MBR Control Panel to operate KMU supplied systems including the RAS pumps, MBR air scour blowers, permeate control system, CIP system, CIP drain pumps, and MBR basin drain pumps. This section discusses the controls which will be provided to control membrane systems.

Membrane Control Modes

The membrane control system has four modes used to control operation: offline, production, CIP, and sleep.

Offline Mode

Offline mode will stop permeation and air scour in the selected basin. This is selected by the operator to perform maintenance for example.

Production Mode

During normal operations, the operator will select "production mode" from the control system's HMI. The MBR control system will automatically select the operating state based on the water level in the deoxygenation basin. This style of control is referred to as "level control" where the permeate rate is set based on the water level in a particular control basin, and varied in response to a change in water level due in increasing or decreasing influent rates. The system can also be designed to run as "rate control" where the influent rate (from an influent flow meter for example) is used to control the permeate rate with the goal of maintaining a constant water level in all process basins.

The permeate rate will be selected by the control system based on the operating state. The operating states during production mode are described in the table below.

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Table 10: MBR Process Operation

Operating State	Description
Relax State	Each MBR basin will automatically go into "relax state" for one (1) minute for every nine (9) minutes of permeation ("filter state"). This relaxation increases the effectiveness of the continuous air scour to stabilize the transmembrane pressure (TMP).
Nap State	When the influent flow rate is below a pre-determined "low" level, the MBR basins will go into a "nap" state to save energy. Permeate pumps turn off, and air scour blowers will turn on for only five (5) minutes every thirty (30) minutes to keep solids suspended.
Filter-Low State	When the influent flow rate is between a pre-determined "low" level and "mid" level, one MBR train will permeate at low permeate flow setpoint, while the other MBR train will go into a "nap" state.
Filter-Mid State	When the influent flow rate is between a pre-determined "mid" level and "high" level, both MBR trains will permeate at the medium permeate flow setpoint.
Filter-High State	When the influent flow rate is between a pre-determined "high" level and "high-high" level, the MBR train will permeate at peak permeate flow setpoint.

CIP Mode

CIP mode is used to prepare a basin for clean in place operations. The control system will stop air scour and permeation, and the operator will be able to access controls for the CIP system. Once the operator confirms manual valves needed for CIP are in the correct position, the system will allow for CIP injection. CIP mode will also create a log of CIP events to help track and confirm maintenance events.

Sleep Mode

Sleep mode can be manually selected by the operator to force a given basin into nap mode where intermittent aeration is performed. This is recommended over "offline" mode when maintenance of in-basin items isn't required. The intermittent aeration helps prevent any fouling and maintain a healthier sludge condition.

Operator Interface

The operator interface is designed to maximize efficiency. The main overview page will show all critical information at a glance include: indicating which basins are in operation; showing current flux, average

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flux, air scour rate, turbidity and permeate rate; showing which blowers are in operation; and displaying TMP and flow trends for the last 4 hours. An example of the main HMI overview screen is shown below.

The operator can see additional information about any piece of process equipment by clicking on tab at

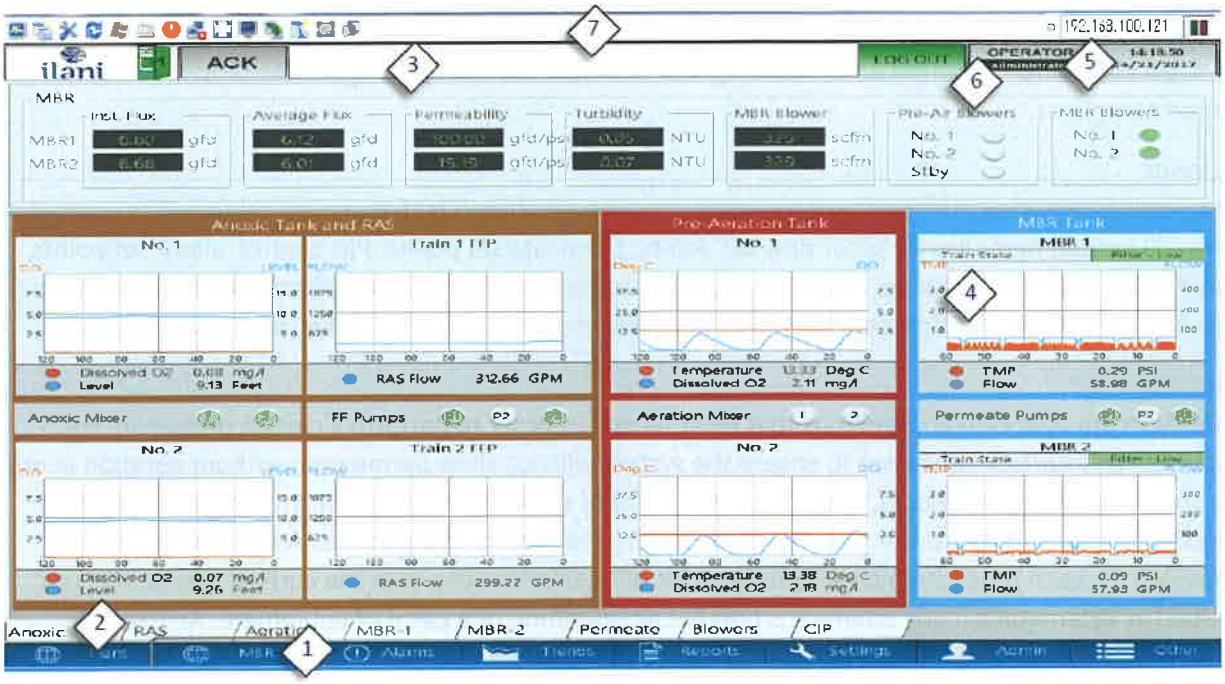


Figure 7 : HMI Overview

the bottom of the page to select the equipment zone (RAS pumps, MBR basins, blowers, CIP, etc). These tabs can be used to see a detailed information about the membrane basin and control individual pieces of equipment by selecting automatic or manual operation.

A second level of tabs allows the operator to access information on alarms, trends, reports, and settings.

Alarms

Active alarms will be displayed on the main overview page and on whatever page the HMI is currently displaying. The alarm system uses a hierarchy of priority to ensure that the most critical alarm(s) is displayed. Alarms can be acknowledged on the main screen and through the alarm screen. The alarm overview screen allows the operator to access an alarm summary showing a list of all active and acknowledged alarms; alarm history to display a filterable list of alarms to permit the operator to troubleshoot past conditions; and tools to suspend, shelve or disable alarms. This last feature allows the operator to manage alarm status and prevent nuisance alarms during testing, maintenance, and repairs.

Trends

The trends tab is used to control and access historical data which is automatically recorded and logged by the system. The list of trended variables can be modified to help the operator manage the MBR system. Common trended variables include permeate flow rate, flux, permeability, air scour flow rate, wastewater

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temperature, RAS flow, etc. Individual trends can be selected on this screen and data correlated to help identify operational challenges.

Reports

The reports tab allows the operator to access reporting tools used to track the overall system including equipment run times, historical alarms, and system events like CIP or outages. Reports can be manually configured through a custom data exporting tool and reoccurring reporting can be simplified by saving report templates.

Settings

The settings tab allows the operator to access operational set points that are critical to system operation. This will include items like air scour flow set points, permeate set points, PID control, alarm set points, interlocks, RAS flow set points, etc. These setting control how the system performs during different production modes (e.g., flow set points for low, medium, and high filter modes, etc).

Interlocks

Interlocks are operational conditions that must be met in order to perform a certain operation. For instance, an interlock will be set to ensure the system will not allow permeation without aeration in order to prevent sludging. Interlocks, unlike alarms, are "hard stops" for the system. Interlocks can not be ignored or overridden in order to prevent damage to the system components. An interlock screen is provided for each process which will display a list of interlocks along with the current status. This is helpful in determining if any interlock is preventing operation of a piece of equipment. An example interlock display is shown below.

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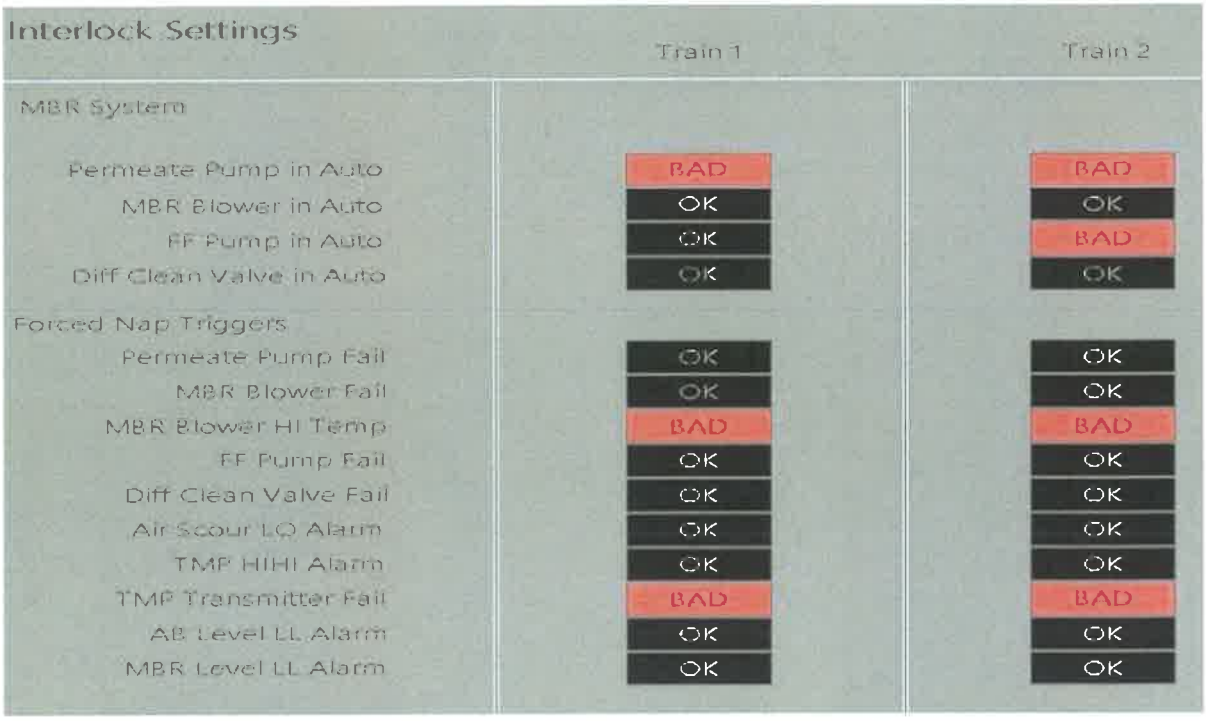


Figure 8: Example Interlock Tab HMI

Remote Operation

The system will be provided with a firewalled ethernet gateway to allow remote access. This allows a remote station to control the operator terminal. A remote user can perform any operation that can be performed while sitting at the operator terminal. The system will allow only one user to access the system, and remote operations are displayed in real time on main operator terminal. This can be used as training and education tool, allowing the operator to see all the steps involved in a given operation.

Login and Privileges

The system will come equipped with a level of privileges. Each login assigned to the system is given a privilege level that controls what that login can do. Typically, there is a single administrator login which can control the most advance variables, like PID loops which don't need to be adjusted during normal operations. A lead operator login may allow access to variables like equipment set points, which may need to be adapted over time but should require only minimal changes. A lower level daily access login may full control of all equipment, but no access to change critical set points. The lowest level login may only allow the user to view process performance and configurations, preventing unauthorized or unintentional changes to process equipment.

For more detailed information regarding the specific operation of the FS150 SMU's themselves, please reference the included O&M Manual.

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Section 5:Proposed Flux Rates

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Specified and Design Flux Rates

Per the specification provided, Kubota understands the flux targets to be the following for a microfiltration system:

Table 11: Specified Flux Table

Parameter	Flow	Membrane System A Flux at 10 degrees Celsius
Net Rate Flux at Maximum Monthly Flow	37,700 gpd	12.0 GFD
Net Rate Flux at Peak Day Flow	61,900,000 gpd	24 GFD

The following table shows Kubota's standard flux for the proposed system at the design temperature. These values are well within the specified targets above for Maximum Monthly and Peak Day Flow, and leave plenty of room to operate should conditions arise that necessitate isolation to an individual membrane or basin.

Table 12 Kubota Standard Flux at Various Design Temperatures

Parameter	Flow	Minimum Flux	Net Flux	Instantaneous Flux (Based on a 9 minute permeate/1 minute "Relax" cycle)
Flux at Maximum Monthly Flows	37,700 gpd	N/A	7.30 GFD	8.11 GFD
Flux at Peak Day Flow	61,900,000 gpd	N/A	12 GFD	13.31 GFD
Flux at Peak Equalized Flow	117,000 gpd	N/A	21.62 GFD	24.02 GFD

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Section 6:Title 22 Documentation

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Attached in our zip submission is a report detailing our compliance with Title 22 regulations as required in the state of California for the membrane proposed in this document, the FS150. If there is additional documentation that can be of use, please let us know.

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Section 7:Mechanical Information

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For information on the mechanical components of each of the significant components, namely the blowers, permeate pumps and membranes, in the included appendices within the uploaded zip file. These documents include plan and section views, CAD files for use in modeling, data sheets, and a rendered physical layout of the membrane portion of the facility in both CAD and PDF format.

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Section 8: Electrical Information

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Akin to the previously listed information in the Mechanical Data section, electrical information for the various inclusions to our scope of supply can be found in the attached zip archives for the three major pieces of equipment. Relevant information for the electrical supply of the individual major components can be found in the scope of supply sheet in Section 3. Our controls section is included in this section as well as in our scope of supply.

Controls Detail

I. PLC Control Panel Features

- NEMA 4/12, 72" x 72" x 18" floor mount enclosure (estimated size)
- Allen Bradley 1769-L36ERM PLC (Non-BABA version)
- Allen Bradley 1756-L81E PLC (BABA-Version)
- Redundant 24 VDC power supply for field devices
- Allen Bradley Stratix or Cisco Lightly managed Ethernet Switch, sized as needed
- All I/O points wired to terminal blocks
- Fuses for power distribution to all instruments
- 15% spare IO for all types
- LED Panel Lights
- Convenience power outlet
- Panel fed by three separate 120VAC circuits (Spec requirement)
- 3-point latching door handle
- DC UPS controller provided to provide power through power outage to emergency generator startup
- Fabricated and listed per UL 508a requirements
- Complete, documented control panel functionality test, including point-to-point testing of all I/O channels.
- Detailed panel drawings and loop interconnects
- Submittals as required

II. IO Count

Based upon our reading of the supplied P&IDs, we estimate the following I/O count:

I/O Type	Qty	# I/O Cards	Spare Channels	Spare Percentage
DI	23	2	9	28%
DO	11	1	5	31%
AI	15	5	5	25%
AO	6	2	2	25%

III. SCADA System Hardware and Software:

- Siemens Simatic IPC427D industrial computer
- Hope Industrial 23.9" touchscreen operator interface
- Wonderware Intouch 3000 Tag Runtime with I/O SCADA software, licensed to owner
- Rockwell Software Studio 5000 PLC Programming software (spec requirement)
- Two licensed copies of RSLinx communication driver software (Spec requirement)

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IV. PLC and HMI Programming:

- PLC Programming following Kubota control narratives using PLC programming standards
- HMI Programming following Kubota control narratives using HMI Programming standards
- PLC/HMI programming FAT at Control Engineers office in Boise, Idaho or remotely witnessed
- Incorporation of HMI Programming into owner's master SCADA system (spec requirement)

V. Engineering:

- Control panel design, drawings, and wiring schematics in AutoCAD
- Loop wiring (point-to-point) drawings in AutoCAD
- Control Narrative and HMI manual based upon process description provided by Kubota
- Submittal documents
- 100% design documentation
- As-delivered documentation
- As-built documentation

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Section 9:Seller Warranty

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Manufacturer's Equipment Warranty

Equipment Warranty

KWU will supply a warranty for all new equipment and materials provided guaranteeing against defects in materials or workmanship for a period of 30 months after delivery or 24 months after successful completion of performance testing, whichever is shorter.

Membrane Warranty

KWU is including a full (non-prorated) Submerged Membrane Unit Warranty guaranteeing against defects in materials or workmanship for a period of ten years after startup, or ten years plus six months following date of delivery, whichever occurs first.. This would supersede the two year, five year, and prorated warranty found in the bid documents. During this warranty period, Kubota will replace any membranes that fail due to material defects or workmanship at no cost to the client.

"Failure" shall constitute the following conditions:

(i) Any pinhole, tear, removal and breakage in or of the Cartridge; and
(ii) Turbidity in the permeate exceeding turbidity in the effluent exceeds 0.2 NTU (Average of four consecutive 24-hour composite samples taken once per week.) under normal operating conditions.

KWU's membrane warranty is governed by the Kubota Products Warranty Terms and Conditions, which are incorporated herein by reference as part of this proposal and are available upon request.

Limitation of the Warranties

Occurrence of any of the following as reasonably determined by KWU may reduce or void this warranty:

- Damage caused by physical abuse, fire, or misuse of the membranes
- Faulty installation of the membranes
- Unauthorized alternation of any parts originally supplied for the membrane system.
- Failure to strictly and exclusively adhere to the specified cleaning procedures.
- Failure to adhere to the operation and maintenance program provided by KWU.
- Failure to maintain and provide operating records including regular information on flow, air scour flow rate, TMP, MLSS quality and temperature, chemical cleaning frequency and duration, and filterability.
- Damage caused by improper handling of membrane modules or cassettes.
- Failure to ensure correct operation and/or functioning of the screening equipment.
- Intentional damage.

Liability of Responsibility of Kubota Water and Environment

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The liability or responsibility of Kubota Water and Environment under this Warranty shall be limited to providing replacement membrane cartridges or modules and shall not include any labor associated with dismantling and/or installation work at the Plant. The number of equipment to be repaired or replaced under this Warranty shall not exceed the number of membrane cartridges/modules or equipment originally supplied by Kubota Water and Environment.

Warranty Action

Any action based on this Warranty is triggered only if the Buyer provides written evidence both of the Failure and that the Buyer has performed all its obligations under this Warranty. Such evidence shall be submitted to KWU within thirty (30) days of the day on which the Failure is identified. KWU is entitled to access the Plant to verify the cause of the Failure at KWU's discretion. The cost and expense for traveling, accommodation and meals for KWU's inspection must be borne by the Buyer unless the Failure is determined to be caused by reasons attributable to KWU.

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Section 10: Payment Terms

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Kubota agrees to payments terms and schedule listed in the RFP, and submits the following additional items as part of its contract.

- **Title Transfer:** Title to and the right to possess the Goods shall pass from the Seller to the Buyer at the same time when the risk of loss or damage to the Goods is passed to the Buyer. However, that the title to and the right to repossess the Goods are to be retained by Seller until Seller has received the full contract amount due to Seller pursuant to this Contract.
- **Price Escalation:** If submittals are approved prior to January 1st, 2026, the Buyer will not be subject to price escalation. Price escalation following this deadline will be in accordance to the PPI Index at the date of the proposal, 2/18/2025, in this case, 146.055. It is then subject to escalation based on the increase in the Producer Price Index (PPI) for Final Demand published by the Bureau of Labor Statistics (Series ID PPIFES). Escalation will be according the following formula, assuming the scope of supply remains unchanged from this proposal, and assuming that the seller meets design submittal requirements as described in Article 2 of the RFP.
    - Price at Time of Approved Submittal = Total Bid Equipment Price ($585,000) x (PPI at time of Approved Submittal / PPI at the time of bid)
    - Escalation terms will only serve to increase the bid price. In the event the PPI at the time of PO is lower than the PPI at the time of bid, the bid price shall remain unchanged.
- **Force Majeure**: Seller shall not be liable for failure or delay to perform its obligations hereunder due to any reason including, but not limited to, acts of God, earthquake, fire, flood, prohibition of exportation, refusal to issue export license, war, blockade, revolution, insurrection, sub vendor manufacturing delays, civil commotion, riots, mobilization, strikes, lockout, plague, other epidemics, pandemics, or any other causes beyond the control of Seller, and may, at its option, extend the time of shipment or delivery of the Goods or terminate unconditionally and without liability of this Contract to the extent so affected or prevented.
- **LIABILITY FOR DELAYS AND RETURN TRIPS:** Buyer agrees that if Seller or any of its representative's must make an additional service trip due to the site conditions not being ready for installation check, start up, or training to compensate them for their cost for additional travel expenses and pay for additional labor at their published labor rates. Additionally, should Buyer (or any of its representative's) cancel an installation check, start up, or training trip with less than 72 hours' notice, that Buyer will be liable for any additional travel costs and that the cancelling party will be liable for unused labor at the following labor rates:
    - Travel Trip $2000.00 per trip
    - Labor, Car Rental, Hotel Accommodations and Food per day $1600.00 per trip
- **Tariff Escalation**
    - This pricing is based on applicable tariffs, taxes, and duties at the time of bid. Any new tariff, taxes, duties, etc. imposed after the bid date will be borne by the buyer and added to the final pricing. Should any price increases from Kubota or any of its sub-vendors come due to the impact of tariffs, taxes and duties on the market following the date of proposal, Kubota will pass this increase to the buyer along with documentation

KUBOTA Water and Environment U.S.A. Corporation 2025
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of the change in tariffs and a statement from the vendor in question that verifies that the cost increase comes as a result of the impact of tariffs upon the market.

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BID BOND (PENAL SUM FORM)

Bidder Name: KUBOTA WATER & ENVIRONMENT USA CORPORATION Address *(principal place of business)*: 19910 North Creek Parkway, Suite 100 Bothell, WA 98011	**Surety** Name: ENDURANCE ASSURANCE CORPORATION Address *(principal place of business)*: 4 Manhattanville Road, Purchase, NY 10577
Owner Name: **Taylor Bay Beach Club HOA** Address *(principal place of business)*: **8215 175th Avenue KPS** **Longbranch, Washington 98351**	**Bid** Project *(name and location)*: **Taylor Bay Beach Club HOA** **Procurement of Membrane Equipment System and Services** Bid Due Date: February 18, 2025
Bond Penal Sum: Five Percent of Amount Bid (5% of Amount Bid) Date of Bond: February 7, 2025	

Surety and Bidder, intending to be legally bound hereby, subject to the terms set forth in this Bid Bond, do each cause this Bid Bond to be duly executed by an authorized officer, agent, or representative.

Bidder	Surety
KUBOTA WATER & ENVIRONMENT USA CORPORATION *(Full formal name of Bidder)*	ENDURANCE ASSURANCE CORPORATION *(Full formal name of Surety) (corporate seal)*
By: _____ *(Signature)*	By: _____ *(Signature) (Attach Power of Attorney)*
Name: Diego Ayala *(Printed or typed)*	Name: Dartonya Wright *(Printed or typed)*
Title: President	Title: Attorney-In-Fact
Attest: _____ *(Signature)*	Attest: _____ *(Signature)*
Name: Koji Sueyoshi *(Printed or typed)*	Name: Susan A. Welsh *(Printed or typed)*
Title: Finance and Administration Manager	Title: Witness

KUBOTA MEMBRANE USA CORP CORPORATE SEAL WASHINGTON

Notes: (1) Note: Addresses are to be used for giving any required notice. (2) Provide execution by any additional parties, such as joint venturers, if necessary.

EJCDC® C-430, Bid Bond (Penal Sum Form).
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1. Bidder and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to pay to Owner upon default of Bidder the penal sum set forth on the face of this Bond. Payment of the penal sum is the extent of Bidder's and Surety's liability. Recovery of such penal sum under the terms of this Bond will be Owner's sole and exclusive remedy upon default of Bidder.
2. Default of Bidder occurs upon the failure of Bidder to deliver within the time required by the Bidding Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Bidding Documents and any performance and payment bonds required by the Bidding Documents.
3. This obligation will be null and void if:
    3.1. Owner accepts Bidder's Bid and Bidder delivers within the time required by the Bidding Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Bidding Documents and any performance and payment bonds required by the Bidding Documents, or
    3.2. All Bids are rejected by Owner, or
    3.3. Owner fails to issue a Notice of Award to Bidder within the time specified in the Bidding Documents (or any extension thereof agreed to in writing by Bidder and, if applicable, consented to by Surety when required by Paragraph 5 hereof).
4. Payment under this Bond will be due and payable upon default of Bidder and within 30 calendar days after receipt by Bidder and Surety of written notice of default from Owner, which notice will be given with reasonable promptness, identifying this Bond and the Project and including a statement of the amount due.
5. Surety waives notice of any and all defenses based on or arising out of any time extension to issue Notice of Award agreed to in writing by Owner and Bidder, provided that the total time for issuing Notice of Award including extensions does not in the aggregate exceed 120 days from the Bid due date without Surety's written consent.
6. No suit or action will be commenced under this Bond prior to 30 calendar days after the notice of default required in Paragraph 4 above is received by Bidder and Surety, and in no case later than one year after the Bid due date.
7. Any suit or action under this Bond will be commenced only in a court of competent jurisdiction located in the state in which the Project is located.
8. Notices required hereunder must be in writing and sent to Bidder and Surety at their respective addresses shown on the face of this Bond. Such notices may be sent by personal delivery, commercial courier, or by United States Postal Service registered or certified mail, return receipt requested, postage pre-paid, and will be deemed to be effective upon receipt by the party concerned.
9. Surety shall cause to be attached to this Bond a current and effective Power of Attorney evidencing the authority of the officer, agent, or representative who executed this Bond on behalf of Surety to execute, seal, and deliver such Bond and bind the Surety thereby.
10. This Bond is intended to conform to all applicable statutory requirements. Any applicable requirement of any applicable statute that has been omitted from this Bond will be deemed to be included herein as if set forth at length. If any provision of this Bond conflicts with any applicable statute, then the provision of said statute governs and the remainder of this Bond that is not in conflict therewith continues in full force and effect.
11. The term "Bid" as used herein includes a Bid, offer, or proposal as applicable.

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SOMPO INTERNATIONAL
INSURANCE

POWER OF ATTORNEY

11118

KNOW ALL BY THESE PRESENTS, that **Endurance Assurance Corporation**, a Delaware corporation ("EAC"), **Endurance American Insurance Company**, a Delaware corporation ("EAIC"), **Lexon Insurance Company**, a Texas corporation ("LIC"), and/or **Bond Safeguard Insurance Company**, a South Dakota corporation ("BSIC"), each, a "Company" and collectively, "**Sompo International**," do hereby constitute and appoint: **Susan A. Welsh, Sandra M. Winsted, Christina L. Sandoval, Judith A. Lucky-Eftimov, Aerie Walton, Derek J. Elston, Jennifer Williams, Salena Wood, Eric Sauer, Bartlomiej Siepierski, Barbara Pannier, Rachel Fore, Kristin L. Hannigan, Samantha Chierici, Corinne Chapman, Jean Torres, Roger Paraison, Nicholas Kertesz, Dartonya Wright, Tara A. Reimer, Richard Casa** as true and lawful Attorney(s)-In-Fact to make, execute, seal, and deliver for, and on its behalf as surety or co-surety; bonds and undertakings given for any and all purposes, also to execute and deliver on its behalf as aforesaid renewals, extensions, agreements, waivers, consents or stipulations relating to such bonds or undertakings provided, however, that no single bond or undertaking so made, executed and delivered shall obligate the Company for any portion of the penal sum thereof in excess of the sum of **One Hundred Million Dollars ($100,000,000.00)**

Such bonds and undertakings for said purposes, when duly executed by said attorney(s)-in-fact, shall be binding upon the Company as fully and to the same extent as if signed by the President of the Company under its corporate seal attested by its Corporate Secretary.

This appointment is made under and by authority of certain resolutions adopted by the board of directors of each Company by unanimous written consent effective the 30th day of March, 2023 for BSIC and LIC and the 17th day of May, 2023 for EAC and EAIC, a copy of which appears below under the heading entitled "Certificate".

This Power of Attorney is signed and sealed by facsimile under and by authority of the following resolution adopted by the board of directors of each Company by unanimous written consent effective the 30th day of March, 2023 for BSIC and LIC and the 17th day of May, 2023 for EAC and EAIC and said resolution has not since been revoked, amended or repealed:

RESOLVED, that the signature of an individual named above and the seal of the Company may be affixed to any such power of attorney or any certificate relating thereto by facsimile, and any such power of attorney or certificate bearing such facsimile signature or seal shall be valid and binding upon the Company in the future with respect to any bond or undertaking to which it is attached.

IN WITNESS WHEREOF, each Company has caused this instrument to be signed by the following officers, and its corporate seal to be affixed this 25th day of May, 2023.

Endurance Assurance Corporation
By: Richard M Appel
Richard Appel; SVP & Senior Counsel

Endurance American Insurance Company
By: Richard M Appel
Richard Appel; SVP & Senior Counsel

Lexon Insurance Company
By: Richard M Appel
Richard Appel; SVP & Senior Counsel

Bond Safeguard Insurance Company
By: Richard M Appel
Richard Appel; SVP & Senior Counsel

ACKNOWLEDGEMENT

On this 25th day of May, 2023, before me, personally came the above signatories known to me, who being duly sworn, did depose and say that he/they is/are officer of each of the Companies; and that he executed said instrument on behalf of each Company by authority of his office under the by-laws of each Company.

By: Amy Taylor
Amy Taylor, Notary Public - My Commission Expires 3/9/27

CERTIFICATE

I, the undersigned Officer of each Company, DO HEREBY CERTIFY that:

1. That the original power of attorney of which the foregoing is a copy was duly executed on behalf of each Company and has not since been revoked, amended or modified; that the undersigned has compared the foregoing copy thereof with the original power of attorney, and that the same is a true and correct copy of the original power of attorney and of the whole thereof;
2. The following are resolutions which were adopted by the board of directors of each Company by unanimous written consent effective 30th day of March, 2023 for BSIC and LIC and the 17th day of May, 2023 for EAC and EAIC and said resolutions have not since been revoked, amended or modified:

   "RESOLVED, that each of the individuals named below is authorized to make, execute, seal and deliver for and on behalf of the Company any and all bonds, undertakings or obligations in surety or co-surety with others: RICHARD M. APPEL, MATTHEW E. CURAN, MARGARET HYLAND, SHARON L. SIMS, CHRISTOPHER L. SPARRO,

   and be it further

   RESOLVED, that each of the individuals named above is authorized to appoint attorneys-in-fact for the purpose of making, executing, sealing and delivering bonds, undertakings or obligations in surety or co-surety for and on behalf of the Company."
3. The undersigned further certifies that the above resolutions are true and correct copies of the resolutions as so recorded and of the whole thereof.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the corporate seal this 7th day of February, 2025.

By:
Daniel S. Lurie, Secretary

NOTICE: U. S. TREASURY DEPARTMENT'S OFFICE OF FOREIGN ASSETS CONTROL (OFAC)

No coverage is provided by this Notice nor can it be construed to replace any provisions of any surety bond or other surety coverage provided. This Notice provides information concerning possible impact on your surety coverage due to directives issued by OFAC. **Please read this Notice carefully.**

The Office of Foreign Assets Control (OFAC) administers and enforces sanctions policy, based on Presidential declarations of "national emergency". OFAC has identified and listed numerous foreign agents, front organizations, terrorists, terrorist organizations, and narcotics traffickers as "Specially Designated Nationals and Blocked Persons". This list can be located on the United States Treasury's website – https://www.treasury.gov/resource-center/sanctions/SDN-List.

In accordance with OFAC regulations, if it is determined that you or any other person or entity claiming the benefits of any coverage has violated U.S. sanctions law or is a Specially Designated National and Blocked Person, as identified by OFAC, any coverage will be considered a blocked or frozen contract and all provisions of any coverage provided are immediately subject to OFAC. When a surety bond or other form of surety coverage is considered to be such a blocked or frozen contract, no payments nor premium refunds may be made without authorization from OFAC. Other limitations on the premiums and payments may also apply.

STATE OF WASHINGTON

BUSINESS LICENSE

Issue Date: Feb 12, 2025

Profit Corporation

Unified Business ID #: 602469835
Business ID #: 001
Location: 0001
Expires: Feb 28, 2026

KUBOTA WATER AND ENVIRONMENT U.S.A. CORPORATION
STE 100
19910 NORTH CREEK PKWY
BOTHELL WA 98011-8253

UNEMPLOYMENT INSURANCE - ACTIVE

INDUSTRIAL INSURANCE - ACTIVE

TAX REGISTRATION - ACTIVE

CITY/COUNTY ENDORSEMENTS:
BOTHELL GENERAL BUSINESS #10501 - ACTIVE

LICENSING RESTRICTIONS:
Not licensed to hire minors without a Minor Work Permit.

REGISTERED TRADE NAMES:
KUBOTA WATER AND ENVIRONMENT U.S.A. CORPORATION

This document lists the registrations, endorsements, and licenses authorized for the business named above. By accepting this document, the licensee certifies the information on the application was complete, true, and accurate to the best of his or her knowledge, and that business will be conducted in compliance with all applicable Washington state, county, and city regulations.

Director, Department of Revenue

STATE OF WASHINGTON

UBI: 602469835 001 0001

Expires: Feb 28, 2026

KUBOTA WATER AND ENVIRONMENT U.S.A. CORPORATION
STE 100
19910 NORTH CREEK PKWY
BOTHELL WA 98011-8253

UNEMPLOYMENT INSURANCE - ACTIVE
INDUSTRIAL INSURANCE - ACTIVE
TAX REGISTRATION - ACTIVE
BOTHELL GENERAL BUSINESS #10501 - ACTIVE

IMPORTANT!

PLEASE READ THE FOLLOWING INFORMATION CAREFULLY BEFORE POSTING THIS LICENSE

General Information

Post this Business License in a visible location at your place of business.

If you were issued a Business License previously, **destroy the old one and post this one in its place.**

Login to My DOR at dor.wa.gov if you need to make changes to your business name, location, mailing address, telephone number, or business ownership.

Telephone: 360-705-6741

Endorsements

All endorsements should be renewed by the expiration date that appears on the front of this license to avoid any late fees.

If there is no expiration date, the endorsements remain active as long as you continue required reporting. Tax Registration, Unemployment Insurance, and Industrial Insurance endorsements require you to submit periodic reports. Each agency will send you the necessary reporting forms and instructions.

For assistance or to request this document in an alternate format, visit http://business.wa.gov/BLS or call (360) 705-6741. Teletype (TTY) users may use the Washington Relay Service by calling 711.

USDA
Form RD 400-6
(Rev.12-09)

Form Approved
OMB No. 0575-0018

COMPLIANCE STATEMENT

This statement relates to a proposed contract with Kubota Water and Environment USA Corporation,

(Name of borrower or grantee)

who expects to finance the contract with assistance from either the Rural Housing Service (RHS), Rural Business-Cooperative Service (RBS), or the Rural Utilities Service (RUS) or their successor agencies, United States Department of Agriculture (whether by a loan, grant, loan insurance, guarantee, or other form of financial assistance). I am the undersigned bidder or prospective contractor, I represent that:

1. I ☒ have, ☐ have not, participated in a previous contract or subcontract subject to Executive Order 11246 (regarding equal employment opportunity) or a preceding similar Executive Order.

2. If I have participated in such a contract or subcontract, I ☒ have, ☐ have not, filed all compliance reports that have been required to file in connection with the contract or subcontract.

☒ If the proposed contract is for $50,000 or more: or ☐ If the proposed nonconstruction contract is for $50,000 or more and I have 50 or more employees, I also represent that:

3. I ☒ have, ☐ have not previously had contracts subject to the written affirmative action programs requirements of the Secretary of Labor.

4. If I have participated in such a contract or subcontract, ☒ I have, ☐ have not developed and placed on file at each establishment affirmative action programs as required by the rules and regulations of the Secretary of Labor.

I understand that if I have failed to file any compliance reports that have been required of me, I am not eligible and will not be eligible to have my bid considered or to enter into the proposed contract unless and until I make an arrangement regarding such reports that is satisfactory to either the RHS, RBS or RUS, or to the office where the reports are required to be filed.

I also certify that I do not maintain or provide for my employees any segregated facilities at any of my establishments, and that I do not permit my employees to perform their services at any location, under my control, where segregated facilities are maintained. I certify further that I will not maintain or provide for my employees any segregated facilities at any of my establishments, and that I will not permit my employees to perform their services at any location, under my control, where segregated facilities are maintained. I agree that a breach of this certification is a violation of the Equal Opportunity clause in my contract. As used in this certification, the term "segregated facilities" means any waiting rooms, work areas, restrooms and wash rooms, restaurants and other eating areas time clocks, locker rooms and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing facilities provided for employees which are segregated by explicit directive or are in fact segregated on the basis of race, creed, color, or national origin, because of habit, local custom, or otherwise. I further agree that (except where I have obtained identical certifications for proposed subcontractors for specific time periods) I will obtain identical certifications from proposed subcontractors prior to the award of subcontracts exceeding $10,000 which are not exempt from the provisions of the Equal Opportunity clause; that I will retain such certifications in my files; and that I will forward the following notice to such proposed subcontractors (except where the proposed subcontractors have submitted identical certifications for specific time periods):

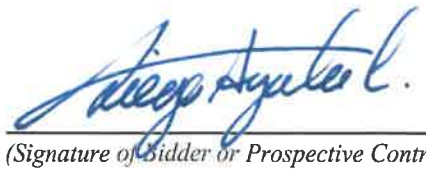
According to the Paperwork Reduction Act of 1995, an agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays the valid OMB control number. The valid OMB control number for this information collection is 0575-0018. The time required to complete this information collection is estimated to average 10 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

NOTICE TO PROSPECTIVE SUBCONTRACTORS OF REQUIREMENTS FOR CERTIFICATIONS OF NON-SEGREGATED FACILITIES

A certification of Nonsegregated Facilities, as required by the May 9, 1967, order (32F.R. 7439, may 19, 1967) on Elimination of Segregated Facilities, by the Secretary of Labor, must be submitted prior to the award of a subcontract exceeding $ 10,000 which is not exempt from the provisions of the Equal Opportunity clause. The certification may be submitted either for each subcontract or for all subcontracts during a period (i.e., quarterly, semiannually, or annually).

NOTE: The penalty for making false statements in offers is prescribed in 18 U.S.C. 1001.

DATE 02/18/2025



(Signature of Bidder or Prospective Contractor)

19910 N Creek Pkwy, Suite 100 Bothell, WA 98011

Address (including Zip Code)

AD-1048

OMB No. 0505-0027
Expiration Date: 09/30/2025

Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion Lower Tier Covered Transactions

The following statement is made in accordance with the Privacy Act of 1974 (5 U.S.C. § 552a, as amended). This certification is required by the regulations implementing Executive Order 12549, Debarment and Suspension, and 2 CFR §§ 180.300, 180.335, Participants' responsibilities. The regulations were amended and published on August 31, 2005, in 70 Fed. Reg. 51865-51880. Copies of the regulations may be obtained by contacting the Department of Agriculture agency offering the proposed covered transaction.

According to the Paperwork Reduction Act of 1995, an agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0505-0027. The time required to complete this information collection is estimated to average 15 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. The provisions of appropriate criminal or civil fraud, privacy, and other statutes may be applicable to the information provided.

(Read instructions on page two before completing certification.)

A. The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principals is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any Federal department or agency;

B. Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

ORGANIZATION NAME	PR/AWARD NUMBER OR PROJECT NAME
Kubota Water and Environment USA Corporation	Taylor Bay Beach Club HOA

NAME(S) AND TITLE(S) OF AUTHORIZED REPRESENTATIVE(S)
Diego Ayala

SIGNATURE	DATE
Diego Ayala	2/18/2025

In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the responsible Agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English.

To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at How to File a Program Discrimination Complaint and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by: (1) mail: U.S. Department of Agriculture, Office of the Assistant Secretary for Civil Rights, 1400 Independence Avenue, SW, Washington, D.C. 20250-9410; (2) fax: (202) 690-7442; or (3) email: program.intake@usda.gov.

USDA is an equal opportunity provider, employer, and lender.

Instructions for Certification

(1) By signing and submitting this form, the prospective lower tier participant is providing the certification set out on page 1 in accordance with these instructions.

(2) The certification in this clause is a material representation of fact upon which reliance was placed when this transaction was entered into. If it is later determined that the prospective lower tier participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the Department or agency with which this transaction originated may pursue available remedies, including suspension or debarment.

(3) The prospective lower tier participant must provide immediate written notice to the person(s) to which this proposal is submitted if at any time the prospective lower tier participant learns that its certification was erroneous when submitted or has become erroneous by reason of changed circumstances.

(4) The terms "covered transaction," "debarred," "suspended," "ineligible," "lower tier covered transaction," "participant," "person, ""primary covered transaction," "principal," "proposal," and "voluntarily excluded," as used in this clause, have the meanings set out in the Definitions and Coverage sections of the rules implementing Executive Order 12549, at 2 CFR Parts 180 and 417. You may contact the Department or agency to which this proposal is being submitted for assistance in obtaining a copy of those regulations.

(5) The prospective lower tier participant agrees by submitting this form that, should the proposed covered transaction be entered into, it may not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the Department or agency with which this transaction originated.

(6) The prospective lower tier participant further agrees by submitting this form that it will include this clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lower Tier Covered Transactions," without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions.

(7) A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant may decide the method and frequency by which it determines the eligibility of its principals. Each participant may, but is not required to, check the General Services Administration's System for Award Management Exclusions database.

(8) Nothing contained in the foregoing shall be construed to require establishment of a system of records to render in good faith the certification required by this clause. The knowledge and information of a participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

(9) Except for transactions authorized under paragraph (5) of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the Department or agency with which this transaction originated may pursue available remedies, including suspension and/or debarment.

CERTIFICATION FOR CONTRACTS, GRANTS AND LOANS

The undersigned certifies, to the best of his or her knowledge and belief, that:

1. No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant or Federal loan, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant or loan.

2. If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant or loan, the undersigned shall complete and submit Standard Form - LLL, "Disclosure of Lobbying Activities," in accordance with its instructions.

3. The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including contracts, subcontracts, and subgrants under grants and loans) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

Diego Ayala  2/18/2025

(name) (date)

President, Kubota Water and Environment U.S.A. Corporation

(title)

oOo

PART 3

AGREEMENT AND BONDS

AGREEMENT BETWEEN BUYER AND SELLER FOR PROCUREMENT CONTRACT

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Exhibit A— Assignment of Procurement Contract, Consent to Assignment, and Acceptance of Assignment 1

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Exhibit B— Surety's Consent to Assignment..... 1

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AGREEMENT BETWEEN BUYER AND SELLER FOR PROCUREMENT CONTRACT

This Procurement Agreement is by and between **Taylor Bay Beach Club HOA** ("Buyer") and **KUBOTA WATER & ENVIRONMENT USA CORPORATION** ("Seller").

Terms used in this Procurement Agreement have the meanings stated in the General Conditions of the Procurement Contract and the Supplementary Conditions of the Procurement Contract.

Buyer and Seller hereby agree as follows:

ARTICLE 1—PROCUREMENT CONTRACT

1.01 *Goods and Special Services*

A. Seller shall furnish the Goods and Special Services as specified or indicated in the Procurement Contract Documents. The Goods and Special Services are generally described as follows: **Procurement of Membrane Equipment System and Services**.

1.02 *The Project*

A. The Project, of which the Goods and Special Services are a part, is generally described as follows: Wastewater Treatment Facilities Upgrade Project.

1.03 *Engineer*

A. Buyer has retained **Gray & Osborne, Inc.** ("Engineer"), to prepare Procurement Contract Documents and act as Buyer's representative. Engineer assumes all duties and responsibilities and has the rights and authority assigned to Engineer in the Procurement Contract Documents in connection with Seller's furnishing of Goods and Special Services.

1.04 *Point of Destination*

A. The Point of Destination is designated as: **8220 178th Court SW, Longbranch, WA 98351**.

ARTICLE 2—PROCUREMENT CONTRACT TIMES

2.01 *Time of the Essence*

A. All time limits for Milestones, including the submittal of Shop Drawings and Samples, the delivery of Goods, and the furnishing of Special Services as stated in the Procurement Contract Documents, are of the essence of the Procurement Contract.

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2.02 *Schedule of Procurement Contract Times*

A. The following schedule sets forth the Procurement Contract Times:

Milestone	Date or Days	Notes
Submit 60% Design Submittal	30 days following NTP	Reference Section 01300
Receipt of Engineer's review comments	45 days following NTP	Reference Section 01300
Submit 100% Design Submittal	75 days following NTP	Reference Section 01300
Membrane Equipment System Delivery	June 1, 2026	

2.03 *Shop Drawings and Samples*

A. *Submittal of Shop Drawings and Samples*: Seller shall submit all Shop Drawings and Samples required by the Procurement Contract Documents to Engineer for its review and approval. A Manufacturer's Certification letter must be included in the submittal for each item subject to Build America, Buy America Act requirements. Refer to the Manufacturer's Certification Letter template provided in these Contract Documents.

B. *Engineer's Review*: It is the intent of the parties that Engineer will conduct its review of Shop Drawings and Samples and issue its approval, or a denial accompanied by substantive comments regarding information needed to gain approval, within **14** days after Seller's submittal of such Shop Drawings and Samples, or within such longer period that is needed because of the quantity and quality of such submittals. Resubmittals will be limited whenever possible. Engineer's review and approval of a Shop Drawing or Sample shall include review of Manufacturers' Certifications in order to document compliance with Build America, Buy America Act requirements, as applicable.

2.04 *Liquidated Damages*

A. Buyer and Seller recognize that time is of the essence as stated in Paragraph 2.01, and that Buyer will suffer financial and other losses if the Goods are not delivered to the Point of Destination and ready for receipt of delivery by Buyer within the time specified in Paragraph 2.02, plus any extensions thereof allowed in accordance with this Procurement Contract. The parties also recognize that the timely performance of services by others involved in the Project is materially dependent upon Seller's specific compliance with the delivery requirements of Paragraph 2.02. Further, the parties recognize the time, expense, and difficulties involved in proving, in a legal or arbitration proceeding, the loss (whether direct, consequential, or otherwise) suffered by Buyer if complete, acceptable Goods are not delivered on time. Accordingly, instead of requiring any such proof, Buyer and Seller agree that as liquidated damages for delay (but not as a penalty) Seller shall pay Buyer **$1,000** for each day that expires after the time specified in Paragraph 2.02 for design submittal delivery. In addition, Buyer and Seller agree that as liquidated damages for delay (but not as a penalty)

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Seller shall pay Buyer $3,500 for each day that expires after the time specified in Paragraph 2.02 for the date for Membrane Equipment System Delivery.

ARTICLE 3—PROCUREMENT CONTRACT PRICE

3.01 *Procurement Contract Price and Total Price—Based on Attached Bid*

A. For furnishing the Goods and Special Services in accordance with the Procurement Contract Documents, Buyer shall pay Seller the prices stated in Seller's Bid, attached hereto as an exhibit subject to the following Buyer-accepted alternates: Alternative A – Guaranteed Membrane Module replacement cost for all modules supplied with this contract.

ARTICLE 4—PAYMENT PROCEDURES

4.01 *Submittal and Processing of Applications for Payment*

A. Seller shall submit Applications for Payment in accordance with Article 13 of the General Conditions and the following paragraphs. Engineer and Buyer will process such Applications for Payment in accordance with said Article 13.

4.02 *Progress Payments; Final Payment*

A. Seller may submit an Application for Payment requesting the stated percentage of Procurement Contract Price upon attainment of each of the items listed in Specification Section 01200

1.	
2.	
3.	
4.	
5.	

B. Buyer shall pay Seller the amount owed under an Application for Payment within 30 days after Engineer's presentation to Buyer of the Application for Payment and Engineer's recommendation.

ARTICLE 5—ASSIGNMENT OF PROCUREMENT CONTRACT

5.01 *Assignment of Contract*

A. Buyer has the right to assign this Procurement Contract for furnishing Goods and Special Services, but only to a person or entity with sufficient apparent ability to satisfy all of Buyer's obligations under this Procurement Contract, and Seller hereby consents to such assignment. Forms documenting the assignment of the Procurement Contract, and consent of Seller's surety to the assignment, have been executed by Buyer, Seller, and Seller's surety, and are attached as exhibits to this Procurement Agreement. If so, assigned the following provisions apply:

1. The Procurement Contract is initially executed in the name of the entity identified herein as Buyer, and will be assigned by such Buyer (as assignor) to a construction

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contractor (Contractor/Assignee) designated by such Buyer. The assignment will occur on the effective date of the construction contract between such Buyer (Project Owner) and the Contractor/Assignee, which is expected to occur on or about **September 1, 2025**. Commencing on the date of acceptance of assignment by the Contractor/Assignee, all references in the Procurement Contract to "Buyer" shall mean the designated Contractor/Assignee.

2. The assignment of this Procurement Contract relieves the assignor from all further obligations and liabilities under this Procurement Contract. After assignment, Seller shall become a subcontractor or supplier to the Contractor/Assignee and, except as noted herein, all rights, duties, and obligations of Buyer under the Procurement Contract become the rights, duties, and obligations of the Contractor/Assignee.

3. After assignment:

    a. The Procurement Drawings and Procurement Specifications, and any modifying Addenda will become "Contract Documents" under the construction contract.

    b. If the Procurement Drawings or Procurement Specifications, as "Contract Documents" under the construction contract, are duly modified under such construction contract, then Seller and Contractor/Assignee shall enter into a corresponding Change Order under the applicable provisions of this Procurement Contract.

    c. The Procurement Drawings and Procurement Specifications may not be modified by Seller or Contractor/Assignee, singly or in tandem, except as such Procurement Drawings or Procurement Specifications, as "Contract Documents" under the construction contract, have been duly modified under such construction contract.

    d. All performance warranties, guarantees, and indemnifications required by the Procurement Contract will continue to run for the benefit of assignor (Project Owner) and, in addition, for the benefit of the Contractor/Assignee. However, if assignor (Project Owner) and Contractor/Assignee make the same warranty or guarantee claim, then Seller shall only be liable once for such claim. Other than its remedies under such warranties, guarantees, and indemnifications, assignor will not retain direct rights under this Procurement Contract, but will have rights and remedies as a party to the construction contract, whose scope of work will encompass the Procurement Drawings, Procurement Specifications, and modifying Addenda; provided, however, that any limitations on Seller's liability in this Procurement Contract will continue to bind the original Buyer (assignor) after assignment.

    e. The Contractor/Assignee shall have all the rights of the Buyer under the Performance Bond and Payment Bond.

    f. Seller shall submit all Applications for Payment directly to Contractor/Assignee.

        1) Contractor/Assignee shall review each Application for Payment promptly, determine the amount that Contractor/Assignee approves for payment, and then include the amount approved in the next application for payment submitted to Project Owner (or Engineer) under the construction contract.

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2) Contractor/Assignee shall pay Seller within **60** days of receipt of payment from the Project Owner under the construction contract.

3) After assignment Engineer will review, approve, or deny the content of Applications for Payment under the Procurement Contract only to the extent that Contractor/Assignee, as construction contractor, has incorporated such content into payment applications that Engineer reviews under the construction contract.

g. The Contractor/Assignee shall have all the rights of the Buyer under any pending Claim by Buyer.

h. All Claims and supporting documentation will be submitted directly by the claimant party (either Buyer **[Contractor/Assignee]** or Seller), to the other party, without submittal to Engineer.

1) The other party will render a response in writing within 30 days of receipt of the last submittal of claimant.

2) If the other party does not render a written response to a Claim within 30 days after receipt of the last submittal of the claimant, the other party shall be deemed to have approved the Claim in its entirety.

3) The other party's written response to a Claim, or the approval of the Claim in its entirety as a function of failure to respond within 30 days, will be final and binding upon Buyer and Seller 30 days after it is issued, unless within such 30 days of issuance either Buyer or Seller appeals the result by initiating the mediation of the Claim in accordance with the dispute resolution procedures set forth in Paragraph 12.02 of the General Conditions.

4) Any Claim by Seller that Contractor/Assignee may choose to submit, present, or forward to Project Owner must be submitted to Buyer within sufficient time for Contractor/Assignee to preserve its rights under the construction contract, notwithstanding any procedures or time limits in this Procurement Contract.

i. Seller's recovery of additional cost, time, or both cost and time for any Claim attributable to the Project Owner will be limited to the proportionate recovery by Contractor/Assignee against Project Owner for such Claim. Seller will cooperate and assist Contractor/Assignee in pursuing any Claim by Contractor/Assignee against Project Owner on behalf of Seller, including the timely preparation and delivery of supporting documentation.

j. If the pursuit of any claim by Contractor/Assignee against Project Owner on Seller's behalf requires the expenditure by Contractor/Assignee of legal or consulting fees, or results in litigation, arbitration, or any dispute resolution procedures, Seller agrees to pay for a proportionate share of attorneys' fees, consultant fees, and litigation, arbitration, and other resolution costs incurred by Contractor/Assignee in pursuing the claim on behalf of Seller, based upon the amount claimed by Seller as compared to the total value of the claim pursued by the Contractor/Assignee.

k. All rights, duties, and obligations of Engineer to Contractor/Assignee and Seller under this Procurement Contract will cease.

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l. Subject to the foregoing provisions, all references in the Procurement Contract to submitting items to Engineer, or to Engineer having tasks or obligations, will be read after such an assignment as requiring submittal to Contractor/Assignee, or as Contractor/Assignee having such tasks or obligations (which Contractor/Assignee may delegate when appropriate).

m. If the Procurement Contract includes a Buyer's Contingency Allowance, upon assignment such allowance will be automatically reduced to the amount previously authorized by Buyer (Project Owner), and cease to be operational.

B. No other assignment by a party hereto of any rights under or interests in the Procurement Contract will be binding on another party hereto without the written consent of the party sought to be bound. Specifically, but without limitation, Procurement Contract payments or other money that may become due, and Procurement Contract payments or other money that are due, may not be assigned without such consent (except to the extent that the effect of this restriction may be limited by Laws and Regulations). Unless specifically stated to the contrary in any written consent to such an assignment, such an assignment will not release or discharge the assignor from any duty or responsibility under the Procurement Contract Documents.

ARTICLE 6—PROCUREMENT CONTRACT DOCUMENTS

6.01 *List of Procurement Contract Documents*

A. The Procurement Contract Documents consist of the following:

1. This Procurement Agreement.
2. The Supplier's Bid Proposal.
3. The Advertisement for Bids.
4. General Conditions of the Procurement Contract.
5. Supplementary Conditions of the Procurement Contract.
6. Procurement Technical Specifications as listed in the Procurement Specifications table of contents.
7. Addenda Numbers – **No Addenda Issued**.
8. Bonds:
    a. Performance bond (together with power of attorney).
    b. Payment bond (together with power of attorney).
9. Exhibits to this Procurement Agreement (enumerated as follows):
    a. Exhibit A, Assignment of Contract, Consent to Assignment, and Acceptance of Assignment.
    b. Exhibit B, Surety's Consent to Assignment.
10. The following which may be delivered or issued on or after the Effective Date of the Procurement Contract and are not attached hereto:
    a. Change Orders;

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b. Change Directives; and

c. Field Orders.

B. The documents listed in Paragraph 6.01.A are attached to this Procurement Agreement (except as expressly noted otherwise above).

C. There are no Procurement Contract Documents other than those listed above.

D. The Procurement Contract Documents may only be amended or supplemented as provided in Paragraph 11.01 of the Procurement General Conditions.

ARTICLE 7—SELLER'S REPRESENTATIONS AND CERTIFICATIONS

7.01 *Seller's Representations*

A. In order to induce Buyer to enter into this Procurement Agreement, Seller makes the following representations:

1. Seller has examined and carefully studied the Procurement Contract Documents.

2. If required by the Instructions to Bidders to visit the Point of Destination and the site where the Goods are to be installed or Special Services will be provided, or if, in Seller's judgment, any observable local or site conditions may affect the delivery, cost, progress, or furnishing of the Goods and Special Services, then Seller has visited the Point of Destination and site where the Goods are to be installed or Special Services will be provided (as applicable) and become familiar with and is satisfied as to the observable local and site conditions that may affect delivery, cost, progress, and furnishing of the Goods and Special Services.

3. Seller is familiar with and is satisfied as to all Laws and Regulations that may affect the cost, progress, and performance of Seller's obligations under the Procurement Contract.

4. Seller has carefully studied, considered, and correlated the information known to Seller with respect to the effect of such information on the cost, progress, and performance of Seller's obligations under the Procurement Contract.

5. Seller has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Seller has discovered in the Procurement Contract Documents, and the written resolution (if any) thereof by Engineer is acceptable to Seller.

6. The Procurement Contract Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performance of Seller's obligations under the Procurement Contract.

7. Seller's entry into this Procurement Contract constitutes an incontrovertible representation by Seller that without exception all prices in the Procurement Agreement are premised upon furnishing the Goods and Special Services as required by the Procurement Contract Documents.

7.02 *Seller's Certifications*

A. Seller certifies that it has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for or in executing the Procurement Contract. For the purposes of this Paragraph 7.02:

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1. "corrupt practice" means the offering, giving, receiving, or soliciting of anything of value likely to influence the action of a public official in the bidding process or in the Procurement Contract execution;

2. "fraudulent practice" means an intentional misrepresentation of facts made (a) to influence the bidding process or the execution of the Procurement Contract to the detriment of Buyer, (b) to establish bid or contract prices at artificial non-competitive levels, or (c) to deprive Buyer of the benefits of free and open competition;

3. "collusive practice" means a scheme or arrangement between two or more Bidders, with or without the knowledge of Buyer, a purpose of which is to establish bid prices at artificial, non-competitive levels; and

4. "coercive practice" means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process or affect the execution of the Procurement Contract.

ARTICLE 8—NOT USED

ARTICLE 9—THE MUTUAL WAIVER

9.01 *Mutual Waiver of Consequential Damages*

A. Buyer and Seller waive against each other, and against the other's officers, directors, members, partners, employees, agents, consultants, and subcontractors, any and all claims for or entitlement to incidental, indirect, or consequential damages arising out of, resulting from, or related to the Procurement Contract. If Buyer (Project Owner) assigns this Procurement Contract to a construction contractor (Contractor/Assignee), then the terms of this Paragraph 9.01.A will be binding upon the Contractor/Assignee with respect to Seller and assignor. The terms of this mutual waiver do not apply to or limit any claim by either Buyer or Seller against the other based on any of the following: (a) contribution or indemnification, (b) liquidated damages, (c) costs, losses, or damages attributable to personal or bodily injury, sickness, disease, or death, or to injury to or destruction of the tangible property of others, (d) intentional or reckless wrongful conduct, or (e) rights conferred by any bond provided by Seller under this Procurement Contract.

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IN WITNESS WHEREOF, Buyer and Seller have signed this Procurement Agreement. Counterparts have been delivered to Buyer and Seller.

The Effective Date of the Procurement Contract is 6-5-2025.

Buyer	Seller
Taylor Bay Beach Club	KUBOTA WATER AND ENVIRONMENT USA CORPORATION
(typed or printed name of organization)	*(typed or printed name of organization)*
By: [signature]	By: [signature]
(individual's signature)	*(individual's signature)*
Date: 6-5-2025	Date: 05/16/2025
(date signed)	*(date signed)*
Name: Mitzi McCart	Name: Diego Ayala
(typed or printed)	*(typed or printed)*
Title: President, HOA	Title: President
(typed or printed)	*(typed or printed)*
	(If Seller is a corporation, a partnership, or a joint venture, attach evidence of authority to sign.)
Attest: [signature]	Attest: J. 西 玉栄美
(individual's signature)	*(individual's signature)*
Title: Acting for HOA	Title: Notary / Office Manager
(typed or printed)	*(typed or printed)*
Address for giving notices:	Address for giving notices:
8215 175th Ave SW	19910 North Creek Parkway
Longbranch WA 98351	Suite 100
	Bothell, WA 98011
Designated Representative:	Designated Representative:
Name: Mitzi McCart	Name: Tamami Konishi
(typed or printed)	*(typed or printed)*
Title: President, HOA	Title:
(typed or printed)	*(typed or printed)*
Address:	Address:
8215 176th Ave SW	19910 North Creek Parkway
Longbranch WA 98351	Suite 100
	Bothell, WA 98011
Phone: 253-970-1116	Phone: 425-287-8113
Email: mitzimccart@gmail.com	Email: tamami.konishi@kubota.com
(If Buyer is a corporation, attach evidence of authority to sign. If Buyer is a public body, attach evidence of authority to sign and resolution or other documents authorizing execution of this Agreement.)	

EJCDC® P-520, Agreement between Buyer and Seller for Procurement Contract.
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EXHIBIT A—ASSIGNMENT OF PROCUREMENT CONTRACT, CONSENT TO ASSIGNMENT, AND ACCEPTANCE OF ASSIGNMENT

This assignment will be effective on the effective date of the construction contract between Buyer (as "Owner") and Contractor/Assignee (as "Contractor").

The Procurement Contract between **Taylor Bay Beach Club HOA** ("Buyer") and **Kubota Water & Environmental USA Corporation** ("Seller") for furnishing Goods and Special Services entitled **Procurement of Membrane Equipment System and Services** (Procurement Contract) is hereby assigned, transferred, and set over to Contractor/Assignee, as assignee, by Buyer, as assignor. Upon assignment the Contractor/Assignee shall have the duties, rights, and obligations of Buyer under the terms of the Procurement Contract, and will be responsible to Owner under the construction contract for the performance of obligations by Seller, which will become a Subcontractor or Supplier to Contractor/Assignee. Buyer, Seller, and Contractor/Assignee hereby acknowledge and agree to be bound by the terms and conditions of assignment set forth in Article 5 of the Agreement Between Buyer and Seller for Procurement Contract.

Assignment Made by Buyer

_____
(typed or printed name of organization)

By: _____ Date: _____
(individual's signature) *(date signed)*

Name: _____ Title: _____
(typed or printed) *(typed or printed)*

If Buyer is a corporation, attach evidence of authority to sign. If Buyer is a public body, attach evidence of authority to sign and resolution or other documents authorizing execution of Buyer-Seller Agreement.

Assignment Acknowledged and Accepted by Seller

_____
(typed or printed name of organization)

By: Diego Ayala Date: 05/16/2025
(individual's signature) *(date signed)*

Name: Diego Ayala Title: President
(typed or printed) *(typed or printed)*

If Seller is a corporation, attach evidence of authority to sign.

Assignment Accepted by Contractor/Assignee

_____
(typed or printed name of organization)

By: _____ Date: _____
(individual's signature) *(date signed)*

Name: _____ Title: _____
(typed or printed) *(typed or printed)*

If Contractor/Assignee is a corporation, attach evidence of authority to sign.

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EXHIBIT B—SURETY'S CONSENT TO ASSIGNMENT

Surety hereby acknowledges, agrees, and consents that the Procurement Contract for furnishing Goods and Special Services entitled **Procurement of Membrane Equipment System and Services** by and between **Taylor Bay Beach Club HOA** ("Buyer") and **KUBOTA WATER & ENVIRONMENT USA CORPORATION** ("Seller") may be assigned, transferred, and set over to **designated Contractor/Assignee** ("Contractor/Assignee"), in accordance with Article 5 and Exhibit A of the Agreement between Buyer and Seller for Procurement Contract.

Surety further agrees that, upon assignment of the Procurement Contract, the Contractor/Assignee shall have all the rights of the Buyer under the Procurement Performance Bond and Procurement Payment Bond.

Agreement to Assignment Acknowledged and Accepted by Surety

ENDURANCE ASSURANCE CORPORATION
(typed or printed name of organization)

By: _____ Date: February 7, 2025
(individual's signature) *(date signed)*

Name: Dartonya Wright Title: Attorney-In-Fact
(typed or printed) *(typed or printed)*

Attach Power of Attorney.

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SOMPO INTERNATIONAL
INSURANCE

POWER OF ATTORNEY

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KNOW ALL BY THESE PRESENTS, that **Endurance Assurance Corporation, a Delaware corporation ('EAC'), Endurance American Insurance Company, a Delaware corporation ('EAIC'), Lexon Insurance Company, a Texas corporation ('LIC'), and/or Bond Safeguard Insurance Company, a South Dakota corporation ('BSIC'), each,** a "Company" and collectively, **"Sompo International,"** do hereby constitute and appoint: **Susan A. Welsh, Sandra M. Winsted, Christina L. Sandoval, Judith A. Lucky-Eftimov, Aerie Walton, Derek J. Elston, Jennifer Williams, Salena Wood, Eric D. Sauer, Bartlomiej Siepierski, Barbara Pannier, Rachel Fore, Kristin L. Hannigan, Samantha Chierici, Corinne Chapman, Jean Torres, Roger Paraison, Nicholas Kertesz, Dartonya Wright, Tara A. Maquinto, Richard Casa, Aaron D. Griffin, Therese M. Jackson**
as true and lawful Attorney(s)-In-Fact to make, execute, seal, and deliver for, and on its behalf as surety or co-surety; bonds and undertakings given for any and all purposes, also to execute and deliver on its behalf as aforesaid renewals, extensions, agreements, waivers, consents or stipulations relating to such bonds or undertakings provided, however, that no single bond or undertaking so made, executed and delivered shall obligate the Company for any portion of the penal sum thereof in excess of the sum of **One Hundred Million ($100,000,000.00)**

Such bonds and undertakings for said purposes, when duly executed by said attorney(s)-in-fact, shall be binding upon the Company as fully and to the same extent as if signed by the President of the Company under its corporate seal attested by its Corporate Secretary.

This appointment is made under and by authority of certain resolutions adopted by the board of directors of each Company by unanimous written consent effective the 30th day of March, 2023 for BSIC and LIC and the 17th day of May, 2023 for EAC and EAIC, a copy of which appears below under the heading entitled "Certificate".

This Power of Attorney is signed and sealed by facsimile under and by authority of the following resolution adopted by the board of directors of each Company by unanimous written consent effective the 30th day of March, 2023 for BSIC and LIC and the 17th day of May, 2023 for EAC and EAIC and said resolution has not since been revoked, amended or repealed:

RESOLVED, that the signature of an individual named above and the seal of the Company may be affixed to any such power of attorney or any certificate relating thereto by facsimile, and any such power of attorney or certificate bearing such facsimile signature or seal shall be valid and binding upon the Company in the future with respect to any bond or undertaking to which it is attached.

IN WITNESS WHEREOF, each Company has caused this instrument to be signed by the following officers, and its corporate seal to be affixed this 25th day of May, 2023.

Endurance Assurance Corporation	Endurance American Insurance Company	Lexon Insurance Company	Bond Safeguard Insurance Company
By: Richard Appel; SVP & Senior Counsel	By: Richard Appel; SVP & Senior Counsel	By: Richard Appel; SVP & Senior Counsel	By: Richard Appel; SVP & Senior Counsel

Endurance Assurance Corporation CORPORATE SEAL 2002 DELAWARE

Endurance American Insurance Company CORPORATE SEAL 1996 DELAWARE

LEXON INSURANCE COMPANY CORPORATE SEAL MARCH 16, 1994 STATE OF TEXAS

BOND SAFEGUARD INSURANCE COMPANY A SOUTH DAKOTA INSURANCE COMPANY

ACKNOWLEDGEMENT

On this 25th day of May, 2023, before me, personally came the above signatories known to me, who being duly sworn, did depose and say that he/they is an officer of each of the Companies; and that he executed said instrument on behalf of each Company by authority of his office under the by-laws of each Company.

By: Amy Taylor
Amy Taylor Notary Public – My Commission Expires 3/9/27

AMY TAYLOR NOTARY PUBLIC STATE OF TENNESSEE DAVIDSON COUNTY

CERTIFICATE

I, the undersigned Officer of each Company, DO HEREBY CERTIFY that:

1. That the original power of attorney of which the foregoing is a copy was duly executed on behalf of each Company and has not since been revoked, amended or modified; that the undersigned has compared the foregoing copy thereof with the original power of attorney, and that the same is a true and correct copy of the original power of attorney and of the whole thereof;
2. The following are resolutions which were adopted by the board of directors of each Company by unanimous written consent effective the 30th day of March, 2023 for BSIC and LIC and the 17th day of May, 2023 for EAC and EAIC and said resolutions have not since been revoked, amended or modified:
   "RESOLVED, that each of the individuals named below is authorized to make, execute, seal and deliver for and on behalf of the Company any and all bonds, undertakings or obligations in surety or co-surety with others: RICHARD M. APPEL, MATTHEW E. CURRAN, MARGARET HYLAND, SHARON L. SIMS, CHRISTOPHER L. SPARRO,
   and be it further
   RESOLVED, that each of the individuals named above is authorized to appoint attorneys-in-fact for the purpose of making, executing, sealing and delivering bonds,
   undertakings or obligations in surety or co-surety for and on behalf of the Company."
3. The undersigned further certifies that the above resolutions are true and correct copies of the resolutions as so recorded and of the whole thereof.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the corporate seal this 7th day of February, 20 25

By: Daniel S. Lude, Secretary

NOTICE: U. S. TREASURY DEPARTMENT'S OFFICE OF FOREIGN ASSETS CONTROL (OFAC)

No coverage is provided by this Notice nor can it be construed to replace any provisions of any surety bond or other surety coverage provided. This Notice provides information concerning possible impact on your surety coverage due to directives issued by OFAC. **Please read this Notice carefully.**
The Office of Foreign Assets Control (OFAC) administers and enforces sanctions policy, based on Presidential declarations of "national emergency". OFAC has identified and listed numerous foreign agents, front organizations, terrorists, terrorist organizations, and narcotics traffickers as "Specially Designated Nationals and Blocked Persons". This list can be located on the United States Treasury's website – https://www.treasury.gov/resource-center/sanctions/SDN-List.
In accordance with OFAC regulations, if it is determined that you or any other person or entity claiming the benefits of any coverage has violated U.S. sanctions law or is a Specially Designated National and Blocked Person, as identified by OFAC, any coverage will be considered a blocked or frozen contract and all provisions of any coverage provided are immediately subject to OFAC. When a surety bond or other form of surety coverage is considered to be such a blocked or frozen contract, no payments nor premium refunds may be made without authorization from OFAC. Other limitations on the premiums and payments may also apply.

Any reproductions are void.

Surety Claims Submission: LexonClaimAdministration@sompo-intl.com
Telephone: 615-553-9500 Mailing Address: Sompo International; 12890 Lebanon Road; Mount Juliet, TN 37122-2870

ATTACHMENT A.1 – CERTIFICATE OF OWNER'S ATTORNEY AND AGENCY CONCURRENCE

Notes to User:

1. This attachment consists of two certificates, on a single page, to be attached to the Contract and signed upon execution.

2. The first is a certificate to be signed by the Owner's attorney and the second is the concurrence to be signed by the State Engineer.

3. This page is to be inserted after the Agreement between Owner and Contractor for Construction Contract (Stipulated Price) (EJCDC C-520, 2018) in the Construction Contract Documents.

4. When the EJCDC C-522 Contract for Construction of a Small Project is used, attach this page to the C-522 document.

CERTFICATE OF OWNER'S ATTORNEY

PROJECT NAME:

CONTRACTOR NAME AND CONTRACT NUMBER:

I, the undersigned, Michael Johns, the duly authorized and acting legal representative of Taylor Bay Beach Club, do hereby certify as follows: I have examined the attached Contract(s) and performance and payment bond(s) and the manner of execution thereof, and I am of the opinion that each of the aforesaid agreements is adequate and has been duly executed by the proper parties thereto acting through their duly authorized representatives; that said representatives have full power and authority to execute said agreements on behalf of the respective parties named thereon; and that the foregoing agreements constitute valid and legally binding obligations upon the parties executing the same in accordance with the terms, conditions, and provisions thereof.

Name

6/6/2025
Date

AGENCY CONCURRENCE

As lender or insurer of funds to defray the costs of this Contract, and without liability for any payments thereunder, the Agency hereby concurs in the form, content, and execution of this Agreement.

Agency Representative

Date

AMBREA CORMIER

Digitally signed by AMBREA CORMIER
Date: 2025.06.10 07:46:38 -07'00'

Name

PERFORMANCE BOND FOR PROCUREMENT CONTRACT

Seller	**Surety**
Name: **KUBOTA WATER & ENVIRONMENT USA CORPORATION** Address *(principal place of business)*: **19910 North Creek Parkway, Suite 100** **Bothell, Washington 98011**	Name: ENDURANCE ASSURANCE CORPORATION Address *(principal place of business)*: 4 Manhattanville Road, Purchase NY 10577
Buyer	**Procurement Contract**
Name: **Taylor Bay Beach Club HOA** Mailing address *(principal place of business)*: **8215 175th Avenue KPS** **Longbranch, Washington 98351**	Description *(name and location)*: **Taylor Bay Beach Club HOA** **Procurement of Membrane Equipment System and Services** Procurement Contract Price: **$951,280.00** Effective Date of Procurement Contract: February 4th, 2025

Bond Number: EACX4012257

Bond Amount: $ Nine Hundred Fifty One Thousand Two Hundred Eighty and 00/100 Dollars ($ 951,280.00)

Date of Bond: May 13th, 2025

(Date of Bond cannot be earlier than Effective Date of Procurement Contract)

Modifications to this Bond form:

☒ None ☐ See Paragraph 15

Surety and Seller, intending to be legally bound hereby, subject to the terms set forth in this Performance Bond, do each cause this Performance Bond to be duly executed by an authorized officer, agent, or representative.

Seller as Principal	Surety
KUBOTA WATER & ENVIRONMENT USA CORPORATION *(Full formal name of Seller)*	ENDURANCE ASSURANCE CORPORATION *(Full formal name of Surety) (corporate seal)*
By: _____ *(Signature)*	By: _____ *(Signature)(Attach Power of Attorney)*
Name: Diego Ayala *(Printed or typed)*	Name: Dartonya Wright *(Printed or typed)*
Title: President	Title: Attorney-in-Fact
Attest: _____ *(Signature)*	Attest: _____ *(Signature)*
Name: Tamami Konishi *(Printed or typed)*	Name: Susan A. Welsh *(Printed or typed)*
Title: Witness	Title: Witness

Notes: (1) Provide supplemental execution by any additional parties, such as joint venturers. (2) Any singular reference to Seller, Surety, Buyer, or other party is considered plural where applicable.

EJCDC® P-610, Performance Bond for Procurement Contract.
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1. The Seller and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to the Buyer for the performance of the Procurement Contract, which is incorporated herein by reference.

2. If the Seller performs the Procurement Contract, the Surety and the Seller shall have no obligation under this Bond, except when applicable to participate in a conference as provided in Paragraph 3.

3. If there is no Buyer Default under the Procurement Contract, the Surety's obligation under this Bond will arise after:

    3.1. The Buyer first provides notice to the Seller and the Surety that the Buyer is considering declaring a Seller Default. Such notice may indicate whether the Buyer is requesting a conference among the Buyer, Seller, and Surety to discuss the Seller's performance. If the Buyer does not request a conference, the Surety may, within five (5) business days after receipt of the Buyer's notice, request such a conference. If the Surety timely requests a conference, the Buyer shall attend. Unless the Buyer agrees otherwise, any conference requested under this Paragraph 3.1 will be held within ten (10) business days of the Surety's receipt of the Buyer's notice. If the Buyer, the Seller, and the Surety agree, the Seller shall be allowed a reasonable time to perform the Procurement Contract, but such an agreement does not waive the Buyer's right, if any, subsequently to declare a Seller Default;

    3.2. The Buyer declares a Seller Default, terminates the Procurement Contract, and notifies the Surety; and

    3.3. The Buyer has agreed to pay the Balance of the Procurement Contract Price in accordance with the terms of the Procurement Contract to the Surety or to a seller selected to perform the Procurement Contract.

4. Failure on the part of the Buyer to comply with the notice requirement in Paragraph 3.1 does not constitute a failure to comply with a condition precedent to the Surety's obligations, or release the Surety from its obligations, except to the extent the Surety demonstrates actual prejudice.

5. When the Buyer has satisfied the conditions of Paragraph 3, the Surety shall promptly and at the Surety's expense take one of the following actions:

    5.1. Arrange for the Seller, with the consent of the Buyer, to perform and complete the Procurement Contract;

    5.2. Undertake to perform and complete the Procurement Contract itself, through its agents or independent contractors;

    5.3. Obtain bids or negotiated proposals from qualified sellers acceptable to the Buyer for a contract for performance and completion of the Procurement Contract, arrange for a contract to be prepared for execution by the Buyer and a seller selected with the Buyer's concurrence, to be secured with performance and payment bonds executed by a qualified surety equivalent to the bonds issued on the Procurement Contract, and pay to the Buyer the amount of damages as described in Paragraph 7 in excess of the Balance of the Procurement Contract Price incurred by the Buyer as a result of the Seller Default; or

    5.4. Waive its right to perform and complete, arrange for completion, or obtain a new seller, and with reasonable promptness under the circumstances:

        5.4.1. After investigation, determine the amount for which Surety may be liable to the Buyer and, as soon as practicable after the amount is determined, make payment to the Buyer; or

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5.4.2. Deny liability in whole or in part and notify the Buyer, citing the reasons for denial.

6. If the Surety does not proceed as provided in Paragraph 5 with reasonable promptness, the Surety shall be deemed to be in default on this Bond seven (7) days after receipt of an additional written notice from the Buyer to the Surety demanding that the Surety perform its obligations under this Bond, and the Buyer shall be entitled to enforce any remedy available to the Buyer. If the Surety proceeds as provided in Paragraph 5.4, and the Buyer refuses the payment, or the Surety has denied liability, in whole or in part, without further notice, the Buyer shall be entitled to enforce any remedy available to the Buyer.

7. If the Surety elects to act under Paragraph 5.1, 5.2, or 5.3, then the responsibilities of the Surety to the Buyer will not be greater than those of the Seller under the Procurement Contract, and the responsibilities of the Buyer to the Surety will not be greater than those of the Buyer under the Procurement Contract. Subject to the commitment by the Buyer to pay the Balance of the Procurement Contract Price, the Surety is obligated, without duplication for:

   7.1. the responsibilities of the Seller for correction of defective or non-conforming Goods and Special Services, and completion of the Procurement Contract;

   7.2. additional legal, design professional, and delay costs resulting from the Seller's Default, and resulting from the actions or failure to act of the Surety under Paragraph 5; and

   7.3. liquidated damages, or if no liquidated damages are specified in the Procurement Contract, actual damages caused by delayed performance or non-performance of the Seller.

8. If the Surety elects to act under Paragraph 5.1, 5.3, or 5.4, the Surety's liability is limited to the amount of this Bond.

9. The Surety shall not be liable to the Buyer or others for obligations of the Seller that are unrelated to the Procurement Contract, and the Balance of the Procurement Contract Price will not be reduced or set off on account of any such unrelated obligations. No right of action will accrue on this Bond to any person or entity other than the Buyer or its heirs, executors, administrators, successors, and assigns.

10. The Surety hereby waives notice of any change, including changes of time, to the Procurement Contract or to related subcontracts, purchase orders, and other obligations.

11. Any proceeding, legal or equitable, under this Bond must be instituted in any court of competent jurisdiction where the Point of Destination is located and must be instituted within two years after a declaration of Seller Default, or within two years after the Seller ceased working, or within two years after the Surety refuses or fails to perform its obligations under this Bond, whichever occurs first. If the provisions of this Paragraph are void or prohibited by law, the minimum periods of limitations available to sureties as a defense in the jurisdiction of the suit will be applicable.

12. Notice to the Surety, the Buyer, or the Seller must be mailed or delivered to the address shown on the page on which their signature appears.

13. When this Bond has been furnished to comply with a statutory or other legal requirement in the location of the Point of Destination, any provision in this Bond conflicting with said statutory or legal requirement will be deemed deleted herefrom and provisions conforming to such statutory or other legal requirement will be deemed incorporated herein. When so furnished, the intent is that this Bond will be construed as a statutory bond and not as a common law bond.

14. Definitions

   14.1. *Balance of the Procurement Contract Price*—The total amount payable by the Buyer to the Seller under the Procurement Contract after all proper adjustments have been made including

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allowance for the Seller for any amounts received or to be received by the Buyer in settlement of insurance or other claims for damages to which the Seller is entitled, reduced by all valid and proper payments made to or on behalf of the Seller under the Procurement Contract.

14.2. *Buyer Default*—Failure of the Buyer, which has not been remedied or waived, to pay the Seller as required under the Procurement Contract or to perform and complete or comply with the other material terms of the Procurement Contract.

14.3. *Goods and Special Services*—The full scope of materials, equipment, other items, and services to be furnished by Seller, as defined in the Procurement Contract.

14.4. *Point of Destination*—The location where delivery of the Goods shall be made, as stated in the Procurement Contract.

14.5. *Procurement Contract*—The contractual agreement between the Buyer and Seller identified on the cover page, including all Procurement Contract Documents and changes made to the Procurement Contract.

14.6. *Seller Default*—Failure of the Seller, which has not been remedied or waived, to perform or otherwise to comply with a material term of the Procurement Contract.

14.7. *Procurement Contract Documents*—All the documents that comprise the contractual agreement between the Buyer and Seller.

15. Modifications to this Bond are as follows: **[Describe modification or enter "None"]**

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KNOW ALL BY THESE PRESENTS, that **Endurance Assurance Corporation**, a Delaware corporation ("EAC"), **Endurance American Insurance Company**, a Delaware corporation ("EAIC"), **Lexon Insurance Company**, a Texas corporation ("LIC"), and/or **Bond Safeguard Insurance Company**, a South Dakota corporation ("BSIC"), each, a "Company" and collectively, "**Sompo International**," do hereby constitute and appoint: **Susan A. Welsh, Sandra M. Winsted, Christina L. Sandoval, Judith A. Lucky-Eftimov, Aerie Walton, Derek J. Elston, Jennifer Williams, Salena Wood, Eric Sauer, Bartlomiej Siepierski, Barbara Pannier, Rachel Fore, Kristin L. Hannigan, Samantha Chierici, Corinne Chapman, Jean Torres, Roger Paraison, Nicholas Kertesz, Dartonya Wright, Tara A. Reimer, Richard Casa** as true and lawful Attorney(s)-In-Fact to make, execute, seal, and deliver for, and on its behalf as surety or co-surety; bonds and undertakings given for any and all purposes, also to execute and deliver on its behalf as aforesaid renewals, extensions, agreements, waivers, consents or stipulations relating to such bonds or undertakings provided, however, that no single bond or undertaking so made, executed and delivered shall obligate the Company for any portion of the penal sum thereof in excess of the sum of **One Hundred Million Dollars ($100,000,000.00)**

Such bonds and undertakings for said purposes, when duly executed by said attorney(s)-in-fact, shall be binding upon the Company as fully and to the same extent as if signed by the President of the Company under its corporate seal attested by its Corporate Secretary.

This appointment is made under and by authority of certain resolutions adopted by the board of directors of each Company by unanimous written consent effective the 30th day of March, 2023 for BSIC and LIC and the 17th day of May, 2023 for EAC and EAIC, a copy of which appears below under the heading entitled "Certificate".

This Power of Attorney is signed and sealed by facsimile under and by authority of the following resolution adopted by the board of directors of each Company by unanimous written consent effective the 30th day of March, 2023 for BSIC and LIC and the 17th day of May, 2023 for EAC and EAIC and said resolution has not since been revoked, amended or repealed:

RESOLVED, that the signature of an individual named above and the seal of the Company may be affixed to any such power of attorney or any certificate relating thereto by facsimile, and any such power of attorney or certificate bearing such facsimile signature or seal shall be valid and binding upon the Company in the future with respect to any bond or undertaking to which it is attached.

IN WITNESS WHEREOF, each Company has caused this instrument to be signed by the following officers, and its corporate seal to be affixed this 25th day of May, 2023.

Endurance Assurance Corporation
By: Richard M Appel
Richard Appel; SVP & Senior Counsel

Endurance American Insurance Company
By: Richard M Appel
Richard Appel; SVP & Senior Counsel

Lexon Insurance Company
By: Richard M Appel
Richard Appel; SVP & Senior Counsel

Bond Safeguard Insurance Company
By: Richard M Appel
Richard Appel; SVP & Senior Counsel

ACKNOWLEDGEMENT

On this 25th day of May, 2023, before me, personally came the above signatories known to me, who being duly sworn, did depose and say that he/they is/are officer of each of the Companies; and that he executed said instrument on behalf of each Company by authority of his office under the by-laws of each Company.

By: Amy Taylor
Amy Taylor, Notary Public - My Commission Expires 3/9/27

CERTIFICATE

I, the undersigned Officer of each Company, DO HEREBY CERTIFY that:

1. That the original power of attorney of which the foregoing is a copy was duly executed on behalf of each Company and has not since been revoked, amended or modified; that the undersigned has compared the foregoing copy thereof with the original power of attorney, and that the same is a true and correct copy of the original power of attorney and of the whole thereof;
2. The following are resolutions which were adopted by the board of directors of each Company by unanimous written consent effective 30th day of March, 2023 for BSIC and LIC and the 17th day of May, 2023 for EAC and EAIC and said resolutions have not since been revoked, amended or modified:

   "RESOLVED, that each of the individuals named below is authorized to make, execute, seal and deliver for and on behalf of the Company any and all bonds, undertakings or obligations in surety or co-surety with others: RICHARD M. APPEL, MATTHEW E. CURAN, MARGARET HYLAND, SHARON L. SIMS, CHRISTOPHER L. SPARRO,

   and be it further

   RESOLVED, that each of the individuals named above is authorized to appoint attorneys-in-fact for the purpose of making, executing, sealing and delivering bonds, undertakings or obligations in surety or co-surety for and on behalf of the Company."
3. The undersigned further certifies that the above resolutions are true and correct copies of the resolutions as so recorded and of the whole thereof.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the corporate seal this 13th day of May, 2025.

By: Daniel S. Lurie, Secretary

NOTICE: U. S. TREASURY DEPARTMENT'S OFFICE OF FOREIGN ASSETS CONTROL (OFAC)

No coverage is provided by this Notice nor can it be construed to replace any provisions of any surety bond or other surety coverage provided. This Notice provides information concerning possible impact on your surety coverage due to directives issued by OFAC. **Please read this Notice carefully.**

The Office of Foreign Assets Control (OFAC) administers and enforces sanctions policy, based on Presidential declarations of "national emergency". OFAC has identified and listed numerous foreign agents, front organizations, terrorists, terrorist organizations, and narcotics traffickers as "Specially Designated Nationals and Blocked Persons". This list can be located on the United States Treasury's website – https://www.treasury.gov/resource-center/sanctions/SDN-List.

In accordance with OFAC regulations, if it is determined that you or any other person or entity claiming the benefits of any coverage has violated U.S. sanctions law or is a Specially Designated National and Blocked Person, as identified by OFAC, any coverage will be considered a blocked or frozen contract and all provisions of any coverage provided are immediately subject to OFAC. When a surety bond or other form of surety coverage is considered to be such a blocked or frozen contract, no payments nor premium refunds may be made without authorization from OFAC. Other limitations on the premiums and payments may also apply.

Any reproductions are void.

Surety Claims Submission: LexonClaimAdministration@sompo-intl.com
Telephone: 615-553-9500 Mailing Address: Sompo International; 12890 Lebanon Road; Mount Juliet, TN 37122-2870

PAYMENT BOND FOR PROCUREMENT CONTRACT

Seller	**Surety**
Name: **KUBOTA WATER & ENVIRONMENT USA CORPORATION** Address *(principal place of business)*: **19910 North Creek Parkway, Suite 100** **Bothell, Washington 98011**	Name: ENDURANCE ASSURANCE CORPORATION Address *(principal place of business)*: 4 Manhattanville Road, Purchase NY 10577
Buyer	**Procurement Contract**
Name: **Taylor Bay Beach Club HOA** Mailing address *(principal place of business)*: **8215 175th Avenue KPS** **Longbranch, Washington 98351**	Description *(name and location)*: **Taylor Bay Beach Club HOA** **Procurement of Membrane Equipment System and Services** Procurement Contract Price: **$951,280.00** Effective Date of Procurement Contract: February 4th, 2025

Bond Number: EACX4012257

Bond Amount: $ Nine Hundred Fifty One Thousand Two Hundred Eighty and 00/100 Dollars ($ 951,280.00)

Date of Bond: May 13th, 2025
(Date of Bond cannot be earlier than Effective Date of Procurement Contract)

Modifications to this Bond form:
☒ None ☐ See Paragraph 17

Surety and Seller, intending to be legally bound hereby, subject to the terms set forth in this Payment Bond, do each cause this Payment Bond to be duly executed by an authorized officer, agent, or representative.

Seller as Principal	Surety
KUBOTA WATER & ENVIRONMENT USA CORPORATION *(Full formal name of Seller)*	ENDURANCE ASSURANCE CORPORATION *(Full formal name of Surety) (corporate seal)*
By: Diego Ayala *(Signature)*	By: Dartonya Wright *(Signature)(Attach Power of Attorney)*
Name: Diego Ayala *(Printed or typed)*	Name: Dartonya Wright *(Printed or typed)*
Title: President	Title: Attorney-in-Fact
Attest: J. 石井孝夫 *(Signature)*	Attest: Susan A Welsh *(Signature)*
Name: Tamami Koriishi *(Printed or typed)*	Name: Susan A. Welsh *(Printed or typed)*
Title: Witness	Title: Witness

Notes: (1) Provide supplemental execution by any additional parties, such as joint venturers. (2) Any singular reference to Seller, Surety, Buyer, or other party is considered plural where applicable.

EJCDC® P-615, Payment Bond for Procurement Contract.
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1. The Seller and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to the Buyer to pay for labor, materials, and equipment furnished for use in the performance of the Procurement Contract, which is incorporated herein by reference, subject to the following terms.

2. If the Seller promptly makes payment of all sums due to Claimants, and defends, indemnifies, and holds harmless the Buyer from claims, demands, liens, or suits by any person or entity seeking payment for labor, materials, or equipment furnished for use in the performance of the Procurement Contract, then the Surety and the Seller shall have no obligation under this Bond.

3. If there is no Buyer Default under the Procurement Contract, the Surety's obligation to the Buyer under this Bond will arise after the Buyer has promptly notified the Seller and the Surety (at the address described in Paragraph 13) of claims, demands, liens, or suits against the Buyer or the Buyer's property by any person or entity seeking payment for labor, materials, or equipment furnished for use in the performance of the Procurement Contract, and tendered defense of such claims, demands, liens, or suits to the Seller and the Surety.

4. When the Buyer has satisfied the conditions in Paragraph 3, the Surety shall promptly and at the Surety's expense defend, indemnify, and hold harmless the Buyer against a duly tendered claim, demand, lien, or suit.

5. The Surety's obligations to a Claimant under this Bond will arise after the following:

    5.1. Claimants who do not have a direct contract with the Seller

        5.1.1. have furnished a written notice of non-payment to the Seller, stating with substantial accuracy the amount claimed and the name of the party to whom the materials were, or equipment was, furnished or supplied or for whom the labor was done or performed, within ninety (90) days after having last performed labor or last furnished materials or equipment included in the Claim; and

        5.1.2. have sent a Claim to the Surety (at the address described in Paragraph 13).

    5.2. Claimants who are employed by or have a direct contract with the Seller have sent a Claim to the Surety (at the address described in Paragraph 13).

6. If a notice of non-payment required by Paragraph 5.1.1 is given by the Buyer to the Seller, that is sufficient to satisfy a Claimant's obligation to furnish a written notice of non-payment under Paragraph 5.1.1.

7. When a Claimant has satisfied the conditions of Paragraph 5.1 or 5.2, whichever is applicable, the Surety shall promptly and at the Surety's expense take the following actions:

    7.1. Send an answer to the Claimant, with a copy to the Buyer, within sixty (60) days after receipt of the Claim, stating the amounts that are undisputed and the basis for challenging any amounts that are disputed; and

    7.2. Pay or arrange for payment of any undisputed amounts.

    7.3. The Surety's failure to discharge its obligations under Paragraph 7.1 or 7.2 will not be deemed to constitute a waiver of defenses the Surety or Seller may have or acquire as to a Claim, except as to undisputed amounts for which the Surety and Claimant have reached agreement. If, however, the Surety fails to discharge its obligations under Paragraph 7.1 or 7.2, the Surety shall indemnify the Claimant for the reasonable attorney's fees the Claimant incurs thereafter to recover any sums found to be due and owing to the Claimant.

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8. The Surety's total obligation will not exceed the amount of this Bond, plus the amount of reasonable attorney's fees provided under Paragraph 7.3, and the amount of this Bond will be credited for any payments made in good faith by the Surety.

9. Amounts owed by the Buyer to the Seller under the Procurement Contract will be used for the performance of the Procurement Contract and to satisfy claims, if any, under any procurement performance bond. By the Seller furnishing and the Buyer accepting this Bond, they agree that all funds earned by the Seller in the performance of the Procurement Contract are dedicated to satisfying obligations of the Seller and Surety under this Bond, subject to the Buyer's priority to use the funds for the completion of the Goods and Special Services.

10. The Surety shall not be liable to the Buyer, Claimants, or others for obligations of the Seller that are unrelated to the Procurement Contract. The Buyer shall not be liable for the payment of any costs or expenses of any Claimant under this Bond, and shall have under this Bond no obligation to make payments to or give notice on behalf of Claimants, or otherwise have any obligations to Claimants under this Bond.

11. The Surety hereby waives notice of any change, including changes of time, to the Procurement Contract or to related subcontracts, purchase orders, and other obligations.

12. No suit or action will be commenced by a Claimant under this Bond other than in a court of competent jurisdiction in the state in which the Point of Destination is located or after the expiration of one year from the date (1) on which the Claimant sent a Claim to the Surety pursuant to Paragraph 5.1.2 or 5.2, or (2) on which the last labor or service was performed by anyone or the last materials or equipment were furnished by anyone under the Procurement Contract, whichever of (1) or (2) first occurs. If the provisions of this paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit will be applicable.

13. Notice and Claims to the Surety, the Buyer, or the Seller must be mailed or delivered to the address shown on the page on which their signature appears. Actual receipt of notice or Claims, however accomplished, will be sufficient compliance as of the date received.

14. When this Bond has been furnished to comply with a statutory or other legal requirement where the Point of Destination is located, any provision in this Bond conflicting with said statutory or legal requirement will be deemed deleted herefrom and provisions conforming to such statutory or other legal requirement will be deemed incorporated herein. When so furnished, the intent is that this Bond will be construed as a statutory bond and not as a common law bond.

15. Upon requests by any person or entity appearing to be a potential beneficiary of this Bond, the Seller and Buyer shall promptly furnish a copy of this Bond or shall permit a copy to be made.

16. Definitions

    16.1. *Buyer Default*—Failure of the Buyer, which has not been remedied or waived, to pay the Seller as required under the Procurement Contract or to perform and complete or comply with the other material terms of the Procurement Contract.

    16.2. *Claim*—A written statement by the Claimant including at a minimum:

        16.2.1. The name of the Claimant;

        16.2.2. The name of the person for whom the labor was done, or materials or equipment furnished;

        16.2.3. A copy of the agreement or purchase order pursuant to which labor, materials, or equipment was furnished for use in the performance of the Procurement Contract;

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16.2.4. A brief description of the labor, materials, or equipment furnished;

16.2.5. The date on which the Claimant last performed labor or last furnished materials or equipment for use in the performance of the Procurement Contract;

16.2.6. The total amount earned by the Claimant for labor, materials, or equipment furnished as of the date of the Claim;

16.2.7. The total amount of previous payments received by the Claimant; and

16.2.8. The total amount due and unpaid to the Claimant for labor, materials, or equipment furnished as of the date of the Claim.

16.3. *Claimant*—An individual or entity having a direct contract with the Seller or with a subcontractor of the Seller to furnish labor, materials, or equipment for use in the performance of the Procurement Contract. The term Claimant also includes any individual or entity that has rightfully asserted a claim under an applicable mechanic's lien or similar statute against the real property upon which the Point of Destination is located or where the Goods and Special Services are to be installed or furnished. The intent of this Bond is to include without limitation in the terms of "labor, materials, or equipment" that part of the water, gas, power, light, heat, oil, gasoline, telephone service, or rental equipment used in the Procurement Contract, architectural and engineering services required for performance of the work of the Seller and the Seller's subcontractors, and all other items for which a mechanic's lien may be asserted in the jurisdiction where the labor, materials, or equipment were furnished.

16.4. *Goods and Special Services*—The full scope of materials, equipment, other items, and services to be furnished by Seller, as defined in the Procurement Contract.

16.5. *Point of Destination*—The location where delivery of the Goods shall be made, as stated in the Procurement Contract.

16.6. *Procurement Contract*—The contractual agreement between the Buyer and Seller identified on the cover page, including all Procurement Contract Documents and all changes made to the Procurement Contract.

16.7. *Procurement Contract Documents*—All the documents that comprise the contractual agreement between the Buyer and Seller.

17. Modifications to this Bond are as follows: **[Describe modification or enter "None"]**

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SOMPO INTERNATIONAL
INSURANCE

POWER OF ATTORNEY

11118

KNOW ALL BY THESE PRESENTS, that **Endurance Assurance Corporation**, a Delaware corporation ("EAC"), **Endurance American Insurance Company**, a Delaware corporation ("EAIC"), **Lexon Insurance Company**, a Texas corporation ("LIC"), and/or **Bond Safeguard Insurance Company**, a South Dakota corporation ("BSIC"), each, a "Company" and collectively, "**Sompo International**," do hereby constitute and appoint: **Susan A. Welsh, Sandra M. Winsted, Christina L. Sandoval, Judith A. Lucky-Eftimov, Aerie Walton, Derek J. Elston, Jennifer Williams, Salena Wood, Eric Sauer, Bartlomiej Siepierski, Barbara Pannier, Rachel Fore, Kristin L. Hannigan, Samantha Chierici, Corinne Chapman, Jean Torres, Roger Paraison, Nicholas Kertesz, Dartonya Wright, Tara A. Reimer, Richard Casa** as true and lawful Attorney(s)-In-Fact to make, execute, seal, and deliver for, and on its behalf as surety or co-surety; bonds and undertakings given for any and all purposes, also to execute and deliver on its behalf as aforesaid renewals, extensions, agreements, waivers, consents or stipulations relating to such bonds or undertakings provided, however, that no single bond or undertaking so made, executed and delivered shall obligate the Company for any portion of the penal sum thereof in excess of the sum of **One Hundred Million Dollars ($100,000,000.00)**

Such bonds and undertakings for said purposes, when duly executed by said attorney(s)-in-fact, shall be binding upon the Company as fully and to the same extent as if signed by the President of the Company under its corporate seal attested by its Corporate Secretary.

This appointment is made under and by authority of certain resolutions adopted by the board of directors of each Company by unanimous written consent effective the 30th day of March, 2023 for BSIC and LIC and the 17th day of May, 2023 for EAC and EAIC, a copy of which appears below under the heading entitled "Certificate".

This Power of Attorney is signed and sealed by facsimile under and by authority of the following resolution adopted by the board of directors of each Company by unanimous written consent effective the 30th day of March, 2023 for BSIC and LIC and the 17th day of May, 2023 for EAC and EAIC and said resolution has not since been revoked, amended or repealed:

RESOLVED, that the signature of an individual named above and the seal of the Company may be affixed to any such power of attorney or any certificate relating thereto by facsimile, and any such power of attorney or certificate bearing such facsimile signature or seal shall be valid and binding upon the Company in the future with respect to any bond or undertaking to which it is attached.

IN WITNESS WHEREOF, each Company has caused this instrument to be signed by the following officers, and its corporate seal to be affixed this 25th day of May, 2023.

Endurance Assurance Corporation
By: Richard M Appel
Richard Appel; SVP & Senior Counsel

Endurance American Insurance Company
By: Richard M Appel
Richard Appel; SVP & Senior Counsel

Lexon Insurance Company
By: Richard M Appel
Richard Appel; SVP & Senior Counsel

Bond Safeguard Insurance Company
By: Richard M Appel
Richard Appel; SVP & Senior Counsel

ACKNOWLEDGEMENT

On this 25th day of May, 2023, before me, personally came the above signatories known to me, who being duly sworn, did depose and say that he/they is/are officer of each of the Companies; and that he executed said instrument on behalf of each Company by authority of his office under the by-laws of each Company.

By: Amy Taylor
Amy Taylor, Notary Public - My Commission Expires 3/9/27

CERTIFICATE

I, the undersigned Officer of each Company, DO HEREBY CERTIFY that:

1. That the original power of attorney of which the foregoing is a copy was duly executed on behalf of each Company and has not since been revoked, amended or modified; that the undersigned has compared the foregoing copy thereof with the original power of attorney, and that the same is a true and correct copy of the original power of attorney and of the whole thereof;
2. The following are resolutions which were adopted by the board of directors of each Company by unanimous written consent effective 30th day of March, 2023 for BSIC and LIC and the 17th day of May, 2023 for EAC and EAIC and said resolutions have not since been revoked, amended or modified:

   "RESOLVED, that each of the individuals named below is authorized to make, execute, seal and deliver for and on behalf of the Company any and all bonds, undertakings or obligations in surety or co-surety with others: RICHARD M. APPEL, MATTHEW E. CURAN, MARGARET HYLAND, SHARON L. SIMS, CHRISTOPHER L. SPARRO,

   and be it further

   RESOLVED, that each of the individuals named above is authorized to appoint attorneys-in-fact for the purpose of making, executing, sealing and delivering bonds, undertakings or obligations in surety or co-surety for and on behalf of the Company."
3. The undersigned further certifies that the above resolutions are true and correct copies of the resolutions as so recorded and of the whole thereof.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the corporate seal this 13th day of May, 2025.

By:
Daniel S. Lurie, Secretary

NOTICE: U. S. TREASURY DEPARTMENT'S OFFICE OF FOREIGN ASSETS CONTROL (OFAC)

No coverage is provided by this Notice nor can it be construed to replace any provisions of any surety bond or other surety coverage provided. This Notice provides information concerning possible impact on your surety coverage due to directives issued by OFAC. **Please read this Notice carefully.**

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In accordance with OFAC regulations, if it is determined that you or any other person or entity claiming the benefits of any coverage has violated U.S. sanctions law or is a Specially Designated National and Blocked Person, as identified by OFAC, any coverage will be considered a blocked or frozen contract and all provisions of any coverage provided are immediately subject to OFAC. When a surety bond or other form of surety coverage is considered to be such a blocked or frozen contract, no payments nor premium refunds may be made without authorization from OFAC. Other limitations on the premiums and payments may also apply.

Any reproductions are void.

Surety Claims Submission: LexonClaimAdministration@sompo-intl.com
Telephone: 615-553-9500 Mailing Address: Sompo International; 12890 Lebanon Road; Mount Juliet, TN 37122-2870

CERTIFICATE OF LIABILITY INSURANCE

DATE(MM/DD/YYYY)
05/23/2025

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AFFIRMATIVELY OR NEGATIVELY AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW. THIS CERTIFICATE OF INSURANCE DOES NOT CONSTITUTE A CONTRACT BETWEEN THE ISSUING INSURER(S), AUTHORIZED REPRESENTATIVE OR PRODUCER, AND THE CERTIFICATE HOLDER.

IMPORTANT: If the certificate holder is an ADDITIONAL INSURED, the policy(ies) must have ADDITIONAL INSURED provisions or be endorsed. If SUBROGATION IS WAIVED, subject to the terms and conditions of the policy, certain policies may require an endorsement. A statement on this certificate does not confer rights to the certificate holder in lieu of such endorsement(s).

PRODUCER
Aon Risk Services Central, Inc.
Indianapolis IN Office
450 East 96th Street
Suite 275
Indianapolis IN 46240 USA

CONTACT NAME:
PHONE (A/C. No, Ext): (866) 283-7122 **FAX (A/C. No.):** (800) 363-0105
E-MAIL ADDRESS:

INSURER(S) AFFORDING COVERAGE		NAIC #
INSURER A:	Sompo America Insurance Company	11126
INSURER B:		
INSURER C:		
INSURER D:		
INSURER E:		
INSURER F:		

INSURED
KUBOTA Water and Environment U.S.A. Corporation
19910 N Creek Pkwy
Suite 100
Bothell WA 98011 USA

COVERAGES **CERTIFICATE NUMBER:** 570112712037 **REVISION NUMBER:**

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

Limits shown are as requested

INSR LTR	TYPE OF INSURANCE	ADDL INSD	SUBR WVD	POLICY NUMBER	POLICY EFF (MM/DD/YYYY)	POLICY EXP (MM/DD/YYYY)	LIMITS	
A	X COMMERCIAL GENERAL LIABILITY CLAIMS-MADE X OCCUR GEN'L AGGREGATE LIMIT APPLIES PER: POLICY X PRO-JECT X LOC OTHER:			AGM30035808102	04/15/2025	04/15/2026	EACH OCCURRENCE DAMAGE TO RENTED PREMISES (Ea occurrence) MED EXP (Any one person) PERSONAL & ADV INJURY GENERAL AGGREGATE PRODUCTS - COMP/OP AGG	$1,000,000 $500,000 $15,000 $1,000,000 $2,000,000 $2,000,000
A	AUTOMOBILE LIABILITY X ANY AUTO OWNED AUTOS ONLY HIRED AUTOS ONLY SCHEDULED AUTOS NON-OWNED AUTOS ONLY			AAM30018567003	04/15/2025	04/15/2026	COMBINED SINGLE LIMIT (Ea accident) BODILY INJURY (Per person) BODILY INJURY (Per accident) PROPERTY DAMAGE (Per accident) Comp./Coll. Deductible	$1,000,000 $1,000
A	X UMBRELLA LIAB X OCCUR EXCESS LIAB CLAIMS-MADE DED X RETENTION $10,000			CPU41189L0	04/15/2025	04/15/2026	EACH OCCURRENCE AGGREGATE Personal and advertising injury	$5,000,000 $5,000,000 $5,000,000
A	WORKERS COMPENSATION AND EMPLOYERS' LIABILITY ANY PROPRIETOR / PARTNER / EXECUTIVE OFFICER/MEMBER EXCLUDED? Y/N: N N/A (Mandatory in NH) If yes, describe under DESCRIPTION OF OPERATIONS below			AWM30085270500	04/15/2025	04/15/2026	X PER STATUTE OTH-ER E.L. EACH ACCIDENT E.L. DISEASE-EA EMPLOYEE E.L. DISEASE-POLICY LIMIT	 $1,000,000 $1,000,000 $1,000,000

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES (ACORD 101, Additional Remarks Schedule, may be attached if more space is required)

Taylor Bay Beach Club HOA Gray & Osborne, Inc., and respective officers, directors, partners, employees, and agents are included as Additional Insured in accordance with the policy provisions of the General Liability policy.

CERTIFICATE HOLDER

Taylor Bay Beach Club HOA
8220 178th Court SW
Longbranch WA 98351 USA

CANCELLATION

SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS.

AUTHORIZED REPRESENTATIVE

Aon Risk Services Central, Inc.

Holder Identifier :

Certificate No : 570112712037

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SOMPO

SCHEDULE OF UNDERLYING INSURANCE

Policy Number: CPU41189L0

UNDERLYING INSURER	TYPE OF COVERAGE	LIMITS OF LIABILITY	
Company: SOMPO AMERICA INSURANCE COMPANY Policy No: AGM30035808102 Effective Date: 04/15/25 Expiration Date: 04/15/26 Retroactive Date:	**COMMERCIAL GENERAL LIABILITY** X **Occurrence** ____ **Claims-Made**	$ 1,000,000 $ 2,000,000 $ 2,000,000 $ 1,000,000	Each Occurrence General Aggregate Products-Completed Operations Aggregate Personal Injury and Advertising Injury (Any one person or organization)
Company: SOMPO AMERICA INSURANCE COMPANY Policy No: AAM30018567003 Effective Date: 04/15/25 Expiration Date: 04/15/26	**COMMERCIAL AUTO LIABILITY**	$ 1,000,000	Bodily Injury Liability Each Person Each Accident Property Damage Liability Each Accident Garage Aggregate Limit For Other Than Autos (if applicable) Each Accident Combined Single Limit
Company: SOMPO AMERICA INSURANCE COMPANY Policy No: AWM30085270500 Effective Date: 04/15/25 Expiration Date: 04/15/26	**EMPLOYERS' LIABILITY***** Bodily Injury by Accident Bodily Injury by Disease	$ 1,000,000 $ 1,000,000 $ 1,000,000	Each Accident*** Each Employee Aggregate

***Except in those jurisdiction where Employer's Liability Coverage afforded by the underlying insurer is by law unlimited.

SOMPO

SCHEDULE OF UNDERLYING INSURANCE

Policy Number: CPU41189L0

UNDERLYING INSURER	TYPE OF COVERAGE	LIMITS OF LIABILITY
Company SOMPO AMERICA INSURANCE COMPANY Policy No AGM30035808102 Effective Date: 04/15/25 Expiration Date: 04/15/26	Employee Benefits	$1,000,000 Each Employee $1,000,000 Aggregate
Company Policy No Effective Date: Expiration Date:		
Company Policy No Effective Date: Expiration Date:		

1. The Seller and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to the Buyer for the performance of the Procurement Contract, which is incorporated herein by reference.

2. If the Seller performs the Procurement Contract, the Surety and the Seller shall have no obligation under this Bond, except when applicable to participate in a conference as provided in Paragraph 3.

3. If there is no Buyer Default under the Procurement Contract, the Surety's obligation under this Bond will arise after:

    3.1. The Buyer first provides notice to the Seller and the Surety that the Buyer is considering declaring a Seller Default. Such notice may indicate whether the Buyer is requesting a conference among the Buyer, Seller, and Surety to discuss the Seller's performance. If the Buyer does not request a conference, the Surety may, within five (5) business days after receipt of the Buyer's notice, request such a conference. If the Surety timely requests a conference, the Buyer shall attend. Unless the Buyer agrees otherwise, any conference requested under this Paragraph 3.1 will be held within ten (10) business days of the Surety's receipt of the Buyer's notice. If the Buyer, the Seller, and the Surety agree, the Seller shall be allowed a reasonable time to perform the Procurement Contract, but such an agreement does not waive the Buyer's right, if any, subsequently to declare a Seller Default;

    3.2. The Buyer declares a Seller Default, terminates the Procurement Contract, and notifies the Surety; and

    3.3. The Buyer has agreed to pay the Balance of the Procurement Contract Price in accordance with the terms of the Procurement Contract to the Surety or to a seller selected to perform the Procurement Contract.

4. Failure on the part of the Buyer to comply with the notice requirement in Paragraph 3.1 does not constitute a failure to comply with a condition precedent to the Surety's obligations, or release the Surety from its obligations, except to the extent the Surety demonstrates actual prejudice.

5. When the Buyer has satisfied the conditions of Paragraph 3, the Surety shall promptly and at the Surety's expense take one of the following actions:

    5.1. Arrange for the Seller, with the consent of the Buyer, to perform and complete the Procurement Contract;

    5.2. Undertake to perform and complete the Procurement Contract itself, through its agents or independent contractors;

    5.3. Obtain bids or negotiated proposals from qualified sellers acceptable to the Buyer for a contract for performance and completion of the Procurement Contract, arrange for a contract to be prepared for execution by the Buyer and a seller selected with the Buyer's concurrence, to be secured with performance and payment bonds executed by a qualified surety equivalent to the bonds issued on the Procurement Contract, and pay to the Buyer the amount of damages as described in Paragraph 7 in excess of the Balance of the Procurement Contract Price incurred by the Buyer as a result of the Seller Default; or

    5.4. Waive its right to perform and complete, arrange for completion, or obtain a new seller, and with reasonable promptness under the circumstances:

        5.4.1. After investigation, determine the amount for which Surety may be liable to the Buyer and, as soon as practicable after the amount is determined, make payment to the Buyer; or

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5.4.2. Deny liability in whole or in part and notify the Buyer, citing the reasons for denial.

6. If the Surety does not proceed as provided in Paragraph 5 with reasonable promptness, the Surety shall be deemed to be in default on this Bond seven (7) days after receipt of an additional written notice from the Buyer to the Surety demanding that the Surety perform its obligations under this Bond, and the Buyer shall be entitled to enforce any remedy available to the Buyer. If the Surety proceeds as provided in Paragraph 5.4, and the Buyer refuses the payment, or the Surety has denied liability, in whole or in part, without further notice, the Buyer shall be entitled to enforce any remedy available to the Buyer.

7. If the Surety elects to act under Paragraph 5.1, 5.2, or 5.3, then the responsibilities of the Surety to the Buyer will not be greater than those of the Seller under the Procurement Contract, and the responsibilities of the Buyer to the Surety will not be greater than those of the Buyer under the Procurement Contract. Subject to the commitment by the Buyer to pay the Balance of the Procurement Contract Price, the Surety is obligated, without duplication for:

   7.1. the responsibilities of the Seller for correction of defective or non-conforming Goods and Special Services, and completion of the Procurement Contract;

   7.2. additional legal, design professional, and delay costs resulting from the Seller's Default, and resulting from the actions or failure to act of the Surety under Paragraph 5; and

   7.3. liquidated damages, or if no liquidated damages are specified in the Procurement Contract, actual damages caused by delayed performance or non-performance of the Seller.

8. If the Surety elects to act under Paragraph 5.1, 5.3, or 5.4, the Surety's liability is limited to the amount of this Bond.

9. The Surety shall not be liable to the Buyer or others for obligations of the Seller that are unrelated to the Procurement Contract, and the Balance of the Procurement Contract Price will not be reduced or set off on account of any such unrelated obligations. No right of action will accrue on this Bond to any person or entity other than the Buyer or its heirs, executors, administrators, successors, and assigns.

10. The Surety hereby waives notice of any change, including changes of time, to the Procurement Contract or to related subcontracts, purchase orders, and other obligations.

11. Any proceeding, legal or equitable, under this Bond must be instituted in any court of competent jurisdiction where the Point of Destination is located and must be instituted within two years after a declaration of Seller Default, or within two years after the Seller ceased working, or within two years after the Surety refuses or fails to perform its obligations under this Bond, whichever occurs first. If the provisions of this Paragraph are void or prohibited by law, the minimum periods of limitations available to sureties as a defense in the jurisdiction of the suit will be applicable.

12. Notice to the Surety, the Buyer, or the Seller must be mailed or delivered to the address shown on the page on which their signature appears.

13. When this Bond has been furnished to comply with a statutory or other legal requirement in the location of the Point of Destination, any provision in this Bond conflicting with said statutory or legal requirement will be deemed deleted herefrom and provisions conforming to such statutory or other legal requirement will be deemed incorporated herein. When so furnished, the intent is that this Bond will be construed as a statutory bond and not as a common law bond.

14. Definitions

   14.1. *Balance of the Procurement Contract Price*—The total amount payable by the Buyer to the Seller under the Procurement Contract after all proper adjustments have been made including

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allowance for the Seller for any amounts received or to be received by the Buyer in settlement of insurance or other claims for damages to which the Seller is entitled, reduced by all valid and proper payments made to or on behalf of the Seller under the Procurement Contract.

14.2. *Buyer Default*—Failure of the Buyer, which has not been remedied or waived, to pay the Seller as required under the Procurement Contract or to perform and complete or comply with the other material terms of the Procurement Contract.

14.3. *Goods and Special Services*—The full scope of materials, equipment, other items, and services to be furnished by Seller, as defined in the Procurement Contract.

14.4. *Point of Destination*—The location where delivery of the Goods shall be made, as stated in the Procurement Contract.

14.5. *Procurement Contract*—The contractual agreement between the Buyer and Seller identified on the cover page, including all Procurement Contract Documents and changes made to the Procurement Contract.

14.6. *Seller Default*—Failure of the Seller, which has not been remedied or waived, to perform or otherwise to comply with a material term of the Procurement Contract.

14.7. *Procurement Contract Documents*—All the documents that comprise the contractual agreement between the Buyer and Seller.

15. Modifications to this Bond are as follows: **[Describe modification or enter "None"]**

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SOMPO INTERNATIONAL
INSURANCE

POWER OF ATTORNEY

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KNOW ALL BY THESE PRESENTS, that **Endurance Assurance Corporation**, a Delaware corporation ("EAC"), **Endurance American Insurance Company**, a Delaware corporation ("EAIC"), **Lexon Insurance Company**, a Texas corporation ("LIC"), and/or **Bond Safeguard Insurance Company**, a South Dakota corporation ("BSIC"), each, a "Company" and collectively, "**Sompo International**," do hereby constitute and appoint: **Susan A. Welsh, Sandra M. Winsted, Christina L. Sandoval, Judith A. Lucky-Eftimov, Aerie Walton, Derek J. Elston, Jennifer Williams, Salena Wood, Eric Sauer, Bartlomiej Siepierski, Barbara Pannier, Rachel Fore, Kristin L. Hannigan, Samantha Chierici, Corinne Chapman, Jean Torres, Roger Paraison, Nicholas Kertesz, Dartonya Wright, Tara A. Reimer, Richard Casa** as true and lawful Attorney(s)-In-Fact to make, execute, seal, and deliver for, and on its behalf as surety or co-surety; bonds and undertakings given for any and all purposes, also to execute and deliver on its behalf as aforesaid renewals, extensions, agreements, waivers, consents or stipulations relating to such bonds or undertakings provided, however, that no single bond or undertaking so made, executed and delivered shall obligate the Company for any portion of the penal sum thereof in excess of the sum of **One Hundred Million Dollars ($100,000,000.00)**

Such bonds and undertakings for said purposes, when duly executed by said attorney(s)-in-fact, shall be binding upon the Company as fully and to the same extent as if signed by the President of the Company under its corporate seal attested by its Corporate Secretary.

This appointment is made under and by authority of certain resolutions adopted by the board of directors of each Company by unanimous written consent effective the 30th day of March, 2023 for BSIC and LIC and the 17th day of May, 2023 for EAC and EAIC, a copy of which appears below under the heading entitled "Certificate".

This Power of Attorney is signed and sealed by facsimile under and by authority of the following resolution adopted by the board of directors of each Company by unanimous written consent effective the 30th day of March, 2023 for BSIC and LIC and the 17th day of May, 2023 for EAC and EAIC and said resolution has not since been revoked, amended or repealed:

RESOLVED, that the signature of an individual named above and the seal of the Company may be affixed to any such power of attorney or any certificate relating thereto by facsimile, and any such power of attorney or certificate bearing such facsimile signature or seal shall be valid and binding upon the Company in the future with respect to any bond or undertaking to which it is attached.

IN WITNESS WHEREOF, each Company has caused this instrument to be signed by the following officers, and its corporate seal to be affixed this 25th day of May, 2023.

Endurance Assurance Corporation
By: Richard M Appel
Richard Appel; SVP & Senior Counsel

Endurance American Insurance Company
By: Richard M Appel
Richard Appel; SVP & Senior Counsel

Lexon Insurance Company
By: Richard M Appel
Richard Appel; SVP & Senior Counsel

Bond Safeguard Insurance Company
By: Richard M Appel
Richard Appel; SVP & Senior Counsel

ACKNOWLEDGEMENT

On this 25th day of May, 2023, before me, personally came the above signatories known to me, who being duly sworn, did depose and say that he/they is an officer of each of the Companies; and that he executed said instrument on behalf of each Company by authority of his office under the by-laws of each Company.

By: Amy Taylor
Amy Taylor, Notary Public – My Commission Expires 3/9/27

CERTIFICATE

I, the undersigned Officer of each Company, DO HEREBY CERTIFY that:

1. That the original power of attorney of which the foregoing is a copy was duly executed on behalf of each Company and has not since been revoked, amended or modified; that the undersigned has compared the foregoing copy thereof with the original power of attorney, and that the same is a true and correct copy of the original power of attorney and of the whole thereof;
2. The following are resolutions which were adopted by the board of directors of each Company by unanimous written consent effective 30th day of March, 2023 for BSIC and LIC and the 17th day of May, 2023 for EAC and EAIC and said resolutions have not since been revoked, amended or modified:

   "RESOLVED, that each of the individuals named below is authorized to make, execute, seal and deliver for and on behalf of the Company any and all bonds, undertakings or obligations in surety or co-surety with others: RICHARD M. APPEL, MATTHEW E. CURAN, MARGARET HYLAND, SHARON L. SIMS, CHRISTOPHER L. SPARRO,

   and be it further

   RESOLVED, that each of the individuals named above is authorized to appoint attorneys-in-fact for the purpose of making, executing, sealing and delivering bonds, undertakings or obligations in surety or co-surety for and on behalf of the Company."
3. The undersigned further certifies that the above resolutions are true and correct copies of the resolutions as so recorded and of the whole thereof.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the corporate seal this 13th day of May, 2025.

By: Daniel S. Lurie, Secretary

NOTICE: U. S. TREASURY DEPARTMENT'S OFFICE OF FOREIGN ASSETS CONTROL (OFAC)

No coverage is provided by this Notice nor can it be construed to replace any provisions of any surety bond or other surety coverage provided. This Notice provides information concerning possible impact on your surety coverage due to directives issued by OFAC. **Please read this Notice carefully.**

The Office of Foreign Assets Control (OFAC) administers and enforces sanctions policy, based on Presidential declarations of "national emergency". OFAC has identified and listed numerous foreign agents, front organizations, terrorists, terrorist organizations, and narcotics traffickers as "Specially Designated Nationals and Blocked Persons". This list can be located on the United States Treasury's website – https://www.treasury.gov/resource-center/sanctions/SDN-List.

In accordance with OFAC regulations, if it is determined that you or any other person or entity claiming the benefits of any coverage has violated U.S. sanctions law or is a Specially Designated National and Blocked Person, as identified by OFAC, any coverage will be considered a blocked or frozen contract and all provisions of any coverage provided are immediately subject to OFAC. When a surety bond or other form of surety coverage is considered to be such a blocked or frozen contract, no payments nor premium refunds may be made without authorization from OFAC. Other limitations on the premiums and payments may also apply.

Any reproductions are void.

Surety Claims Submission: LexonClaimAdministration@sompo-intl.com
Telephone: 615-553-9500 Mailing Address: Sompo International; 12890 Lebanon Road; Mount Juliet, TN 37122-2870

PAYMENT BOND FOR PROCUREMENT CONTRACT

Seller	**Surety**
Name: **KUBOTA WATER & ENVIRONMENT USA CORPORATION**	Name: ENDURANCE ASSURANCE CORPORATION
Address *(principal place of business)*: **19910 North Creek Parkway, Suite 100 Bothell, Washington 98011**	Address *(principal place of business)*: 4 Manhattanville Road, Purchase NY 10577
Buyer	**Procurement Contract**
Name: **Taylor Bay Beach Club HOA**	Description *(name and location)*: **Taylor Bay Beach Club HOA Procurement of Membrane Equipment System and Services**
Mailing address *(principal place of business)*: **8215 175th Avenue KPS Longbranch, Washington 98351**	Procurement Contract Price: **$951,280.00**
	Effective Date of Procurement Contract: February 4th, 2025

Bond Number: EACX4012257

Bond Amount: $ Nine Hundred Fifty One Thousand Two Hundred Eighty and 00/100 Dollars ($ 951,280.00)

Date of Bond: May 13th, 2025

(Date of Bond cannot be earlier than Effective Date of Procurement Contract)

Modifications to this Bond form:

☒ None ☐ See Paragraph 17

Surety and Seller, intending to be legally bound hereby, subject to the terms set forth in this Payment Bond, do each cause this Payment Bond to be duly executed by an authorized officer, agent, or representative.

Seller as Principal	Surety
KUBOTA WATER & ENVIRONMENT USA CORPORATION *(Full formal name of Seller)*	ENDURANCE ASSURANCE CORPORATION *(Full formal name of Surety) (corporate seal)*
By: *(Signature)*	By: *(Signature)(Attach Power of Attorney)*
Name: Diego Ayala *(Printed or typed)*	Name: Dartonya Wright *(Printed or typed)*
Title: President	Title: Attorney-in-Fact
Attest: *(Signature)*	Attest: *(Signature)*
Name: Tamami Konishi *(Printed or typed)*	Name: Susan A. Welsh *(Printed or typed)*
Title: Witness	Title: Witness

Notes: (1) Provide supplemental execution by any additional parties, such as joint venturers. (2) Any singular reference to Seller, Surety, Buyer, or other party is considered plural where applicable.

EJCDC® P-615, Payment Bond for Procurement Contract.
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1. The Seller and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to the Buyer to pay for labor, materials, and equipment furnished for use in the performance of the Procurement Contract, which is incorporated herein by reference, subject to the following terms.

2. If the Seller promptly makes payment of all sums due to Claimants, and defends, indemnifies, and holds harmless the Buyer from claims, demands, liens, or suits by any person or entity seeking payment for labor, materials, or equipment furnished for use in the performance of the Procurement Contract, then the Surety and the Seller shall have no obligation under this Bond.

3. If there is no Buyer Default under the Procurement Contract, the Surety's obligation to the Buyer under this Bond will arise after the Buyer has promptly notified the Seller and the Surety (at the address described in Paragraph 13) of claims, demands, liens, or suits against the Buyer or the Buyer's property by any person or entity seeking payment for labor, materials, or equipment furnished for use in the performance of the Procurement Contract, and tendered defense of such claims, demands, liens, or suits to the Seller and the Surety.

4. When the Buyer has satisfied the conditions in Paragraph 3, the Surety shall promptly and at the Surety's expense defend, indemnify, and hold harmless the Buyer against a duly tendered claim, demand, lien, or suit.

5. The Surety's obligations to a Claimant under this Bond will arise after the following:

    5.1. Claimants who do not have a direct contract with the Seller

        5.1.1. have furnished a written notice of non-payment to the Seller, stating with substantial accuracy the amount claimed and the name of the party to whom the materials were, or equipment was, furnished or supplied or for whom the labor was done or performed, within ninety (90) days after having last performed labor or last furnished materials or equipment included in the Claim; and

        5.1.2. have sent a Claim to the Surety (at the address described in Paragraph 13).

    5.2. Claimants who are employed by or have a direct contract with the Seller have sent a Claim to the Surety (at the address described in Paragraph 13).

6. If a notice of non-payment required by Paragraph 5.1.1 is given by the Buyer to the Seller, that is sufficient to satisfy a Claimant's obligation to furnish a written notice of non-payment under Paragraph 5.1.1.

7. When a Claimant has satisfied the conditions of Paragraph 5.1 or 5.2, whichever is applicable, the Surety shall promptly and at the Surety's expense take the following actions:

    7.1. Send an answer to the Claimant, with a copy to the Buyer, within sixty (60) days after receipt of the Claim, stating the amounts that are undisputed and the basis for challenging any amounts that are disputed; and

    7.2. Pay or arrange for payment of any undisputed amounts.

    7.3. The Surety's failure to discharge its obligations under Paragraph 7.1 or 7.2 will not be deemed to constitute a waiver of defenses the Surety or Seller may have or acquire as to a Claim, except as to undisputed amounts for which the Surety and Claimant have reached agreement. If, however, the Surety fails to discharge its obligations under Paragraph 7.1 or 7.2, the Surety shall indemnify the Claimant for the reasonable attorney's fees the Claimant incurs thereafter to recover any sums found to be due and owing to the Claimant.

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8. The Surety's total obligation will not exceed the amount of this Bond, plus the amount of reasonable attorney's fees provided under Paragraph 7.3, and the amount of this Bond will be credited for any payments made in good faith by the Surety.

9. Amounts owed by the Buyer to the Seller under the Procurement Contract will be used for the performance of the Procurement Contract and to satisfy claims, if any, under any procurement performance bond. By the Seller furnishing and the Buyer accepting this Bond, they agree that all funds earned by the Seller in the performance of the Procurement Contract are dedicated to satisfying obligations of the Seller and Surety under this Bond, subject to the Buyer's priority to use the funds for the completion of the Goods and Special Services.

10. The Surety shall not be liable to the Buyer, Claimants, or others for obligations of the Seller that are unrelated to the Procurement Contract. The Buyer shall not be liable for the payment of any costs or expenses of any Claimant under this Bond, and shall have under this Bond no obligation to make payments to or give notice on behalf of Claimants, or otherwise have any obligations to Claimants under this Bond.

11. The Surety hereby waives notice of any change, including changes of time, to the Procurement Contract or to related subcontracts, purchase orders, and other obligations.

12. No suit or action will be commenced by a Claimant under this Bond other than in a court of competent jurisdiction in the state in which the Point of Destination is located or after the expiration of one year from the date (1) on which the Claimant sent a Claim to the Surety pursuant to Paragraph 5.1.2 or 5.2, or (2) on which the last labor or service was performed by anyone or the last materials or equipment were furnished by anyone under the Procurement Contract, whichever of (1) or (2) first occurs. If the provisions of this paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit will be applicable.

13. Notice and Claims to the Surety, the Buyer, or the Seller must be mailed or delivered to the address shown on the page on which their signature appears. Actual receipt of notice or Claims, however accomplished, will be sufficient compliance as of the date received.

14. When this Bond has been furnished to comply with a statutory or other legal requirement where the Point of Destination is located, any provision in this Bond conflicting with said statutory or legal requirement will be deemed deleted herefrom and provisions conforming to such statutory or other legal requirement will be deemed incorporated herein. When so furnished, the intent is that this Bond will be construed as a statutory bond and not as a common law bond.

15. Upon requests by any person or entity appearing to be a potential beneficiary of this Bond, the Seller and Buyer shall promptly furnish a copy of this Bond or shall permit a copy to be made.

16. Definitions

    16.1. *Buyer Default*—Failure of the Buyer, which has not been remedied or waived, to pay the Seller as required under the Procurement Contract or to perform and complete or comply with the other material terms of the Procurement Contract.

    16.2. *Claim*—A written statement by the Claimant including at a minimum:

        16.2.1. The name of the Claimant;

        16.2.2. The name of the person for whom the labor was done, or materials or equipment furnished;

        16.2.3. A copy of the agreement or purchase order pursuant to which labor, materials, or equipment was furnished for use in the performance of the Procurement Contract;

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16.2.4. A brief description of the labor, materials, or equipment furnished;

16.2.5. The date on which the Claimant last performed labor or last furnished materials or equipment for use in the performance of the Procurement Contract;

16.2.6. The total amount earned by the Claimant for labor, materials, or equipment furnished as of the date of the Claim;

16.2.7. The total amount of previous payments received by the Claimant; and

16.2.8. The total amount due and unpaid to the Claimant for labor, materials, or equipment furnished as of the date of the Claim.

16.3. *Claimant*—An individual or entity having a direct contract with the Seller or with a subcontractor of the Seller to furnish labor, materials, or equipment for use in the performance of the Procurement Contract. The term Claimant also includes any individual or entity that has rightfully asserted a claim under an applicable mechanic's lien or similar statute against the real property upon which the Point of Destination is located or where the Goods and Special Services are to be installed or furnished. The intent of this Bond is to include without limitation in the terms of "labor, materials, or equipment" that part of the water, gas, power, light, heat, oil, gasoline, telephone service, or rental equipment used in the Procurement Contract, architectural and engineering services required for performance of the work of the Seller and the Seller's subcontractors, and all other items for which a mechanic's lien may be asserted in the jurisdiction where the labor, materials, or equipment were furnished.

16.4. *Goods and Special Services*—The full scope of materials, equipment, other items, and services to be furnished by Seller, as defined in the Procurement Contract.

16.5. *Point of Destination*—The location where delivery of the Goods shall be made, as stated in the Procurement Contract.

16.6. *Procurement Contract*—The contractual agreement between the Buyer and Seller identified on the cover page, including all Procurement Contract Documents and all changes made to the Procurement Contract.

16.7. *Procurement Contract Documents*—All the documents that comprise the contractual agreement between the Buyer and Seller.

17. Modifications to this Bond are as follows: **[Describe modification or enter "None"]**

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SOMPO INTERNATIONAL
INSURANCE

POWER OF ATTORNEY

11118

KNOW ALL BY THESE PRESENTS, that **Endurance Assurance Corporation**, a Delaware corporation ("EAC"), **Endurance American Insurance Company**, a Delaware corporation ("EAIC"), **Lexon Insurance Company**, a Texas corporation ("LIC"), and/or **Bond Safeguard Insurance Company**, a South Dakota corporation ("BSIC"), each, a "Company" and collectively, "**Sompo International**," do hereby constitute and appoint: **Susan A. Welsh, Sandra M. Winsted, Christina L. Sandoval, Judith A. Lucky-Eftimov, Aerie Walton, Derek J. Elston, Jennifer Williams, Salena Wood, Eric Sauer, Bartlomiej Siepierski, Barbara Pannier, Rachel Fore, Kristin L. Hannigan, Samantha Chierici, Corinne Chapman, Jean Torres, Roger Paraison, Nicholas Kertesz, Dartonya Wright, Tara A. Reimer, Richard Casa** as true and lawful Attorney(s)-In-Fact to make, execute, seal, and deliver for, and on its behalf as surety or co-surety; bonds and undertakings given for any and all purposes, also to execute and deliver on its behalf as aforesaid renewals, extensions, agreements, waivers, consents or stipulations relating to such bonds or undertakings provided, however, that no single bond or undertaking so made, executed and delivered shall obligate the Company for any portion of the penal sum thereof in excess of the sum of **One Hundred Million Dollars ($100,000,000.00)**

Such bonds and undertakings for said purposes, when duly executed by said attorney(s)-in-fact, shall be binding upon the Company as fully and to the same extent as if signed by the President of the Company under its corporate seal attested by its Corporate Secretary.

This appointment is made under and by authority of certain resolutions adopted by the board of directors of each Company by unanimous written consent effective the 30th day of March, 2023 for BSIC and LIC and the 17th day of May, 2023 for EAC and EAIC, a copy of which appears below under the heading entitled "Certificate".

This Power of Attorney is signed and sealed by facsimile under and by authority of the following resolution adopted by the board of directors of each Company by unanimous written consent effective the 30th day of March, 2023 for BSIC and LIC and the 17th day of May, 2023 for EAC and EAIC and said resolution has not since been revoked, amended or repealed:

RESOLVED, that the signature of an individual named above and the seal of the Company may be affixed to any such power of attorney or any certificate relating thereto by facsimile, and any such power of attorney or certificate bearing such facsimile signature or seal shall be valid and binding upon the Company in the future with respect to any bond or undertaking to which it is attached.

IN WITNESS WHEREOF, each Company has caused this instrument to be signed by the following officers, and its corporate seal to be affixed this 25th day of May, 2023.

Endurance Assurance Corporation
By: Richard M Appel
Richard Appel; SVP & Senior Counsel

Endurance American Insurance Company
By: Richard M Appel
Richard Appel; SVP & Senior Counsel

Lexon Insurance Company
By: Richard M Appel
Richard Appel; SVP & Senior Counsel

Bond Safeguard Insurance Company
By: Richard M Appel
Richard Appel; SVP & Senior Counsel

ACKNOWLEDGEMENT

On this 25th day of May, 2023, before me, personally came the above signatories known to me, who being duly sworn, did depose and say that he/they is an officer of each of the Companies; and that he executed said instrument on behalf of each Company by authority of his office under the by-laws of each Company.

By: Amy Taylor
Amy Taylor, Notary Public - My Commission Expires 3/9/27

CERTIFICATE

I, the undersigned Officer of each Company, DO HEREBY CERTIFY that:

1. That the original power of attorney of which the foregoing is a copy was duly executed on behalf of each Company and has not since been revoked, amended or modified; that the undersigned has compared the foregoing copy thereof with the original power of attorney, and that the same is a true and correct copy of the original power of attorney and of the whole thereof;
2. The following are resolutions which were adopted by the board of directors of each Company by unanimous written consent effective 30th day of March, 2023 for BSIC and LIC and the 17th day of May, 2023 for EAC and EAIC and said resolutions have not since been revoked, amended or modified:

   "RESOLVED, that each of the individuals named below is authorized to make, execute, seal and deliver for and on behalf of the Company any and all bonds, undertakings or obligations in surety or co-surety with others: RICHARD M. APPEL, MATTHEW E. CURAN, MARGARET HYLAND, SHARON L. SIMS, CHRISTOPHER L. SPARRO,

   and be it further

   RESOLVED, that each of the individuals named above is authorized to appoint attorneys-in-fact for the purpose of making, executing, sealing and delivering bonds, undertakings or obligations in surety or co-surety for and on behalf of the Company."
3. The undersigned further certifies that the above resolutions are true and correct copies of the resolutions as so recorded and of the whole thereof.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the corporate seal this 13th day of May, 2025.

By:
Daniel S. Lurie, Secretary

NOTICE: U. S. TREASURY DEPARTMENT'S OFFICE OF FOREIGN ASSETS CONTROL (OFAC)

No coverage is provided by this Notice nor can it be construed to replace any provisions of any surety bond or other surety coverage provided. This Notice provides information concerning possible impact on your surety coverage due to directives issued by OFAC. **Please read this Notice carefully.**

The Office of Foreign Assets Control (OFAC) administers and enforces sanctions policy, based on Presidential declarations of "national emergency". OFAC has identified and listed numerous foreign agents, front organizations, terrorists, terrorist organizations, and narcotics traffickers as "Specially Designated Nationals and Blocked Persons". This list can be located on the United States Treasury's website – https://www.treasury.gov/resource-center/sanctions/SDN-List.

In accordance with OFAC regulations, if it is determined that you or any other person or entity claiming the benefits of any coverage has violated U.S. sanctions law or is a Specially Designated National and Blocked Person, as identified by OFAC, any coverage will be considered a blocked or frozen contract and all provisions of any coverage provided are immediately subject to OFAC. When a surety bond or other form of surety coverage is considered to be such a blocked or frozen contract, no payments nor premium refunds may be made without authorization from OFAC. Other limitations on the premiums and payments may also apply.

CERTIFICATE OF LIABILITY INSURANCE

DATE(MM/DD/YYYY): 05/23/2025

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AFFIRMATIVELY OR NEGATIVELY AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW. THIS CERTIFICATE OF INSURANCE DOES NOT CONSTITUTE A CONTRACT BETWEEN THE ISSUING INSURER(S), AUTHORIZED REPRESENTATIVE OR PRODUCER, AND THE CERTIFICATE HOLDER.

IMPORTANT: If the certificate holder is an ADDITIONAL INSURED, the policy(ies) must have ADDITIONAL INSURED provisions or be endorsed. If SUBROGATION IS WAIVED, subject to the terms and conditions of the policy, certain policies may require an endorsement. A statement on this certificate does not confer rights to the certificate holder in lieu of such endorsement(s).

PRODUCER
Aon Risk Services Central, Inc.
Indianapolis IN Office
450 East 96th Street
Suite 275
Indianapolis IN 46240 USA

CONTACT NAME:
PHONE (A/C. No. Ext): (866) 283-7122 **FAX (A/C. No.):** (800) 363-0105
E-MAIL ADDRESS:

INSURER(S) AFFORDING COVERAGE		NAIC #
INSURER A:	Sompo America Insurance Company	11126
INSURER B:		
INSURER C:		
INSURER D:		
INSURER E:		
INSURER F:		

INSURED
KUBOTA Water and Environment U.S.A. Corporation
19910 N Creek Pkwy
Suite 100
Bothell WA 98011 USA

COVERAGES **CERTIFICATE NUMBER:** 570112712037 **REVISION NUMBER:**

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

Limits shown are as requested

INSR LTR	TYPE OF INSURANCE	ADDL INSD	SUBR WVD	POLICY NUMBER	POLICY EFF (MM/DD/YYYY)	POLICY EXP (MM/DD/YYYY)	LIMITS	
A	X COMMERCIAL GENERAL LIABILITY CLAIMS-MADE [ ] OCCUR [X] GEN'L AGGREGATE LIMIT APPLIES PER: POLICY [ ] PRO-JECT [ ] LOC [X] OTHER:			AGM30035808102	04/15/2025	04/15/2026	EACH OCCURRENCE DAMAGE TO RENTED PREMISES (Ea occurrence) MED EXP (Any one person) PERSONAL & ADV INJURY GENERAL AGGREGATE PRODUCTS - COMP/OP AGG	$1,000,000 $500,000 $15,000 $1,000,000 $2,000,000 $2,000,000
A	AUTOMOBILE LIABILITY X ANY AUTO OWNED AUTOS ONLY [ ] SCHEDULED AUTOS HIRED AUTOS ONLY [ ] NON-OWNED AUTOS ONLY			AAM30018567003	04/15/2025	04/15/2026	COMBINED SINGLE LIMIT (Ea accident) BODILY INJURY (Per person) BODILY INJURY (Per accident) PROPERTY DAMAGE (Per accident) Comp./Coll. Deductible	$1,000,000 $1,000
A	X UMBRELLA LIAB [X] OCCUR EXCESS LIAB [ ] CLAIMS-MADE DED [X] RETENTION $10,000			CPU41189L0	04/15/2025	04/15/2026	EACH OCCURRENCE AGGREGATE Personal and advertising injury	$5,000,000 $5,000,000 $5,000,000
A	WORKERS COMPENSATION AND EMPLOYERS' LIABILITY Y/N ANY PROPRIETOR / PARTNER / EXECUTIVE OFFICER/MEMBER EXCLUDED? N (Mandatory in NH) If yes, describe under DESCRIPTION OF OPERATIONS below	N / A		AWM30085270500	04/15/2025	04/15/2026	X PER STATUTE [ ] OTH-ER E.L. EACH ACCIDENT E.L. DISEASE-EA EMPLOYEE E.L. DISEASE-POLICY LIMIT	 $1,000,000 $1,000,000 $1,000,000

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES (ACORD 101, Additional Remarks Schedule, may be attached if more space is required)

Taylor Bay Beach Club HOA Gray & Osborne, Inc., and respective officers, directors, partners, employees, and agents are included as Additional Insured in accordance with the policy provisions of the General Liability policy.

CERTIFICATE HOLDER

Taylor Bay Beach Club HOA
8220 178th Court SW
Longbranch WA 98351 USA

CANCELLATION

SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS.

AUTHORIZED REPRESENTATIVE

Aon Risk Services Central, Inc.

Holder Identifier :

Certificate No : 570112712037

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SOMPO

SCHEDULE OF UNDERLYING INSURANCE

Policy Number: CPU41189L0

UNDERLYING INSURER	TYPE OF COVERAGE	LIMITS OF LIABILITY
Company: SOMPO AMERICA INSURANCE COMPANY Policy No: AGM30035808102 Effective Date: 04/15/25 Expiration Date: 04/15/26 Retroactive Date:	**COMMERCIAL GENERAL LIABILITY** X **Occurrence** ____ **Claims-Made**	$ 1,000,000 Each Occurrence $ 2,000,000 General Aggregate $ 2,000,000 Products-Completed Operations Aggregate $ 1,000,000 Personal Injury and Advertising Injury (Any one person or organization)
Company: SOMPO AMERICA INSURANCE COMPANY Policy No: AAM30018567003 Effective Date: 04/15/25 Expiration Date: 04/15/26	**COMMERCIAL AUTO LIABILITY**	Bodily Injury Liability Each Person Each Accident Property Damage Liability Each Accident Garage Aggregate Limit For Other Than Autos (if applicable) $ 1,000,000 Each Accident Combined Single Limit
Company: SOMPO AMERICA INSURANCE COMPANY Policy No: AWM30085270500 Effective Date: 04/15/25 Expiration Date: 04/15/26	**EMPLOYERS' LIABILITY***** Bodily Injury by Accident $ 1,000,000 Each Accident*** Bodily Injury by Disease $ 1,000,000 Each Employee $ 1,000,000 Aggregate	
	***Except in those jurisdiction where Employer's Liability Coverage afforded by the underlying insurer is by law unlimited.	

CU EXT 002 (Ed. 09/05)
Schedule of Underlying Insurance

SOMPO

SCHEDULE OF UNDERLYING INSURANCE

Policy Number: CPU41189L0

UNDERLYING INSURER	TYPE OF COVERAGE	LIMITS OF LIABILITY
Company SOMPO AMERICA INSURANCE COMPANY Policy No AGM30035808102 Effective Date: 04/15/25 Expiration Date: 04/15/26	Employee Benefits	$1,000,000 Each Employee $1,000,000 Aggregate
Company Policy No Effective Date: Expiration Date:		
Company Policy No Effective Date: Expiration Date:		

PART 4

EJCDC STANDARD GENERAL CONDITIONS

STANDARD GENERAL CONDITIONS OF THE PROCUREMENT CONTRACT

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ARTICLE 1—DEFINITIONS AND TERMINOLOGY

1.01 *Defined Terms*

A. Whenever used in the Procurement Bidding Requirements or Procurement Contract Documents and printed with initial capital letters, the terms listed below will have the meanings indicated, which are applicable to the singular or plural thereof. In addition to terms specifically defined, terms with initial capital letters in the Procurement Contract Documents include references to identified articles and paragraphs, and the titles of other documents or forms.

1. *Addenda*—Written or graphic instruments issued prior to the opening of Bids which clarify, correct, or change the Bidding Requirements or the proposed Procurement Contract Documents.

2. *Application for Payment*—The document prepared by Seller, in a form acceptable to Buyer, to request progress or final payments, and which is to be accompanied by such supporting documentation as is required by the Procurement Contract Documents.

3. *Bid*—An offer or proposal of a prospective Seller submitted on the prescribed form setting forth the prices for the Goods and Special Services to be provided.

4. *Bidder*—An individual or entity that, as a prospective Seller, submits a Bid to Buyer.

5. *Buyer*—The individual or entity purchasing the Goods and Special Services.

6. *Change Directive*—A written directive from Buyer to Seller issued on or after the Effective Date of the Procurement Contract, ordering an addition, deletion, or revision in the Goods and Special Services.

7. *Change Order*—A document which is signed by Seller and Buyer and authorizes an addition, deletion, or revision to the Procurement Contract Documents or an adjustment in the Procurement Contract Price or the Procurement Contract Times, issued on or after the Effective Date of the Procurement Contract. Change Orders may be the result of mutual agreement by Buyer and Seller, or of resolution of a Claim.

8. *Claim*—A demand or assertion by Buyer or Seller seeking an adjustment of Procurement Contract Price or Procurement Contract Times, or both, or other relief with respect to the terms of the Procurement Contract. A demand for money or services by a third party is not a Claim.

9. *Contractor/Assignee*—A construction contractor with which Project Owner enters into a construction contract, and to which Project Owner, as initial Buyer, assigns this Procurement Contract.

10. *Effective Date of the Procurement Contract*—The date indicated in the Procurement Agreement on which the Procurement Contract becomes effective.

11. *Electronic Document*—Any Project-related correspondence, attachments to correspondence, data, documents, drawings, information, or graphics, including but not limited to Shop Drawings and other Submittals, that are in an electronic or digital format.

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12. *Electronic Means*—Electronic mail (e-mail), upload/download from a secure Project website, or other communications methods that allow: the transmission or communication of Electronic Documents; the documentation of transmissions, including sending and receipt; printing of the transmitted Electronic Document by the recipient; the storage and archiving of the Electronic Document by sender and recipient; and the use by recipient of the Electronic Document for purposes permitted by this Procurement Contract. Electronic Means does not include the use of text messaging, or of Facebook, Twitter, Instagram, or similar social media services for transmission of Electronic Documents.

13. *Engineer*—The individual or entity designated as such in the Procurement Agreement.

14. *Field Order*—A written order issued by Engineer which requires minor changes in the Goods or Special Services, but which does not involve a change in the Procurement Contract Price or Procurement Contract Times.

15. *Goods*—The tangible and movable personal property that is described in the Procurement Contract Documents, regardless of whether the property is to be later attached to realty.

16. *Goods and Special Services*—The full scope of materials, equipment, other items, and services to be furnished by Seller, including Goods, as defined herein, and Special Services, if any, as defined herein. This term refers to both the Goods and the Special Services, or to either the Goods or the Special Services, and to any portion of the Goods or the Special Services, as the context requires.

17. *Laws and Regulations; Laws or Regulations*—Any and all applicable laws, statutes, rules, regulations, ordinances, codes, and binding decrees, resolutions, and orders of any and all governmental bodies, agencies, authorities, and courts having jurisdiction.

18. *Milestone*—A principal event specified in the Procurement Contract that Seller must attain by the date or within the number of days indicated, including but not limited to the delivery of the Goods and the furnishing of Special Services.

19. *Notice of Award*—The written notice, by Buyer to a Bidder, of Buyer's acceptance of the Bid.

20. *Point of Destination*—The specific address of the location where delivery of the Goods will be made, as stated in the Procurement Agreement.

21. *Procurement Agreement*—The written instrument, executed by Buyer and Seller, that sets forth the Procurement Contract Price and Procurement Contract Times, identifies the parties and the Engineer, and designates the specific items that are Procurement Contract Documents.

22. *Procurement Bidding Documents*—The Procurement Bidding Requirements and the proposed Procurement Contract Documents (including all Addenda).

23. *Procurement Bidding Requirements*—The advertisement or invitation to bid, Instructions to Bidders, Bid security of acceptable form, if any, and Bid Form with any supplements.

24. *Procurement Contract*—The entire and integrated written agreement between Buyer and Seller concerning the Goods and Special Services.

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25. *Procurement Contract Documents*—Those items so designated in the Procurement Agreement, and which together comprise the Procurement Contract. Shop Drawings and other Seller submittals are not Procurement Contract Documents, even if accepted, reviewed, or approved by Engineer or Buyer.

26. *Procurement Contract Price*—The money that Buyer has agreed to pay Seller for furnishing the Goods and Special Services in accordance with the Procurement Contract Documents.

27. *Procurement Contract Times*—The times stated in the Procurement Agreement by which the Goods must be delivered, Special Services must be furnished, and other Milestones must be attained.

28. *Procurement Drawings*—That part of the Procurement Contract Documents prepared or approved by Engineer which graphically shows the scope, extent, and character of the Goods and Special Services to be furnished by Seller. Shop Drawings and other Seller submittals are not Procurement Drawings as so defined.

29. *Procurement Specifications*—That part of the Procurement Contract Documents consisting of written requirements for materials, equipment, systems, standards and workmanship as applied to the furnishing of the Goods and Special Services, and certain administrative requirements and procedural matters applicable thereto.

30. *Project*—The total undertaking to be accomplished for Project Owner by engineers, contractors, and others, including planning, study, design, construction, testing, commissioning, and start-up, and of which the Goods and Special Services are a part.

31. *Project Owner*—The entity that has retained (or will retain) engineers, contractors, and others for the planning, study, design, construction, testing, commissioning, and start-up of facilities and improvements. As of the Effective Date of the Procurement Contract, the Project Owner is the Buyer.

32. *Samples*—Physical examples of materials, equipment, or workmanship that are representative of some portion of the Goods and Special Services and which establish the standards by which such portion of the Goods and Special Services will be judged.

33. *Schedule of Submittals*—A schedule, prepared and maintained by Seller, of required Submittals and the time requirements for Engineer's review of the Submittals.

34. *Seller*—The individual or entity furnishing the Goods and Special Services.

35. *Shop Drawings*—All drawings, diagrams, illustrations, schedules, and other data or information which are specifically prepared or assembled by or for Seller and submitted by Seller to illustrate some portion of the Goods and Special Services. Shop Drawings, whether approved or not, are not Procurement Drawings and are not Procurement Contract Documents.

36. *Special Services*—Services to be performed by Seller (or its agents or subcontractors) in association with the Goods to be furnished by Seller, as required by the Procurement Contract Documents.

37. *Submittal*—A written or graphic document, prepared by or for Seller, which the Procurement Contract Documents require Seller to submit to Engineer, or that is indicated as a Submittal in the Schedule of Submittals accepted by Engineer. Submittals

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may include Shop Drawings and Samples; schedules; product data; sustainable design information; information on special procedures; testing plans; results of tests and evaluations, source quality-control testing and inspections, and field or site quality-control testing and inspections; warranties and certifications; suppliers' instructions and reports; records of delivery of spare parts and tools; operations and maintenance data; record documents; and other such documents required by the Procurement Contract Documents. Submittals, whether or not approved or accepted by Engineer, are not Procurement Contract Documents. Change proposals, Change Orders, Claims, notices, Applications for Payment, and requests for interpretation or clarification are not Submittals.

38. *Successful Bidder*—The Bidder whose Bid the Buyer accepts, and to which Buyer makes an award of the Procurement Contract.

39. *Supplementary Conditions*—The part of the Procurement Contract that amends or supplements these General Conditions.

40. *Unit Price Goods and Special Services*—Goods and Special Services to be paid for on the basis of unit prices (if any).

1.02 *Terminology*

A. The words and terms discussed in Paragraphs 1.02.B and 1.02.C are not defined, but have the indicated meanings when used in the Bidding Requirements or Procurement Contract Documents.

B. *Intent of Certain Terms or Adjectives*

1. The Procurement Contract Documents include the terms "as allowed," "as approved," "as ordered," "as directed" or terms of like effect or import to authorize an exercise of professional judgment by Engineer. In addition, the adjectives "reasonable," "suitable," "acceptable," "proper," "satisfactory," or adjectives of like effect or import are used to describe an action or determination of Engineer as to the Goods and Special Services. It is intended that such exercise of professional judgment, action, or determination will be commercially reasonable and will be solely to evaluate, in general, the Goods and Special Services for compliance with the requirements of and information in the Procurement Contract Documents and conformance with the design concept of the completed Project as a functioning whole, as shown or indicated in the Procurement Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective will not be effective to assign to Engineer any duty or authority to supervise or direct the furnishing of Goods or Special Services or any duty or authority to undertake responsibility contrary to any other provision of the Procurement Contract Documents.

2. The word "non-conforming" when modifying the words "Goods and Special Services," "Goods," or "Special Services," refers to Goods and Special Services that are unsatisfactory, faulty, or deficient in that they:

a. do not conform to or comply with the requirements of the Procurement Contract Documents;

b. do not meet the requirements of any applicable inspection, reference standard, test, or approval referred to in the Procurement Contract Documents; or

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c. in the case of Special Services, have not been completed.

3. The word “receipt” when referring to the Goods, means the physical taking and possession by the Buyer under the conditions specified in Paragraph 9.02.B.2.

4. The word “day” means a calendar day of 24 hours measured from midnight to the next midnight.

5. The word "furnish," when used in connection with the Goods and Special Services means to supply and deliver said Goods to the Point of Destination (or some other specified location) and to perform said Special Services fully, all in accordance with the Procurement Contract Documents.

C. *Procurement Contract Price or Procurement Contract Times*: References to a change in “Procurement Contract Price or Procurement Contract Times” or “Procurement Contract Times or Procurement Contract Price” or similar, indicate that such change applies to (1) Procurement Contract Price, (2) Procurement Contract Times, or (3) both Procurement Contract Price and Procurement Contract Times, as warranted, even if the term “or both” is not expressed.

D. Unless stated otherwise in the Procurement Contract Documents, words or phrases that have a well-known technical or construction industry or trade meaning are used in the Procurement Contract Documents in accordance with such recognized meaning.

ARTICLE 2—PRELIMINARY MATTERS

2.01 *Delivery of Bonds and Evidence of Insurance*

A. When Seller delivers the executed counterparts of the Procurement Agreement to Buyer, the Seller also shall deliver to Buyer the performance bond and payment bond (if the Procurement Contract requires Seller to furnish such bonds).

B. *Evidence of Seller’s Insurance*: When Seller delivers the signed counterparts of the Procurement Agreement to Buyer, the Seller also shall deliver to Buyer, with copies to each additional insured (as identified in the Procurement Contract), the certificates, endorsements, and other evidence of insurance required to be provided by Seller in accordance with Article 5. Evidence of insurance to be obtained at a later date, such as insurance relating to transit or storage of the Goods, will be provided to Buyer at the time of such insurance is obtained.

C. *Evidence of Buyer’s Insurance*: After receipt of the signed counterparts of the Procurement Agreement and all required bonds and insurance documentation, Buyer shall promptly deliver to Seller, with copies to each additional insured (as identified in the Procurement Contract), certificates and other evidence of insurance (if any) required to be provided by Buyer.

2.02 *Copies of Documents*

A. Buyer shall furnish to Seller four printed copies of the Procurement Contract (including one fully executed counterpart of the Procurement Agreement), and one copy in electronic portable document format (PDF). Additional printed copies will be furnished upon request at the cost of reproduction.

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2.03 *Electronic Transmittals*

A. Except as otherwise stated elsewhere in the Procurement Contract, the Buyer, Seller, and Engineer may send, and shall accept, Electronic Documents transmitted by Electronic Means.

B. If the Procurement Contract does not establish protocols for Electronic Means, then Buyer, Seller, and Engineer shall jointly develop such protocols.

C. Subject to any governing protocols for Electronic Means, when transmitting Electronic Documents by Electronic Means, the transmitting party makes no representations as to long-term compatibility, usability, or readability of the Electronic Documents resulting from the recipient's use of software application packages, operating systems, or computer hardware differing from those used in the drafting or transmittal of the Electronic Documents.

2.04 *Preliminary Schedules*

A. Within 15 days after the Effective Date of the Procurement Contract, Seller shall submit to Buyer and Engineer for timely review:

1. a progress schedule of activities, consistent with the Procurement Contract Times, including at a minimum, Shop Drawing and Sample submittals, tests, and deliveries as required by the Procurement Contract Documents.

a. The progress schedule will be acceptable to Buyer and Engineer if it provides an orderly progression of the Submittals, tests, and deliveries to completion within the specified Milestones of the Procurement Contract Times.

b. Such acceptance will not impose on Buyer or Engineer responsibility for the progress schedule, for sequencing, scheduling, or progress of Seller's performance of its obligations under the Procurement Contract, nor interfere with or relieve Seller from Seller's full responsibility therefor.

c. Such acceptance will not be deemed as an acknowledgment of the reasonableness and attainability of the schedule.

2. a preliminary schedule of Submittals.

B. No progress payment will be made to Seller until an acceptable progress schedule and acceptable schedule of Submittals are submitted to Buyer and Engineer (and other conditions applicable to progress payments are met).

2.05 *Preliminary Conference*

A. Within 20 days after the Procurement Contract Times start to run, a conference attended by Seller, Buyer, Engineer and others as appropriate will be held to establish a working understanding among the parties as to the Goods and Special Services and to discuss the schedules referred to in Paragraph 2.04.A, procedures for handling Shop Drawings and other Submittals, processing Applications for Payment, and maintaining required records.

2.06 *Safety*

A. Buyer and Seller shall comply with all applicable Laws and Regulations relating to the safety of persons or property, and to the protection of persons or property from damage, injury, or loss.

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B. When Seller's personnel, or the personnel of any subcontractor to Seller, are present at the Point of Destination or any work area or site controlled by Buyer, the Seller shall be responsible for the compliance by such personnel with any applicable requirements of Buyer's safety programs that are made known to Seller.

C. If Buyer or its representatives visit the Seller's manufacturing or storage facilities, for testing, inspection, or other purposes, Seller shall inform Buyer in advance of any safety preparations, standards, or programs with which Buyer and its representatives must comply.

ARTICLE 3—PROCUREMENT CONTRACT DOCUMENTS

3.01 *Intent*

A. The Procurement Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. Any labor, documentation, services, materials, or equipment that may reasonably be inferred from the Procurement Contract Documents or from prevailing custom or trade usage as being required to produce or furnish the indicated Goods and Special Services will be provided, whether or not specifically called for, at no additional cost to Buyer.

C. Unless otherwise stated in the Procurement Contract Documents, if there is a discrepancy between the electronic or digital versions of the Procurement Contract Documents (including any printed copies derived from such electronic or digital versions) and the printed record version, the printed record version will govern.

D. The Procurement Contract supersedes prior negotiations, representations, and agreements, whether written or oral.

E. Engineer will issue clarifications and interpretations of the Procurement Contract Documents, as provided in Paragraph 3.04.

F. Any provision or part of the Procurement Contract Documents held to be void or unenforceable under any Law or Regulation will be deemed stricken, and all remaining provisions will continue to be valid and binding upon Buyer and Seller.

3.02 *Reference Standards*

A. Reference to standards, specifications, manuals, or codes of any technical society, organization, or association, or to Laws and Regulations, whether such reference be specific or by implication, means the standard, specification, manual, code, or Laws and Regulations in effect at the time of opening of Bids (or on the Effective Date of the Procurement Agreement if there were no Bids), except as may be otherwise specifically stated in the Procurement Contract Documents.

B. No provision of any such standard specification, manual, reference standard, or code, and no instruction of a supplier, will be effective to change the duties or responsibilities of Buyer, Seller, or Engineer from those set forth in the part of the Procurement Contract Documents prepared by or for Engineer. No such provision or instruction will be effective to assign to Buyer or Engineer any duty or authority to supervise or direct the performance of Seller's obligations, or any duty or authority to undertake responsibility inconsistent with the provisions of the part of the Procurement Contract Documents prepared by or for Engineer.

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3.03 *Reporting and Resolving Discrepancies*

A. *Reporting Discrepancies*

1. *Seller's Review of Procurement Contract Documents*: If, before or during the performance of Seller's obligations, Seller discovers any conflict, error, ambiguity, or discrepancy within the Procurement Contract Documents, or between the Procurement Contract Documents and (a) any applicable Law or Regulation, (b) actual field conditions, (c) any standard specification, manual, reference standard, or code, or (d) any instruction of any supplier to Seller, then Seller shall promptly report it to Engineer (or if the Procurement Contract is assigned, then directly to Contractor/Assignee) in writing. Seller shall not proceed with the Goods and Special Services affected thereby until the conflict, error, ambiguity, or discrepancy is resolved, by a clarification or interpretation by Engineer (or if the Procurement Contract is assigned, then by Contractor/Assignee) or by an amendment or supplement to the Procurement Contract Documents issued pursuant to Article 11.

2. Seller shall not be liable to Buyer or Engineer for failure to report any conflict, error, ambiguity, or discrepancy in the Procurement Contract Documents unless Seller had actual knowledge thereof.

B. *Resolving Discrepancies*: Except as may be otherwise specifically stated in the Procurement Contract Documents, the provisions of the Procurement Contract Documents will take precedence in resolving any conflict, error, ambiguity, or discrepancy between the provisions of the Procurement Contract Documents and:

1. the provisions of any standard, specification, manual, code, or instruction (whether or not specifically incorporated by reference in the Procurement Contract Documents); or

2. the provisions of any Laws or Regulations applicable to the furnishing of the Goods and Special Services (unless such an interpretation of the provisions of the Procurement Contract Documents would result in violation of such Law or Regulation).

3.04 *Requirements of the Procurement Drawings and Procurement Specifications*

A. During the performance of Seller's obligations and until final payment, Seller and Buyer shall submit to the Engineer all matters in question concerning the requirements of the Procurement Drawings and Procurement Specifications (sometimes referred to as requests for information or interpretation—RFIs), or relating to the acceptability of the Goods and Special Services, as soon as possible after such matters arise. Engineer will be the initial interpreter of the requirements of the Procurement Drawings and Procurement Specifications, and judge of the acceptability of the Goods and Special Services thereunder.

1. After assignment (if any) Seller shall submit such matters directly to Contractor/Assignee for response or administration, and the Procurement Contract provisions in Paragraphs 3.04.B and C will not apply.

B. Engineer will issue with reasonable promptness a written clarification, interpretation, or decision on the issue submitted, and if necessary, initiate an amendment or supplement to the Procurement Drawings or Procurement Specifications. Engineer's written clarification, interpretation, or decision will be consistent with the overall intent of the Procurement Contract Documents, and will be final and binding on Seller and Buyer. If either Buyer or Seller believes that a written clarification or interpretation justifies an adjustment in the

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Procurement Contract Price or Procurement Contract Times, either may make a Claim for such adjustment as provided in Article 12.

C. If a submitted matter in question concerns terms and conditions of the Procurement Contract Documents that do not involve (1) the performance or acceptability of the Goods and Services, (2) the design (as set forth in the Procurement Drawings, Procurement Specifications, or otherwise), or (3) other engineering or technical matters, then Engineer will promptly give written notice to Buyer and Seller that Engineer is unable to provide a decision or interpretation.

3.05 *Reuse of Documents*

A. Seller and its subcontractors and suppliers shall not:

1. have or acquire any title to or ownership rights in any of the Procurement Drawings, Procurement Specifications, or other documents (or copies of any thereof) prepared by or bearing the seal of Engineer or its consultants, including electronic media editions, or reuse any such Procurement Drawings, Procurement Specifications, other documents, or copies thereof, on extensions of the Project or any other project, without written consent of Buyer and Engineer and specific written verification or adaptation by Engineer; or

2. have or acquire any title or ownership rights in any other Procurement Contract Documents, reuse any such Procurement Contract Documents for any purpose without Buyer's express written consent, or violate any copyrights pertaining to such Procurement Contract Documents.

B. The prohibitions of this Paragraph 3.05 will survive final payment, or termination of the Procurement Contract. Nothing herein precludes Seller from retaining copies of the Procurement Contract Documents for record purposes.

ARTICLE 4—COMMENCEMENT AND SCHEDULE

4.01 *Commencement of Procurement Contract Times*

A. The Procurement Contract Times will commence to run on the Effective Date of the Procurement Contract.

4.02 *Continuing Performance*

A. Seller shall adhere to the progress schedule established in accordance with Paragraph 2.04.A., as duly adjusted, and the Goods will be delivered and the Special Services furnished within the Procurement Contract Times.

B. Seller shall carry on furnishing of the Goods and Special Services and adhere to the progress schedule during all disputes or disagreements with Buyer. No furnishing of Goods and Special Services will be delayed or postponed pending resolution of any disputes or disagreements, except as expressly permitted herein, or as Buyer and Seller may otherwise agree in writing.

4.03 *Adjustments to Progress Schedule*

A. The progress schedule established in accordance with Paragraph 2.04 may be adjusted from time to time as provided below.

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1. Seller shall submit to Buyer for acceptance (to the extent indicated in Paragraph 2.04) proposed adjustments in the progress schedule that will not result in changing the Procurement Contract Times. Such adjustments will comply with any applicable provisions of the Procurement Specifications.

2. Proposed adjustments in the progress schedule that will change the Procurement Contract Times must be submitted in accordance with the requirements of Article 11. Adjustments in Procurement Contract Times may only be made by a Change Order.

4.04 *Delays*

A. If Buyer, Engineer, or anyone for whom Buyer is responsible, delays, disrupts, or interferes with Seller's performance or progress, then Seller shall be entitled to an equitable adjustment in Procurement Contract Price or Procurement Contract Times.

B. Seller shall not be entitled to an adjustment in Procurement Contract Price or Procurement Contract Times for delay, disruption, or interference caused by or within the control of Seller or anyone for whom Seller is responsible.

C. If Seller's performance or progress is delayed, disrupted, or interfered with by unanticipated causes not the fault of and beyond the control of Buyer, Seller, and those for which they are responsible, then Seller shall be entitled to an equitable adjustment in Procurement Contract Times. Such an adjustment will be Seller's sole and exclusive remedy for the delays, disruption, and interference described in this paragraph. Causes of delay, disruption, or interference that may give rise to an adjustment in Procurement Contract Times under this paragraph include but are not limited to the following:

1. severe and unavoidable natural catastrophes such as fires, floods, epidemics, and earthquakes;

2. abnormal weather conditions;

3. inspection delays by governmental authorities, and custom delays;

4. international shipping delays;

5. acts or failures to act of third-party entities; and

6. acts of war or terrorism.

D. *Adjustments of Procurement Contract Times or Procurement Contract Price—General Provisions*: Seller's entitlement to an adjustment of Procurement Contract Times or Procurement Contract Price is limited as follows:

1. Seller's entitlement to an adjustment of the Procurement Contract Times is conditioned on the delay, disruption, or interference adversely affecting an activity on the critical path to completion of Seller's obligations, as of the time of the delay, disruption, or interference.

2. Seller shall not be entitled to an adjustment in Procurement Contract Price for any delay, disruption, or interference if such delay is concurrent with a delay, disruption, or interference caused by or within the control of Seller. Such a concurrent delay by Seller does not preclude an adjustment of Procurement Contract Times to which Seller is otherwise entitled.

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3. Adjustments of Procurement Contract Times or Procurement Contract Price are subject to the provisions of Articles 11 and 12.

E. Each Seller request seeking a delay-related increase in Procurement Contract Times or Procurement Contract Price must be supplemented by supporting data that sets forth in detail the following: (1) the circumstances that form the basis for the requested adjustment; (2) the date upon which each cause of delay, disruption, or interference began to affect Seller's progress; (3) the date upon which each cause of delay, disruption, or interference ceased to affect Seller's progress; (4) the number of days' increase in Procurement Contract Times claimed as a consequence of each such cause of delay, disruption, or interference; and (5) the impact on Procurement Contract Price. Seller shall also furnish such additional supporting documentation as Buyer or Engineer may require including, where appropriate, a revised progress schedule indicating all the activities affected by the delay, disruption, or interference, and an explanation of the effect of the delay, disruption, or interference on the critical path to completion.

ARTICLE 5—BONDS AND INSURANCE

5.01 *Performance, Payment, and Other Bonds*

A. Seller shall furnish a performance bond and a payment bond, each in an amount at least equal to the Procurement Contract Price, as security for the faithful performance and payment of Seller's obligations under the Procurement Contract. These bonds must remain in effect until one year after the date when final payment becomes due or until completion of the correction period specified in Paragraph 9.04, whichever is later, except as provided otherwise by Laws or Regulations, the terms of a prescribed bond form, the Supplementary Conditions, or other provisions of the Procurement Contract.

B. Seller shall also furnish such other bonds (if any) as are required by the Supplementary Conditions or other provisions of the Procurement Contract.

C. All bonds must be in the form included in the Bidding Documents or otherwise specified by Buyer prior to execution of the Procurement Contract, except as provided otherwise by Laws or Regulations, and must be issued and signed by a surety named in "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" as published in Department Circular 570 (as amended and supplemented) by the Bureau of the Fiscal Service, U.S. Department of the Treasury. A bond signed by an agent or attorney-in-fact must be accompanied by a certified copy of that individual's authority to bind the surety. The evidence of authority must show that it is effective on the date the agent or attorney-in-fact signed the accompanying bond.

D. Seller shall obtain the required bonds from surety companies that are duly licensed or authorized, in the state or jurisdiction in which the Project is located, to issue bonds in the required amounts.

E. If the surety on a bond furnished by Seller is declared bankrupt or becomes insolvent, or the surety ceases to meet the requirements above, then Seller shall promptly notify Buyer and Engineer and shall, within 20 days after the event giving rise to such notification, provide another bond and surety, both of which shall comply with the bond and surety requirements of this Procurement Contract.

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F. If Seller has failed to obtain a required bond, Buyer may exercise Buyer's termination rights under Article 14.

G. Upon request to Buyer from any subcontractor, supplier, or other person or entity claiming to have furnished labor, services, materials, or equipment used in the performance of Seller's obligations, Buyer shall provide a copy of the payment bond to such person or entity.

H. Upon request to Seller from any subcontractor, supplier, or other person or entity claiming to have furnished labor, services, materials, or equipment used in the performance of Seller's obligations, Seller shall provide a copy of the payment bond to such person or entity.

5.02 *Insurance*

A. Seller shall provide insurance of the types and coverages and in the amounts stipulated in the Supplementary Conditions.

B. Failure of Buyer to demand certificates of insurance or other evidence of Seller's full compliance with these insurance requirements or failure of Buyer to identify a deficiency in compliance from the evidence provided will not be construed as a waiver of Seller's obligation to maintain such insurance.

C. Upon assignment of this Procurement Contract, Seller shall name the Contractor/Assignee as an additional insured and comply with the written request of Contractor/Assignee to provide evidence of insurance.

D. Buyer does not represent that insurance coverage and limits established in this Procurement Contract necessarily will be adequate to protect Seller.

E. The insurance and insurance limits required herein will not be deemed as a limitation on Seller's liability under the indemnities and other rights granted to Buyer in the Procurement Contract.

5.03 *Surety or Insurance Companies*

A. All bonds and insurance required by the Procurement Contract Documents to be purchased and maintained by Buyer or Seller shall be obtained from surety or insurance companies that are duly licensed or authorized in the jurisdiction in which the Project is located to issue bonds or insurance policies for the limits and coverages so required. Such surety and insurance companies must also meet such additional requirements and qualifications as may be provided in the Supplementary Conditions.

ARTICLE 6—LICENSES AND FEES

6.01 *Intellectual Property and License Fees*

A. Except to the extent stated elsewhere in the Procurement Contract Documents, Seller is not transferring any patent rights, copyrights, or other intellectual property rights for the Goods delivered.

B. To the extent Seller is manufacturing to Buyer's design, Buyer retains all patent rights, copyrights, and other intellectual property rights in such design.

C. If an invention, design, process, product, or device is specified in the Procurement Contract Documents for incorporation in the Goods or for the performance of Special Services, and if, to the actual knowledge of Buyer or Engineer, its use is subject to patent rights, copyrights,

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or other intellectual property rights calling for the payment of a license fee or royalty to others, then the existence of such rights and payment obligations will be disclosed to Seller in the Procurement Contract Documents.

D. Seller shall pay all license fees and royalties and assume all costs incident to the use or the furnishing of the Goods, unless specified otherwise by the Procurement Contract Documents.

6.02 *Seller's Infringement*

A. Subject to Paragraph 6.01, to the fullest extent permitted by Laws and Regulations, Seller shall indemnify and hold harmless Buyer, Engineer, and their officers, directors, members, partners, employees, agents, consultants, contractors, and subcontractors, from and against all claims, costs, losses, damages, and judgments (including but not limited to all reasonable fees and charges of engineers, architects, attorneys and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement or alleged infringement of any patent, copyright, or other intellectual property right by any of the Goods as delivered or Special Services as performed.

B. Buyer will promptly notify Seller in writing of any claim, suit, or threat of suit by a third party for any infringement or alleged infringement of any patent, copyright, or other intellectual property right with respect to the Goods as delivered or Special Services as performed.

C. Seller shall promptly defend or settle the claim or suit. Seller shall have control over such claim or suit, bear all expenses, and satisfy any adverse judgment.

1. If Seller fails to defend such suit or claim after written notice by Buyer, Seller will be bound, in any subsequent suit or claim against Seller by Buyer, by any factual determination in the prior suit or claim.

2. If Buyer fails to provide Seller the opportunity to defend such suit or claim, Buyer shall be barred from any remedy against Seller for such suit or claim.

D. If a determination is made that Seller has infringed upon the intellectual property rights of another, Seller may, at Seller's own expense, obtain the necessary licenses for Buyer's benefit, or replace the Goods and provide related design and construction, consistent with the requirements of the Procurement Contract Documents, to avoid the infringement.

6.03 *Buyer's Infringement*

A. Subject to Paragraph 6.01, and to the fullest extent permitted by Laws and Regulations, Buyer shall be responsible to Seller for any infringement or alleged infringement of any patent, copyright, or other intellectual property right caused by Seller's compliance with the Procurement Drawings or Procurement Specifications, and will reimburse Seller for any license fee or royalties paid by Seller to others if such payment resulted from any invention, design, process, product, or device specified to be furnished or performed in the Procurement Drawings or Procurement Specifications, but not identified as being subject to payment of such license fee or royalty.

B. Seller will promptly notify Buyer in writing of any claim, suit, or threat of suit by a third party for intellectual property infringement arising from Seller's compliance with the Procurement Drawings or Procurement Specifications.

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C. Buyer shall defend or settle the claim or suit. Buyer shall have control over such claim or suit, bear all expenses, and satisfy any adverse judgment.

1. If Buyer fails to defend such suit or claim after written notice by Seller, Buyer will be bound, in any subsequent suit or claim against Buyer by Seller, by any factual determination in the prior suit or claim.

2. If Seller fails to provide Buyer the opportunity to defend such suit or claim, Seller shall be barred from any remedy against Buyer for such suit or claim.

ARTICLE 7—SELLER'S RESPONSIBILITIES

7.01 *Performance of Obligations*

A. Seller shall be solely responsible for the means, methods, techniques, sequences, and procedures necessary to perform its obligations in accordance with the Procurement Contract Documents.

B. Seller shall supervise, inspect, and direct the furnishing of the Goods and Special Services competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform its obligations in accordance with the Procurement Contract Documents.

C. Seller shall coordinate the provision of Special Services to avoid or limit interference or disruption of other activities at the location where the Special Services are to occur, including but not limited to ongoing facility operations and construction activities.

7.02 *Labor, Materials and Equipment*

A. Seller shall provide competent, qualified and trained personnel in all aspects of its performance of the Procurement Contract.

B. All Goods, and all equipment and material incorporated into the Goods, must be as specified, and unless specified otherwise in the Procurement Contract Documents, must be:

1. new, and of good quality;

2. protected, assembled, connected, cleaned, and conditioned in accordance with the original manufacturer's instructions; and

3. shop-assembled to the greatest extent practicable.

7.03 *Laws and Regulations*

A. Seller shall give all notices required by and shall comply with all Laws and Regulations applicable to the performance of its obligations in accordance with the Procurement Contract Documents. Except where otherwise expressly required by such Laws and Regulations, neither Buyer nor Engineer shall be responsible for monitoring Seller's compliance with any Laws or Regulations.

B. If Seller furnishes Goods and Special Services knowing or having reason to know that such furnishing is contrary to Laws or Regulations, Seller shall bear all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such performance. It will not be Seller's responsibility to make certain

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that the Procurement Specifications and Procurement Drawings are in accordance with Laws and Regulations, but this provision will not relieve Seller of Seller's obligations under Paragraph 3.03.

C. Changes in Laws or Regulations not known at the time of opening of Bids (or, on the Effective Date of the Procurement Contract if there were no Bids) that have a direct effect on the cost or time of Seller's performance will be the subject of an adjustment in Procurement Contract Price or Procurement Contract Times. If Buyer and Seller are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment, a Claim may be made therefor as provided in Article 12.

7.04 *"Or Equals"*

A. Whenever an item of material or equipment to be incorporated into the Goods is specified or described in the Procurement Contract Documents by using the names of one or more proprietary items or specific suppliers or manufacturers, the specification or description is intended to establish the type, function, appearance, and quality required. Unless the specification or description contains or is followed by words reading that no like, equivalent, or "or equal" item is permitted, other items of material or equipment or material or equipment of other suppliers or manufacturers may be submitted to Buyer for Engineer's review.

1. If in Engineer's sole discretion, such an item of material or equipment proposed by Seller is functionally equal to that named and sufficiently similar so that no change in related work will be required, it may be considered by Engineer as an "or equal" item.

2. For the purposes of this paragraph, a proposed item of material or equipment may be considered functionally equal to an item so named only if in the exercise of reasonable judgment, Engineer determines that: 1) it is at least equal in quality, durability, appearance, strength, and design characteristics; 2) it will reliably perform at least equally well the function imposed by the design concept of the completed Project as a functioning whole; 3) it has an acceptable record of performance and availability of responsive service; and (4) Seller certifies that if approved: a) there will be no increase in any cost, including capital, installation or operating costs, to Buyer; and b) the proposed item will conform substantially to the detailed requirements of the item named in the Procurement Contract Documents.

B. *Engineer's Evaluation*: Engineer will be allowed a reasonable time within which to evaluate each proposal or Submittal made pursuant to Paragraph 7.04.A. Engineer will be the sole judge of whether to accept or reject such a proposal or Submittal. No "or equal" will be ordered, manufactured or utilized until Engineer's review is complete, which will be evidenced by an approved Shop Drawing. Engineer will advise Buyer and Seller in writing of any negative determination. Notwithstanding Engineer's approval of an "or-equal" item, Seller shall remain obligated to comply with the requirements of the Procurement Contract Documents.

C. *Special Guarantee*: Buyer may require Seller to furnish at Seller's expense a special performance guarantee or other surety with respect to any such proposed "or-equal."

D. *Data*: Seller shall provide all data in support of any such proposed "or equal" at Seller's expense.

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7.05 *Taxes*

A. Seller shall pay all taxes and duties arising out of the sale of the Goods and the performance of Special Services. All taxes and duties are included in the Procurement Contract Price, except as noted in the Supplementary Conditions.

7.06 *Submittals*

A. *Shop Drawing and Sample Requirements*

1. Before submitting a Shop Drawing or Sample, Seller shall:

a. review and coordinate the Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Procurement Contract Documents;

b. determine and verify:

1) all field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect to the Submittal; and

2) the suitability of all materials and equipment offered with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of Seller's obligations.

c. confirm that the Submittal is complete with respect to all related data included in the Submittal.

2. Each Shop Drawing or Sample must bear a stamp or specific written certification that Seller has satisfied its obligations under the Procurement Contract Documents with respect to Seller's review of that Submittal, and that Seller approves the Submittal.

3. With each Shop Drawing or Sample, Seller shall give Engineer specific written notice of any variations that the Submittal may have from the requirements of the Procurement Contract Documents. This notice will be set forth in a written communication separate from the Submittal; and, in addition, in the case of a Shop Drawing by a specific notation made on the Shop Drawing itself.

B. *Submittal Procedures for Shop Drawings and Samples*: Seller shall label and submit Shop Drawings and Samples to Engineer for review and approval in accordance with the accepted Schedule of Submittals.

1. *Shop Drawings*

a. Seller shall submit the number of copies required in the Procurement Specifications.

b. Data shown on the Shop Drawings must be complete with respect to quantities, dimensions, specified performance and design criteria, materials, and similar data to show Engineer the services, materials, and equipment Seller proposes to provide, and to enable Engineer to review the information for the limited purposes required by Paragraph 7.06.C.

2. *Samples*

a. Seller shall submit the number of Samples required in the Procurement Specifications.

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b. Seller shall clearly identify each Sample as to material, supplier, pertinent data such as catalog numbers, the use for which intended and other data as Engineer may require to enable Engineer to review the Submittal for the limited purposes required by Paragraph 7.06.C.

3. Where a Shop Drawing or Sample is required by the Procurement Contract Documents or the Schedule of Submittals, any related work performed by Seller prior to Engineer's review and approval of the pertinent Submittal will be at the sole expense and responsibility of Seller.

C. *Engineer's Review of Shop Drawings and Samples*

1. Engineer will provide timely review of Shop Drawings and Samples in accordance with the accepted Schedule of Submittals. Engineer's review and approval will be only to determine if the items covered by the Submittals will, after installation or incorporation in the Goods, comply with the requirements of the Procurement Contract Documents, and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Procurement Contract Documents.

2. Engineer's review and approval will not extend to means, methods, techniques, sequences, or procedures of construction, manufacturing, fabrication, installation, or shipping, or to safety precautions or programs incident thereto.

3. Engineer's review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.

4. Engineer's review and approval of a Shop Drawing or Sample will not relieve Seller from responsibility for any variation from the requirements of the Procurement Contract Documents unless Seller has complied with the requirements of Paragraph 7.06.A.3 and Engineer has given written approval of each such variation by specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample. Engineer will document any such approved variation from the requirements of the Procurement Contract Documents in a Field Order or other appropriate Procurement Contract modification.

5. Engineer's review and approval of a Shop Drawing or Sample will not relieve Seller from responsibility for complying with the requirements of Paragraphs 7.06.A and B.

6. Engineer's review and approval of a Shop Drawing or Sample, or of a variation from the requirements of the Procurement Contract Documents, will not, under any circumstances, change the Procurement Contract Times or Procurement Contract Price, unless such changes are included in a Change Order.

7. Neither Engineer's receipt, review, acceptance or approval of a Shop Drawing or Sample will result in such item becoming a Procurement Contract Document.

8. Seller shall furnish Goods that comply with the requirements and commitments set forth in approved Shop Drawings and Samples, subject to the provisions of Paragraph 7.06.C.4.

D. *Resubmittal Procedures for Shop Drawings and Samples*

1. Seller shall make corrections required by Engineer and shall return the required number of corrected copies of Shop Drawings and submit, as required, new Samples for review

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and approval. Seller shall direct specific attention in writing to revisions other than the corrections called for by Engineer on previous Submittals.

2. Seller shall furnish required Shop Drawing and Sample Submittals with sufficient information and accuracy to obtain required approval of an item with no more than two resubmittals. Engineer will record Engineer's time for reviewing a third or subsequent resubmittal of a Shop Drawing or Sample, and Seller shall be responsible for Engineer's charges to Buyer for such time. Buyer may impose a set-off against payments due Seller to secure reimbursement for such charges.

3. If Seller requests a change of a previously approved Shop Drawing or Sample, Seller shall be responsible for Engineer's charges to Buyer for its review time, and Buyer may impose a set-off against payments due Seller to secure reimbursement for such charges, unless the need for such change is beyond the control of Seller.

E. *Submittals Other than Shop Drawings and Samples*

1. The following provisions apply to all Submittals other than Shop Drawings and Samples:

a. Seller shall submit all such Submittals to the Engineer in accordance with the schedule of Submittals and pursuant to the applicable terms of the Procurement Contract Documents.

b. Engineer will provide timely review of all such Submittals in accordance with the schedule of Submittals and return such Submittals with a notation of either Accepted or Not Accepted. Any such Submittal that is not returned within the time established in the schedule of Submittals will be deemed accepted.

c. Engineer's review will be only to determine if the Submittal is acceptable under the requirements of the Procurement Contract Documents as to general form and content of the Submittal.

d. If any such Submittal is not accepted, Seller shall confer with Engineer regarding the reason for the non-acceptance, and resubmit an acceptable document.

2. Procedures for the submittal and acceptance of the Progress Schedule, the Schedule of Submittals, and the Schedule of Values are set forth in Paragraphs 2.04 and 2.05.

7.07 *Indemnification*

A. To the fullest extent permitted by Laws and Regulations, Seller shall indemnify and hold harmless Buyer, Engineer, Project Owner, and any assignee of Buyer, including Contractor/Assignee, and their officers, directors, members, partners, employees, agents, consultants, contractors, and subcontractors, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to the performance of Seller's obligations under the Procurement Contract, provided that any such claim, cost, loss, or damage is attributable to bodily injury, sickness, disease, or death, or to injury to or destruction of tangible property (other than the Goods themselves), including the loss of use resulting therefrom, but only to the extent caused by any negligent act or omission of Seller, or any individual or entity directly or indirectly employed by Seller or anyone for whose acts Seller may be liable.

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B. In any and all claims against Buyer, Engineer, Project Owner, or any assignee of Buyer, including Contractor/Assignee, or their officers, directors, members, partners, employees, agents, consultants, contractors, or subcontractors, by any employee (or the survivor or personal representative of such employee) of Seller, any subcontractor, any supplier, or any individual or entity directly or indirectly employed by any of them to furnish any of the Goods and Special Services, or anyone for whose acts any of them may be liable, the indemnification obligation under Paragraph 7.07.A will not be limited in any way by any limitation on the amount or type of damages, compensation, or benefits payable by or for Seller or any such subcontractor, supplier, or other individual or entity under workers' compensation acts, disability benefit acts, or other employee benefit acts.

7.08 *Concerning Subcontractors and Suppliers*

A. Seller may retain subcontractors and suppliers for the performance of parts of the furnishing of the Goods and Special Services. The Seller's retention of a subcontractor or supplier will not relieve Seller's obligation to Buyer to perform and complete the furnishing the Goods and Special Services in accordance with the Procurement Contract Documents.

ARTICLE 8—SHIPPING AND DELIVERY

8.01 *Shipping*

A. Seller shall select the carrier and bear all costs of packaging, transportation, insurance, special handling, and all other costs associated with shipment and delivery.

8.02 *Delivery*

A. Seller shall deliver the Goods free on board (FOB) to the Point of Destination, freight prepaid, in accordance with the Procurement Contract Times set forth in the Procurement Agreement, or other date agreed to by Buyer and Seller.

B. At least 10 days before shipment, Seller shall provide written notice to Buyer of the manner of shipment and the anticipated delivery date. The notice must also include any instructions concerning special equipment or services required at the Point of Destination to unload and care for the Goods. Seller shall also require the carrier to give Buyer at least 24 hours' notice by telephone prior to the anticipated time of delivery.

C. Buyer will be responsible and bear all costs for unloading the Goods from carrier.

D. Buyer will assure that adequate facilities are available to receive delivery of the Goods at the time established for delivery, or on another date agreed to by Buyer and Seller.

E. No partial deliveries will be allowed, unless permitted or required by the Procurement Contract Documents or agreed to in writing by Buyer.

F. Provisions governing inspection on delivery are set forth in Paragraph 9.02.

8.03 *Risk of Loss*

A. Risk of loss and insurable interests transfer from Seller to Buyer upon Buyer's receipt of the Goods.

B. Notwithstanding the provisions of Paragraph 8.03.A, if Buyer rejects the Goods as non-conforming, the risk of loss on such Goods will remain with Seller until Seller corrects the non-conformity or Buyer accepts the Goods. If rejected Goods remain at the Point of

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Destination pending modification and acceptance, then Seller shall be responsible for arranging adequate protection and maintenance of the Goods at Seller's expense.

ARTICLE 9—BUYER'S RIGHTS

9.01 *Seller's Warranties and Guarantees*

A. Seller warrants and guarantees to Buyer that the title to the Goods conveyed will be proper, its transfer rightful, and free from any security interest, lien, or other encumbrance. Seller shall defend, indemnify, and hold Buyer harmless against any liens, claims, or demands contesting or affecting title of the Goods conveyed.

B. Seller warrants and guarantees to Buyer that all Goods and Special Services will conform with the Procurement Contract Documents, and with the standards established by any Samples approved by Engineer. Engineer shall be entitled to rely on Seller's warranty and guarantee. If the Procurement Contract Documents do not otherwise specify the characteristics or the quality of the Goods, the Goods must comply with the requirements of Paragraph 7.02.B.

C. Seller's warranty and guarantee hereunder excludes defects or damage caused by:

1. abuse, improper modification, improper maintenance, or improper operation by persons other than Seller;

2. excessive corrosion or chemical attack, unless corrosive or chemically-damaging conditions were disclosed by Buyer in the Procurement Contract Documents and the Procurement Contract Documents required the Goods to withstand such conditions;

3. use in a manner contrary to Seller's written instructions for installation, operation, and maintenance; or

4. normal wear and tear under normal usage.

D. Seller's obligation to furnish the Goods and Special Services in accordance with the Procurement Contract Documents will be absolute. None of the following will constitute an acceptance of Goods and Special Services that are non-conforming, or a release of Seller's obligation to furnish the Goods and Special Services in accordance with the Procurement Contract Documents:

1. observations by Buyer, Engineer, or Project Owner;

2. recommendation by Engineer or payment by Buyer of any progress or final payment;

3. use of the Goods by Buyer or Project Owner;

4. any acceptance by Buyer, Engineer, or Project Owner, or any failure to do so;

5. the end of the correction period established in Paragraph 9.04;

6. the issuance of a notice of acceptance;

7. any inspection, test or approval by others; or

8. any correction of non-conforming Goods and Special Services by Buyer or Project Owner.

E. Buyer shall promptly notify Seller of any breach of Seller's warranties or guarantees.

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9.02 *Inspections and Testing*

A. *General Provisions*

1. The Procurement Contract Documents specify required inspections and tests. Buyer shall have the right to perform, or cause to be performed, reasonable inspections and require reasonable tests of the Goods at Seller's facility, and at the Point of Destination. Seller shall allow Buyer a reasonable time to perform such inspections or tests.

2. Seller shall reimburse Buyer for all expenses, except for travel, lodging, and subsistence expenses of Buyer's and Engineer's representatives, for inspections and tests specified in the Procurement Contract Documents. If as the result of any such specified testing the Goods are determined to be non-conforming, then Seller shall also bear the travel, lodging, and subsistence expenses of Buyer's and Engineer's representatives, and all expenses of re-inspection or retesting.

3. Buyer shall bear all expenses of inspections and tests that are not specified in the Procurement Contract Documents (other than any re-inspection or retesting resulting from a determination of non-conformity, as set forth in Paragraph 9.03); provided, however, that if as the result of any such non-specified inspections or testing the Goods are determined to be non-conforming, then Seller shall bear all expenses of such inspections and testing, and of any necessary re-inspection and retesting.

4. Seller shall provide Buyer timely written notice of the readiness of the Goods for all inspections, tests, or approvals which the Procurement Contract Documents specify are to be observed by Buyer prior to shipment.

5. Buyer will give Seller timely notice of all specified tests, inspections, and approvals of the Goods which are to be conducted at the Point of Destination, and a representative of Seller will attend such tests, inspections, and approvals.

6. If, on the basis of inspections or testing, the Goods appear to be conforming, Buyer will give Seller prompt notice thereof. If on the basis of inspections or testing, the Goods appear to be non-conforming, Buyer will give Seller prompt notice thereof and will advise Seller of the remedy Buyer elects under the provisions of Paragraph 9.03.

7. Neither payments made by Buyer to Seller prior to any tests or inspections, nor any tests or inspections, will constitute acceptance of non-conforming Goods, or prejudice Buyer's rights under the Procurement Contract.

B. *Visual Inspection on Delivery*

1. Buyer will visually inspect the Goods upon delivery solely for purposes of identifying the Goods, general verification of quantities, and observation of apparent condition. Such visual inspection will not be construed as final or as receipt of any Goods and Special Services that, as a result of subsequent inspections and tests, are determined to be non-conforming.

2. If, on the basis of the visual inspection specified in Paragraph 9.02.B.1, the Goods appear to comply with the requirements of the Procurement Contract Documents as to quantities and condition, then within 10 days of delivery Buyer shall issue to Seller Buyer's acknowledgment of the receipt of Goods.

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C. *Final Inspection*

1. After all of the Goods have been incorporated into the Project, tested in accordance with such testing requirements as are specified, and are functioning as required, and Seller has performed and completed all Special Services, Buyer will make a final inspection.

2. If, on the basis of the final inspection, Buyer determines that the Goods and Special Services are conforming, Buyer's notice thereof will constitute Buyer's acceptance of the Goods and Special Services, subject to any limitations stated in the notice.

3. If, on the basis of the final inspection, the Goods and Special Services are non-conforming, Buyer will identify the non-conformity in writing.

9.03 *Non-Conforming Goods and Special Services*

A. If, on the basis of inspections and testing prior to delivery, the Goods and Special Services are found to be non-conforming, or if at any time after Buyer has acknowledged receipt of delivery and before the expiration of the correction period described in Paragraph 9.04, Buyer determines that the Goods and Special Services are non-conforming, then Seller shall promptly, without cost to Buyer and in response to written instructions from Buyer, either correct such non-conforming Goods and Special Services, or, if Goods are rejected by Buyer, remove and replace the non-conforming Goods with conforming Goods, including all work required for reinstallation.

B. *Buyer's Rejection of Non-Conforming Goods*

1. If Buyer elects to reject the Goods in whole or in part, Buyer's notice to Seller will describe in sufficient detail the non-conforming aspect of the Goods. If Goods have been delivered to Buyer, Seller shall promptly, and within the Procurement Contract Times, remove and replace the rejected Goods.

2. Seller shall bear all costs, losses and damages attributable to the removal, replacement, reinspection, and retesting of the non-conforming Goods.

3. Upon rejection of the Goods, Buyer retains a security interest in the Goods to the extent of any payments made and expenses incurred in their testing and inspection.

C. *Buyer's Rejection of Non-Conforming Special Services*

1. If at any time Buyer elects to reject the Special Services in whole or in part, Buyer's notice to Seller will describe in sufficient detail the non-conforming aspect of the Special Services.

2. Seller shall promptly provide conforming Special Services acceptable to Buyer.

3. If Seller fails to provide conforming Special Services, Buyer may remove the Special Services from the scope of the Procurement Contract, and equitably reduce the Procurement Contract Price.

D. *Remedying Non-Conforming Goods*: If Buyer elects to permit the Seller to modify the Goods to correct the non-conformance, then Seller shall promptly provide a schedule for such modifications and shall make the Goods conforming within a reasonable time.

E. *Buyer's Acceptance of Non-Conforming Goods*: Instead of requiring correction or removal and replacement of non-conforming Goods discovered either before or after final payment,

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Buyer may accept the non-conforming Goods. Seller shall bear all reasonable costs, losses, and damages attributable to Buyer's evaluation of and determination to accept such non-conforming Goods.

F. *Seller Obligations*: Seller shall pay all claims, costs, losses, and damages, including but not limited to all fees and charges for re-inspection, retesting and for any engineers, architects, attorneys and other professionals, and all court or arbitration or other dispute resolution costs arising out of or relating to the non-conforming Goods and Special Services. Seller's obligations will include the costs of the correction or removal and replacement of the non-conforming Goods and the replacement of property of Buyer and others destroyed by the correction or removal and replacement of the non-conforming Goods, and obtaining conforming Special Services from others.

G. *Buyer's Rejection of Conforming Goods*: If Buyer asserts that Goods and Special Services are non-conforming and such Goods and Special Services are determined to be conforming, or if Buyer rejects as non-conforming Goods and Special Services that are later determined to be conforming, then Seller shall be entitled to reimbursement from Buyer of costs incurred by Seller in inspecting, testing, correcting, removing, or replacing the conforming Goods and Special Services, including but not limited to fees and charges of engineers, architects, attorneys and other professionals, and all court or arbitration or other dispute resolution costs associated with the incorrect assertion of non-conformance or rejection of conforming Goods and Special Services.

9.04 *Correction Period*

A. Seller's responsibility for correcting all non-conformities in the Goods and Special Services will extend for a period of one year after the acceptance of the Goods and Special Services in accordance with Paragraph 9.02.C.2.

B. Where non-conforming Goods and Services (and damage to other work resulting therefrom) have been corrected or removed and replaced under this paragraph, the correction period hereunder with respect to such Goods and Services will be extended for an additional period of one year after such correction or removal and replacement has been satisfactorily completed.

C. Seller's obligations under this paragraph are in addition to all other obligations and warranties. The provisions of this paragraph may not be construed as a substitute for, or a waiver of, the provisions of any applicable statute of limitation or repose.

ARTICLE 10—ENGINEER'S STATUS

10.01 *Engineer's Role Defined*

A. Engineer will be Buyer's representative until assignment (if any) of the Procurement Contract.

B. The duties and responsibilities and the limitations of authority of Engineer prior to assignment, if any, of the Procurement Contract, are set forth in the Procurement Contract Documents.

C. Engineer's responsibilities, if any, after an assignment (if any) of the Procurement Contract, are set forth in the Procurement Agreement.

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10.02 *Duties and Responsibilities; Authority; Limitations*

A. As set forth in Article 3, Engineer will be the initial interpreter of the Procurement Contract Documents and judge of the acceptability of the Goods and Special Services, and will issue clarifications, interpretations, and decisions regarding such issues.

B. Acting on behalf of Buyer under the provisions of Article 9, Engineer has the authority to disapprove or reject Goods and Special Services that Engineer believes to be non-conforming. Engineer also has the authority to require special inspection or testing of the Goods or Special Services as provided in Paragraph 9.02, whether or not the Goods are fabricated or installed, or the Special Services are completed.

C. Engineer may authorize minor deviations or variations in the Procurement Contract Documents by: 1) written approval of specific variations set forth in Shop Drawings when Seller has duly noted such variations as required in Paragraph 7.06.A.3, or 2) a Field Order.

D. As set forth in Article 12, Engineer will review Claims, and render decisions on Claims.

E. In rendering any interpretations, clarifications, reviews, decisions, disapprovals, acceptances, rejections, authorizations, and judgments, Engineer will not show partiality to Buyer or Seller. Engineer will not be liable to Buyer, Seller, or others in connection with any interpretations, clarifications, reviews, decisions, disapprovals, acceptances, rejections, authorizations, or judgments conducted or rendered by Engineer in good faith.

F. Engineer will not supervise, direct, control, or have authority over or be responsible for the means, methods, techniques, sequences, or procedures used by Seller to perform its obligations under this Procurement Contract, or the safety precautions and programs incident thereto, or for any failure of Seller to comply with Laws and Regulations applicable to the performance of its obligations. Engineer will not be responsible for Seller's failure to furnish the Goods and Special Services in accordance with the Procurement Contract Documents.

ARTICLE 11—CHANGES

11.01 *Amending and Supplementing the Procurement Contract*

A. The Procurement Contract may be amended or supplemented by a Change Order, a Change Directive, or a Field Order.

B. If an amendment or supplement to the Procurement Contract includes a change in the Procurement Contract Price or the Procurement Contract Times, such amendment or supplement must be set forth in a Change Order.

C. All changes to the Procurement Contract that involve (1) the conformance or acceptability of the Goods and Special Services, (2) the design (as set forth in the Procurement Drawings, Procurement Specifications, or otherwise), or (3) other engineering or technical matters, must be supported by Engineer's recommendation. Buyer and Seller may amend other terms and conditions of the Procurement Contract without the recommendation of the Engineer.

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11.02 *Change Orders*

A. Buyer and Seller shall execute appropriate Change Orders covering:

1. Changes in Procurement Contract Price or Procurement Contract Times which are agreed to by the parties, including any undisputed sum or amount of time for Goods and Special Services furnished in accordance with a Change Directive;

2. Changes in Procurement Contract Price resulting from a Buyer set-off, unless Seller has duly contested such set-off;

3. Changes in the Goods and Special Services which are: (a) ordered by Buyer pursuant to Paragraph 11.05, (b) required because of Buyer's acceptance of non-conforming Goods and Services under Paragraph 9.03 or (c) agreed to by the parties, subject to the need for Engineer's recommendation if the change in the Goods and Special Services involves the design (as set forth in the Procurement Drawings, Procurement Specifications, or otherwise) or other engineering or technical matters; and

4. Changes that embody the substance of any final and binding results under: Paragraph 11.03.B, resolving the impact of a Change Directive; Article 12, Claims; and similar provisions.

B. If Buyer or Seller refuses to execute a Change Order that is required to be executed under the terms of Paragraph 11.02.A, it will be deemed to be of full force and effect, as if fully executed.

11.03 *Change Directives*

A. A Change Directive will not change the Procurement Contract Price or the Procurement Contract Times but is evidence that the parties expect that the modification ordered or documented by a Change Directive will be incorporated in a subsequently issued Change Order, following negotiations by the parties as to the Change Directive's effect, if any, on the Procurement Contract Price and Procurement Contract Times; or, if negotiations are unsuccessful, by a determination under the terms of the Procurement Contract Documents governing adjustments, expressly including Paragraph 11.08 regarding change of Procurement Contract Price.

B. If Buyer has issued a Change Directive and Buyer or Seller believes that an adjustment in Procurement Contract Times or Procurement Contract Price is necessary, then such party shall submit a Claim seeking such an adjustment no later than 30 days after the completion of the Goods and Services set out in the Change Directive.

11.04 *Field Orders*

A. Engineer may authorize minor changes in the Goods and Services if the changes do not involve an adjustment in the Procurement Contract Price or the Procurement Contract Times and are compatible with the design concept as indicated by the Procurement Contract Documents. Such changes will be accomplished by a Field Order and will be binding on Buyer and also on Seller, which shall perform the Goods and Special Services involved promptly.

B. If Seller believes that a Field Order justifies an adjustment in the Procurement Contract Price or Procurement Contract Times, then before proceeding with the Goods and Special Services at issue, Seller shall submit a Claim as provided herein.

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11.05 *Buyer-Authorized Changes in the Goods and Special Services*

A. Without invalidating the Procurement Contract and without notice to any surety, Buyer may, at any time or from time to time, order additions, deletions, or revisions in the Goods and Special Services. Changes involving the design (as set forth in the Procurement Drawings, Procurement Specifications, or otherwise) or other engineering or technical matters will be supported by Engineer's recommendation.

B. Such changes in the Goods and Special Services may be accomplished by a Change Order, if Buyer and Seller have agreed as to the effect, if any, of the changes on Procurement Contract Times or Procurement Contract Price; or by a Change Directive. Upon receipt of any such document, Seller shall promptly proceed with the Goods and Special Services involved; or, in the case of a deletion in the Goods and Special Services, promptly cease activities with respect to such deletion. Added or revised Goods and Special Services must be performed under the applicable conditions of the Procurement Contract Documents.

11.06 *Buyer's Contingency Allowance*

A. The Buyer's Contingency Allowance, if any such is set forth in the Procurement Agreement, is for the sole use of Buyer to cover unanticipated costs.

B. If Buyer exercises its unilateral right to use all or a portion of the Buyer's Contingency Allowance, Buyer will issue a written directive that documents the costs to which the allowance is applied, Seller's entitlement to compensation, and the consequent reduction in such allowance.

C. Prior to final payment, the Total Price, as set forth in the Procurement Agreement, will be duly adjusted to account for any unused portion of the Buyer's Contingency Allowance.

D. The Procurement Agreement, Article 5, addresses the impact on Buyer's Contingency Allowance of an assignment of the Procurement Contract.

11.07 *Unauthorized Changes in the Goods and Special Services*

A. Seller shall not be entitled to an increase in the Procurement Contract Price or an extension of the Procurement Contract Times with respect to any work performed that is not required by the Procurement Contract Documents, as amended, modified, or supplemented.

11.08 *Change of Procurement Contract Price*

A. The Procurement Contract Price may only be changed by a Change Order. Any Claim for an adjustment of Procurement Contract Price must comply with the provisions of Article 12.

B. An adjustment in the Procurement Contract Price will be determined as follows:

1. For changes in Unit Price Goods and Special Services, by application of the unit prices to the quantities of the items involved;

2. To the extent the cost of the change is not covered by unit prices, then by a mutually agreed lump sum; or

3. To the extent the cost of the change is not covered by unit prices and the parties do not reach mutual agreement to a lump sum, then on the basis of documented costs plus a Seller's fee for overhead and profit of 15%.

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11.09 *Change of Procurement Contract Times*

A. The Procurement Contract Times may only be changed by a Change Order. Any Claim for an adjustment in the Procurement Contract Times must comply with the provisions of Article 12.

11.10 *Notification to Surety*

A. If the provisions of any bond require notice to be given to a surety of any change affecting the general scope of the Goods and Special Services or the provisions of the Procurement Contract (including, but not limited to, Procurement Contract Price or Procurement Contract Times), the giving of any such notice will be Seller's responsibility. The amount of each applicable bond will be adjusted to reflect the effect of any such change.

ARTICLE 12—CLAIMS, DISPUTES, AND DISPUTE RESOLUTION

12.01 *Claims*

A. The parties agree to endeavor to avoid or resolve Claims through direct, good faith discussions and negotiations whenever practicable. Such discussions and negotiations should at the outset address whether the parties mutually agree to suspend the Claims process, including the time periods established in this Paragraph 12.01; if so, a written record of such mutual agreement should be made and jointly executed.

B. Claimant shall deliver to Engineer and the other party to the Procurement Contract written notice of each Claim within 15 days after the occurrence of the event giving rise to the Claim.

C. Claimant shall deliver written supporting data to Engineer and the other party within 45 days after such occurrence unless Engineer allows an additional period of time.

D. Engineer will review each such Claim and render a decision in writing within 30 days after receipt of the last submittal of the claimant or the last submittal of the opposing party, if any.

E. If Engineer does not render a formal written decision on a Claim within the time stated in Paragraph 12.01.D., Engineer shall be deemed to have issued a decision denying the Claim in its entirety 31 days after receipt of the last submittal of the claimant or the last submittal of the opposing party, if any.

F. The rendering of a decision by Engineer pursuant to this Paragraph 12.01 with respect to any such Claim, dispute, or other matter (except any which have been waived by the making or acceptance of final payment) will be a condition precedent to any exercise by Buyer or Seller of such rights or remedies as either may otherwise have under the Procurement Contract Documents or by Laws or Regulations in respect of any such Claim, dispute, or other matter. If the exercise of such rights or remedies will imminently be time-barred, a party may take actions necessary to preserve such rights and remedies notwithstanding the lack of the condition precedent referred to in this paragraph.

G. If a submitted matter in question concerns terms and conditions of the Procurement Contract Documents that do not involve (1) the performance or acceptability of Goods and Special Services under the Procurement Contract Documents, (2) the design (as set forth in the Procurement Drawings, Procurement Specifications, Addenda, or otherwise), or (3) other engineering or technical matters, then Engineer will promptly give written notice to Buyer and Seller that Engineer is unable to provide a decision or interpretation. If Buyer and Seller

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are unable to agree on resolution of such a matter in question, either party may pursue resolution as provided in Paragraph 12.02.

H. Engineer's written decision on such Claim or a decision denying the Claim in its entirety that is deemed to have been issued pursuant to Paragraph 12.01, will be final and binding upon Buyer and Seller 30 days after it is issued unless within 30 days of issuance Buyer or Seller appeals Engineer's decision by initiating the mediation of such Claim in accordance with the dispute resolution procedures set forth in Paragraph 12.02.

I. If Article 12 has been amended to delete the mediation requirement, then Buyer or Seller may appeal Engineer's decision within 30 days of issuance by following the alternative dispute resolution process set forth in Article 12, as amended; or if no such alternative dispute resolution process has been set forth, Buyer or Seller may appeal Engineer's decision by 1) delivering to the other party within 30 days of the date of such decision a written notice of intent to submit the Claim to a court of competent jurisdiction, and 2) within 60 days after the date of such decision instituting a formal proceeding in a court of competent jurisdiction.

J. No Claim for an adjustment in Procurement Contract Price or Procurement Contract Times will be valid if not submitted in accordance with Article 12.

K. The effect on Claims of an assignment of the Procurement Contract by Buyer to a Contractor/Assignee is addressed in the Procurement Agreement, Article 5.

12.02 *Dispute Resolution Method*

A. Either Buyer or Seller may initiate the mediation of (1) any Claim decided in writing by Engineer under Paragraph 12.01 before such decision becomes final and binding, or (2) any other dispute between the parties, including but not limited to any dispute arising after final inspection of the Goods and Services. The mediation will be governed by the Construction Industry Mediation Rules of the American Arbitration Association in effect as of the Effective Date of the Procurement Contract. The request for mediation must be submitted in writing to the American Arbitration Association and the other party to the Procurement Contract. Timely submission of the request will stay Engineer's decision from becoming final and binding.

B. Mediation is a condition precedent to seeking final dispute resolution under Paragraph 12.01.C. Buyer and Seller shall participate in the mediation process in good faith. The process must be concluded within 60 days of filing of the request. The date of termination of the mediation will be determined by application of the mediation rules referenced above.

C. If the mediation process does not result in resolution of the dispute, then Engineer's written Claim decision under Paragraph 12.01.D or a Claim denial pursuant to Paragraph 12.01.E becomes final and binding, or if applicable such other dispute is deemed resolved in favor of respondent, unless, within 30 days after termination of the mediation, Buyer or Seller:

1. elects in writing to invoke any final dispute resolution process provided for in the Supplementary Conditions, or

2. agrees with the other party to submit the Claim or dispute to another final dispute resolution process, or

3. if no final dispute resolution process has been provided for in the Supplementary Conditions, delivers to the other party written notice of the intent to submit the Claim

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or dispute to a court of competent jurisdiction, and within 60 days of the termination of the mediation institutes such formal proceeding.

ARTICLE 13—PAYMENT

13.01 *Applications for Progress Payments*

A. Seller shall submit to Buyer for Engineer's review Applications for Payment filled out and signed by Seller and accompanied by such supporting documentation as is required by the Procurement Contract Documents and also as Buyer or Engineer may reasonably require.

B. The timing and amounts of progress payments will be as stipulated in the Procurement Agreement.

C. Any Application for Payment that is based in whole or in part on the delivery of Goods must be accompanied by a bill of sale, invoice, or other documentation reasonably satisfactory to Buyer warranting that Buyer has rightfully received good title to the Goods from Seller and that, upon payment, the Goods will be free and clear of all liens. Such documentation will include releases and waivers from all parties with viable lien rights.

D. Buyer shall notify Seller promptly of any deficiency in the required documentation.

13.02 *Review of Applications for Progress Payments*

A. *Review of Applications*

1. Engineer will, within 10 days after receipt of each Application for Payment, including each resubmittal, either indicate in writing a recommendation of payment and present the Application to Buyer, or return the Application to Seller indicating in writing Engineer's reasons for refusing to recommend payment.

2. Engineer's recommendation of any payment requested in an Application for Payment will constitute a representation by Engineer to Buyer, based on Engineer's observations of Seller's progress, as an experienced and qualified design professional, and on Engineer's review of the Application for Payment and the accompanying data and schedules, that to the best of Engineer's knowledge, information and belief:

a. the Goods and Special Services or other obligations of Seller have progressed to the point indicated;

b. the quality of the Goods and Special Services or other obligations of Seller are generally in accordance with the Procurement Contract Documents; and

c. the conditions precedent to Seller being entitled to such payment appear to have been fulfilled in so far as it is Engineer's responsibility to observe the Seller's progress.

3. By recommending any such payment Engineer will not thereby be deemed to have represented that:

a. inspections made to check the quality or the quantity of the Goods and Special Services or other obligations of Seller have been exhaustive, extended to every aspect of the Goods and Special Services or other obligations of Seller in progress, or involved detailed inspections of the Goods and Special Services or other

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obligations of Seller beyond the responsibilities specifically assigned to Engineer in the Procurement Contract; or

b. there may not be other matters or issues between the parties that might entitle Seller to be paid additionally by Buyer, or entitle Buyer to withhold payment to Seller.

4. Neither Engineer's review of Seller's progress for the purposes of recommending payments nor Engineer's recommendation of any payment, including final payment, will impose responsibility on Engineer:

a. to supervise, direct, or control the Seller's performance or furnishing of Goods and Special Services or other obligations of Seller; or

b. for the means, methods, techniques, sequences, or procedures of construction, manufacturing, fabrication, installation, or shipping, or the safety precautions and programs incident thereto; or

c. for Seller's failure to comply with Laws and Regulations applicable to Seller's performance under the Procurement Contract; or

d. to make any examination to ascertain how or for what purposes Seller has used the money paid for the Procurement Contract Price; or

e. to determine that title to any of the Goods or component parts have passed to Buyer free and clear of any Liens.

5. Engineer may refuse to recommend the whole or any part of any payment if, in Engineer's opinion, it would be incorrect to make the representations to Buyer stated in Paragraph 13.02.A.2.

6. Engineer will recommend reductions in payment (set-offs) necessary in Engineer's opinion to protect Buyer from loss because:

a. the Goods and Services are non-conforming, requiring correction or replacement;

b. the Procurement Contract Price has been reduced by Change Orders;

c. Buyer has been required to correct non-conforming Goods and Special Services in accordance with Paragraph 9.03.C, or has accepted non-conforming Goods and Special Services pursuant to Paragraph 9.03.E; or

d. Engineer has actual knowledge of the occurrence of any of the events that would constitute a default by Seller and therefore justify termination for cause under the Procurement Contract Documents.

13.03 *Basis and Amount of Progress Payments*

A. The basis and amounts of the progress payments will be as provided in the Procurement Agreement, subject to the provisions of this Article 13 regarding reductions in payment.

13.04 *Suspension of or Reduction in Payment*

A. Buyer may temporarily cease making progress payments, or reduce the amount of a progress payment, even though recommended for payment by Engineer, under the following circumstances:

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1. Buyer has reasonable grounds to conclude that Seller will not furnish the Goods or the Special Services in accordance with the Procurement Contract Documents, and

2. Buyer has requested in writing assurances from Seller that the Goods and Special Services will be delivered or furnished in accordance with the Procurement Contract Documents, and Seller has failed to provide adequate assurances within ten days of Buyer's written request.

3. In addition to any reductions in payment (set-offs) recommended by Engineer, Buyer is entitled to impose a set-off against payment based on any of the following:

    a. claims have been made against Buyer based on Seller's conduct in the performance or furnishing of the Goods and Special Services, or has incurred costs, losses, or damages resulting from Seller's conduct in the performance or furnishing of the Goods and Special Services, including but not limited to claims, costs, losses, or damages from workplace injuries, adjacent property damage, non-compliance with Laws and Regulations, and patent infringement;

    b. Seller has failed to take reasonable and customary measures to avoid damage, delay, disruption, and interference with other work at or adjacent to the Point of Destination or the worksite;

    c. Seller has failed to provide and maintain required bonds or insurance;

    d. Buyer has incurred extra charges or engineering costs related to Submittal reviews, evaluations of proposed substitutes, tests and inspections, or return visits to manufacturing or assembly facilities;

    e. the Goods and Special Services are non-conforming, requiring correction or replacement;

    f. Buyer has been required to correct non-conforming Goods and Special Services, in accordance with Paragraph 9.03.C, or has accepted non-conforming Goods and Special Services pursuant to Paragraph 9.03.E;

    g. the Procurement Contract Price has been reduced by Change Orders;

    h. an event that would constitute a default by Seller and therefore justify a termination for cause has occurred;

    i. liquidated or other damages have accrued as a result of Seller's failure to achieve Milestones, Substantial Completion, or final completion of the Goods and Special Services; or

    j. liens have been filed in connection with the Procurement Contract, except where Seller has delivered a specific bond satisfactory to Buyer to secure the satisfaction and discharge of such liens.

B. If Buyer refuses to make payment of the full amount recommended by Engineer, Buyer will provide Seller and Engineer immediate written notice stating the reason for such action and promptly pay Seller any amount remaining after deduction of the amount withheld. Buyer shall promptly pay Seller the amount withheld when Seller corrects the reason for such action to Buyer's satisfaction.

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13.05 *Final Payment*

A. After Seller has corrected all non-conformities to the reasonable satisfaction of Buyer and Engineer and furnished all Special Services, Seller may submit its final Application for Payment following the procedures for progress payments.

B. The final Application for Payment will be accompanied by all documentation called for in the Procurement Contract Documents (including but not limited to all final operations and maintenance manuals, and any special warranties), a list of all unsettled Claims, and the written consent of surety to the making of final payment.

C. If, on the basis of final inspection and the review of the final Application for Payment and accompanying documentation, Engineer is reasonably satisfied that Seller has furnished the Goods and Special Services in accordance with the Procurement Contract Documents, and that Seller has fulfilled all other obligations under the Procurement Contract Documents, then Engineer will, within 10 days after receipt of the final Application for Payment, indicate in writing Engineer's recommendation of final payment subject to the provisions of Paragraph 13.02, and present the final Application for Payment to Buyer. Such recommendation will account for any set-offs against payment that are necessary in Engineer's opinion to protect Buyer from loss for the reasons stated in Paragraph 13.02.

D. If Engineer does not recommend final payment, Engineer will return the final Application for Payment to Seller, indicating the reasons for refusing to recommend final payment, in which case Seller shall make the necessary corrections and resubmit the final Application for Payment.

E. In support of its recommendation of final payment Engineer will also give written notice to Buyer and Seller that the Goods and Special Services are acceptable, subject to stated limitations in the notice and to the provisions of Paragraph 13.06.

F. If the final Application for Payment and accompanying documentation are appropriate as to form and substance, Buyer shall, within 30 days after receipt thereof, pay Seller the amount recommended by Engineer, less any sum Buyer is entitled to set off against Engineer's recommendation, pursuant to the provisions of Paragraph 13.04.

G. Buyer will not make final payment, or return or release included retainage (if any) at any time, unless Seller submits written consent of the surety to such payment, return, or release.

13.06 *Waiver of Claims*

A. By making final payment, Buyer waives its claim or right to liquidated damages or other damages for late completion by Seller, except as set forth in an outstanding Claim, appeal, set-off, or express reservation of rights by Buyer. Buyer reserves all other claims or rights after final payment.

B. The acceptance of final payment by Seller will constitute a waiver by Seller of all claims and rights against Buyer other than those pending matters that have been duly submitted or appealed under the provisions of Article 12.

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ARTICLE 14—CANCELLATION, SUSPENSION, AND TERMINATION

14.01 *Cancellation*

A. Buyer has the right to cancel the Procurement Contract, without cause, at any time prior to delivery of the Goods by written notice. Cancellation pursuant to the terms of this paragraph will not constitute a breach of contract by Buyer. Upon cancellation:

1. Buyer shall pay Seller for the direct costs incurred in producing any Goods that Seller has specially manufactured for the Project, plus a fair and reasonable amount for overhead and profit.

2. For Goods that are not specially manufactured for the Project, Seller shall be entitled to a restocking charge of 10 percent of the unpaid Procurement Contract Price of such Goods.

14.02 *Suspension of Performance by Buyer*

A. Buyer has the right to suspend performance of the Procurement Contract for up to 90 days, without cause, by written notice. Upon suspension under this paragraph, Seller shall be entitled to an increase in the Procurement Contract Times and Procurement Contract Price caused by the suspension, provided that performance would not have been suspended or delayed for causes attributable to Seller.

14.03 *Suspension of Performance by Seller*

A. Seller may suspend the furnishing of the Goods and Special Services only under the following circumstance:

1. Seller has reasonable grounds to conclude that Buyer will not perform its future payment obligations under the Procurement Contract; and

2. Seller has requested in writing assurances from Buyer that future payments will be made in accordance with the Procurement Contract, and Buyer has failed to provide such assurances within ten days of Seller's written request.

14.04 *Breach and Termination*

A. *Buyer's Breach*

1. Seller shall have the right to terminate the Procurement Contract for cause by declaring a breach if Buyer fails to comply with any material provision of the Procurement Contract. Upon termination, Seller shall be entitled to all remedies provided by Laws and Regulations.

2. If Seller believes Buyer is in breach of its obligations under the Procurement Contract, Seller shall provide Buyer with reasonably prompt written notice setting forth in sufficient detail the reasons for declaring that it believes a breach has occurred. Buyer shall have 7 days from receipt of the written notice declaring the breach (or such longer period of time as Seller may grant in writing) within which to cure or to proceed diligently to cure such alleged breach.

B. *Seller's Breach*

1. Buyer may terminate Seller's right to perform the Procurement Contract for cause by declaring a breach should Seller fail to comply with any material provision of the

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Procurement Contract Documents. Upon termination, Buyer shall be entitled to all remedies provided by Laws and Regulations.

2. In the event Buyer believes Seller is in breach of its obligations under the Procurement Contract, Buyer shall provide Seller with reasonably prompt written notice setting forth in sufficient detail the reasons for declaring that it believes a breach has occurred. Seller shall have 7 days from receipt of the written notice declaring the breach (or such longer period of time as Buyer may grant in writing) within which to cure or to proceed diligently to cure such alleged breach.

3. If and to the extent that Seller has provided a performance bond under the provisions of Paragraph 5.01, the notice and cure procedures of that bond, if any, will supersede the notice and cure procedures of Paragraph 14.04.B.2.

ARTICLE 15—MISCELLANEOUS

15.01 *Giving Notice*

A. Whenever any provision of the Procurement Contract requires the giving of written notice to Buyer, Seller, or Engineer, it will be deemed to have been validly given if delivered:

1. in person, by a commercial courier service or otherwise, to the recipient's place of business;

2. by registered or certified mail, postage prepaid, to the recipient's place of business; or

3. by e-mail to the recipient, with the words "Formal Notice" or similar in the e-mail's subject line.

15.02 *Controlling Law*

A. This Procurement Contract is to be governed by the law of the state in which the Goods are to be installed.

B. In the case of any conflict between the express terms of this Procurement Contract and the Uniform Commercial Code, as adopted in the state whose law governs, it is the intent of the parties that the express terms of this Procurement Contract will apply.

15.03 *Computation of Time*

A. When any period of time is referred to in the Procurement Contract by number of days, it will be computed to exclude the first and include the last day of such period. If the last day of any such period falls on a Saturday or Sunday or on a day made a legal holiday by the law of the applicable jurisdiction, such day will be omitted from the computation.

15.04 *Cumulative Remedies*

A. The duties and obligations imposed by these General Conditions and the rights and remedies available hereunder to the parties hereto are in addition to, and are not to be construed in any way as a limitation of, any rights and remedies available to any or all of them which are otherwise imposed or available by Laws or Regulations, by special warranty or guarantee, or by other provisions of the Procurement Contract, and the provisions of this paragraph will be as effective as if repeated specifically in the Procurement Contract in connection with each particular duty, obligation, right, and remedy to which they apply.

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15.05 *Survival of Obligations*

A. All representations, indemnifications, warranties, and guarantees made in, required by, or given in accordance with the Procurement Contract, as well as all continuing obligations indicated in the Procurement Contract, will survive final payment, completion, and acceptance of the Goods and Special Services or termination or completion of the Procurement Contract or of the services of Seller.

15.06 *Entire Agreement*

A. Buyer and Seller agree that this Procurement Contract is the complete and final agreement between them, and supersedes all prior negotiations, representations, or agreements, either written or oral. This Procurement Contract may not be altered, modified, or amended except in writing signed by an authorized representative of both parties.

15.07 *No Waiver*

A. A party's non-enforcement of any provision will not constitute a waiver of that provision, nor will it affect the enforceability of that provision or of the remainder of this Procurement Contract.

15.08 *Headings*

A. Article and paragraph headings are inserted for convenience only and do not constitute parts of these General Conditions.

15.09 *Successors and Assigns*

A. Buyer and Seller each binds itself, its partners, successors, assigns, and legal representatives to the other party hereto, its partners, successors, assigns, and legal representatives in respect to all covenants, agreements, and obligations contained in the Procurement Contract.

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PART 5

EJCDC SUPPLEMENTARY GENERAL CONDITIONS

SUPPLEMENTARY CONDITIONS OF THE PROCUREMENT CONTRACT

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SUPPLEMENTARY CONDITIONS OF THE PROCUREMENT CONTRACT

These Supplementary Conditions amend or supplement EJCDC® P-700, Standard General Conditions of the Procurement Contract (2019). The General Conditions remain in full force and effect except as amended.

The terms used in these Supplementary Conditions have the meanings stated in the General Conditions. Additional terms used in these Supplementary Conditions have the meanings stated below, which are applicable to both the singular and plural thereof.

The address system used in these Supplementary Conditions is the same as the address system used in the General Conditions, with the prefix "SC" added—for example, "Paragraph SC-4.05."

ARTICLE 1—DEFINITIONS AND TERMINOLOGY

1.01 *Defined Terms*

SC-1.01.A.5 Add the following at the end of the Paragraph:

For the purposes of Rural Development, this term is synonymous with the term "applicant" as defined in 7 CFR 1780.7 (a) (1), (2) and (3) and is an entity receiving financial assistance from the federal programs.

SC-1.01.A.7 Add the following at the end of the Paragraph:

The Change Order form to be used on this Project is EJCDC C-941 (2018). Agency approval is required before Change Orders are effective.

SC-1.01.A.41 Add the following new paragraph immediately after Paragraph 1.01.A.40:

41. Agency - The Project is financed in whole or in part by USDA Rural Utilities Service pursuant to the Consolidated Farm and Rural Development Act (7 USC Section 1921 et seq.). The Rural Utilities Service programs are administered through the USDA Rural Development offices; therefore, the Agency for these documents is USDA Rural Development.

SC-1.01.A.42 Add the following new paragraph with the title "Domestic Preference Definitions" immediately after Paragraph 1.01.A.41:

42. Build America, Buy America Act Definitions:

a. *Build America, Buy America Act (BABAA)* – Requirements mandated by Title IX of the Infrastructure Investment and Jobs Act (IIJA), Pub. L. 117-58, §§ 70901-70953-58 mandating domestic preference that all iron and steel, manufactured products, and construction materials are produced in the United States, in accordance with 2 CFR part 184.
b. *Construction Materials* – Those articles, materials, or supplies — other than an item of primarily iron or steel; a manufactured product; cement and cementitious materials; aggregates such as stone, sand, or gravel; or aggregate binding agents or additives— that are or consist primarily of: non-ferrous metals, plastic and polymer-based products, glass, lumber or drywall.

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c. *Contractor's Certification* – A certification submitted by Contractor that, to the best of the Contractor's knowledge and belief, all Work complies with Domestic Preference requirements.
d. *De Minimis* – Materials and products that represent a small portion of an infrastructure project, specifically no more than 5% of the project costs up to a maximum of $1,000,000,
e. *Domestic Preference* – The Build America, Buy America Act (BABAA) requirements under Title IX of the Infrastructure Investment and Jobs Act (IIJA), Pub. L. 117-58, §§ 70901-70953.
f. *Engineer's Certification* – Documentation submitted by the Engineer that Drawings, Specifications, and Bidding Documents comply with Domestic Preference requirements.
g. *Manufactured Product* – Items assembled out of components, or otherwise made or processed from raw materials into finished products. Manufactured products must be manufactured (assembled) in the United States, and the cost of components that were mined, produced, or manufactured in the United States must be greater than 55 percent of the total cost of all components of the product.
h. *Manufacturer's Certification* – Documentation provided by the Manufacturer stating that Domestic Preference requirements have been satisfied for all provided items. Manufacturers' Certifications must include (at a minimum): specific list of products (using common names) associated with the certificate, location of the final manufacturing, signature of the manufacturer's representative, and a reference to the Domestic Preference statute. If items are purchased via a Supplier, distributor, vendor, etc. from the Manufacturer directly, then the Supplier, distributor, vendor, etc. will be responsible for obtaining and providing these certifications to the parties purchasing the products.
i. *Minor Components* - Components *within* an iron and/or steel product otherwise compliant with the Domestic Preference requirements. This waiver, typically used by Manufacturers, allows use of non-domestically produced miscellaneous Minor Components comprising up to five percent of the total material cost of an otherwise domestically produced iron and steel product. However, unless a separate waiver for a product has been approved, all other iron and steel components in said product must still meet the Domestic Preference requirements. This waiver does not exempt the whole product from the Domestic Preference requirements only Minor Components within said product and the iron or steel components of the product must be produced domestically. *Primarily Iron or Steel* - A product is made of greater than 50 percent iron or Steel on a materials cost basis.

1.02 *Terminology*

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ARTICLE 2—PRELIMINARY MATTERS

2.01 *Delivery of Bonds and Evidence of Insurance*

2.02 *Copies of Documents*

SC-2.02 Amend the first sentence of Paragraph 2.02.A. to read as follows:

Buyer shall furnish to Seller **[number]** printed copies of the Procurement Contract Documents (including one fully signed counterpart of the Procurement Agreement), and **[one copy] [none]** in electronic portable document format (PDF).

SC-2.02.A Delete "four" and insert in its place "five."

2.03 *Electronic Transmittals*

2.04 *Preliminary Schedules*

ARTICLE 3—PROCUREMENT CONTRACT DOCUMENTS

3.01 *Intent*

3.02 *Reference Standards*

ARTICLE 4—COMMENCEMENT AND PROGRESS OF WORK

No suggested Supplementary Conditions in this Article.

ARTICLE 5—BONDS AND INSURANCE

5.01 *Performance, Payment, and Other Bonds*

SC-5.01 Add the following paragraphs immediately after Paragraph 5.01.A:

1. *Required Performance Bond Form*: The performance bond that Seller furnishes will be in the form of EJCDC® P-610, Performance Bond (2010 or 2019 edition).

2. *Required Payment Bond Form*: The payment bond that Contractor furnishes will be in the form of EJCDC® P-615, Payment Bond (2010 or 2019 edition).

5.02 *Insurance*

SC-5.02 Add the following new paragraphs immediately after Paragraph 5.02.E:

F. Seller shall purchase and maintain such liability and other insurance as is appropriate for the furnishing of Goods and Special Services and as will provide protection from claims set forth below which may arise out of or result from Seller's furnishing of the Goods or Special Services and Seller's other obligations under the Procurement Contract Documents, whether the furnishing of Goods and Special Services or other obligations are to be performed by Seller, any subcontractor or supplier, or by anyone directly or indirectly employed by any of them to furnish the Goods and Special Services, or by anyone for whose acts any of them may be liable:

1. claims under workers' compensation, disability benefits, and other similar employee benefit acts;

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2. claims for damages because of bodily injury, occupational sickness or disease, or death of Seller's employees;

3. claims for damages because of bodily injury, sickness or disease, or death of any person other than Seller's employees;

4. claims for damages insured by reasonably available personal injury liability coverage which are sustained: (a) by any person as a result of an offense directly or indirectly related to the employment of such person by Seller, or (b) by any other person for any other reason;

5. claims for damages, other than to the Goods, because of injury to or destruction of tangible property wherever located, including loss of use resulting therefrom; and

6. claims for damages because of bodily injury or death of any person or property damage arising out of the ownership, maintenance or use of any motor vehicle.

G. The policies of insurance so required by this Paragraph 5.02 to be purchased and maintained must:

1. with respect to insurance required by Paragraphs SC-5.02.F.3 through SC-5.02.F.6 inclusive, include as additional insureds (subject to any customary exclusion in respect of professional liability) Buyer, Engineer, their consultantsall of whom must be listed as additional insureds, and include coverage for the respective officers, directors, partners, employees, agents, and other consultants and subcontractors of each and any of all such additional insureds, and the insurance afforded to these additional insureds must provide primary coverage for all claims covered thereby;

2. include at least the specific coverages and be written for not less than the limits of liability provided below or required by Laws or Regulations, whichever is greater;

3. include completed operations insurance;

4. include contractual liability insurance covering Seller's indemnity obligations under Paragraph 7.07;

5. contain a provision or endorsement that the coverage afforded will not be canceled, or renewal refused, until at least 10 days prior written notice has been given to the purchasing policyholder. Within three days of receipt of any such written notice, the purchasing policyholder will provide a copy of the notice to the other party, each other insured, and Engineer;

6. remain in effect at least until final payment and at all times thereafter when Seller may be correcting, removing, or replacing non-conforming Goods in accordance with Paragraph 9.03 and 9.04; and

7. with respect to completed operations insurance, and any insurance coverage written on a claims-made basis, remain in effect for at least two years after final payment (and Seller shall furnish Buyer and each other additional insured identified in these Supplementary Conditions, to whom a certificate of insurance has been issued, evidence satisfactory to Buyer and any such additional insured of continuation of such insurance at final payment and one year thereafter).

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H. The limits of liability for the insurance required by Paragraph SC-5.02.F must provide coverage for not less than the following amounts or greater where required by Laws and Regulations:

1. Workers' Compensation, and related coverages under Paragraphs SC-5.02.F.1 and F.2:

Workers' Compensation and Related Policies	Policy limits of not less than
Workers' Compensation	
State	Statutory
Applicable Federal (e.g., Longshoreman's)	Statutory
Foreign voluntary workers' compensation (employer's responsibility coverage), if applicable	Statutory

2. Seller's General Liability under Paragraphs SC-5.02.F.3 through F.6 which must include completed operations and product liability coverages and eliminate the exclusion with respect to property under the care, custody and control of Seller:

Commercial General Liability	Policy limits of not less than
Each Occurrence	**$2,000,000**
General Aggregate	$3,000,000
Products—Completed Operations Aggregate	$3,000,000
Personal and Advertising Injury	$2,000,000
Stop Gap/Employers' Liability, each Accident	$2,000,000

3. Automobile Liability under Paragraph SC-5.02.F.6:

Automobile Liability	Policy limits of not less than
Combined Single Limit	
Combined Single Limit (Bodily Injury and Property Damage)	$1,000,000

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I. Seller shall deliver to Buyer, with copies to each additional insured identified in these Supplementary Conditions, certificates of insurance (and other evidence of insurance requested by Buyer or any other additional insured) which Seller is required to purchase and maintain.

ARTICLE 6—LICENSES AND FEES

No suggested Supplementary Conditions in this Article.

ARTICLE 7—SELLER'S RESPONSIBILITIES

SC-7.02.C Add the following new paragraph immediately after Paragraph 7.02.B:

C. All materials must meet Buy America, Build America requirements.

7.03 *Laws and Regulations*

7.04 *"Or Equals"*

SC-7.04.A Amend the second sentence of paragraph by striking out the following words:

Unless the specification or description contains or is followed by words reading that no like, equivalent, or "or-equal" item is permitted,

SC-7.04.A.2 Amend the first sentence of Paragraph by deleting the following:

"it has an acceptable record of performance and availability of responsive service; 4)"

SC-7.04.D Add the following at the end of paragraph:

Seller shall include a Manufacturer's Certification letter for compliance with Build America, Buy America requirements, if applicable. Refer to Manufacturer's Certification Letter provided in these Contract Documents.

7.05 *Taxes*

SC-7.05 Add a new paragraph immediately after Paragraph 7.05.A:

B. Buyer is exempt from payment of sales and compensating use taxes of the State of **[insert name of state where Project is located]** and of cities and counties thereof on all materials and equipment to be incorporated into the Project facilities.

1. Buyer will furnish the required certificates of tax exemption to Seller with respect to materials and equipment to be incorporated into the Project facilities.

2. Buyer's exemption does not apply to construction tools, machinery, equipment, or other property purchased by or leased by Seller, or to supplies or materials not incorporated into the Project facilities.

3. The Procurement Contract Price does not include the cost of sales or compensating use taxes to the extent such are exempted by this paragraph.

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7.06 *Submittals*

SC-7.06.A.1.c Amend paragraph by deleting the last period and adding:

, including Manufacturer's Certification letter for any item in the submittal subject to Build America, Buy America requirements. Refer to Manufacturer's Certification Letter provided in these Contract Documents.

SC-7.06.C.9 Add new paragraph immediately after Paragraph 7.06.C.8:

9. Engineer's review and approval of a Shop Drawing or Sample shall include review of Manufacturers' Certifications in order to document compliance with Build America, Buy America requirements, as applicable.

7.07 *Indemnification*

SC-7.08.A Amend by adding the following to the end of the paragraph:

The total amount of work subcontracted by the Seller shall not exceed fifty percent of the Procurement Contract price without prior approval from the Owner, Engineer and Agency.

ARTICLE 8—SHIPPING AND DELIVERY

8.02 *Delivery*

8.03 *Risk of Loss*

ARTICLE 9—BUYER'S RIGHTS

SC-9.01.F Add new paragraph immediately after Paragraph 9.01.E:

F. Seller shall certify that all Work and Materials have complied with Build America, Buy America requirements as mandated by Section 746 of Title VII of the Consolidated Appropriations Act of 2017 (Division A - Agriculture, Rural Development, Food and Drug Administration, and Related Agencies Appropriations Act, 2017) and subsequent statutes mandating domestic preference. Contractor shall provide said Certification to Owner. Refer to General Contractor's Certification Letter provided in these Contract Documents.

SC-9.03.A.1 Add new Paragraph 9.03.A.1 immediately after Paragraph 9.03.A:

1. Goods that are non-compliant with Build America, Buy America requirements are considered non-conforming.

9.04 *Correction Period*

SC-9.05 Add the following new paragraph after Paragraph 9.04:

9.05 *Limitation of Seller's Liability*

A. Buyer and Seller agree that the total liability of Seller to Buyer for claims, costs, losses, and damages arising from this Procurement Contract will be limited to the amount established in the Procurement Agreement as the Procurement Contract Price.

B. Upon assignment the terms of this Paragraph 9.05 will be binding upon both the assignor and assignee with respect to Seller's liability, The terms of this limitation do not apply to or limit any claim by Buyer against Seller based on any of the following: (a) contribution or indemnification with respect to third-party claims, losses, and damages; (b) costs, losses, or

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damages attributable to personal or bodily injury, sickness, disease, or death, or to injury to or destruction of the tangible property of others, (c) intentional or reckless wrongful conduct, or (d) rights conferred by any bond provided by Seller under this Contract.

ARTICLE 10—ENGINEER'S STATUS

ARTICLE 11—CHANGES

SC-11.02.C Add new paragraph immediately after Paragraph 11.02.B:

C. The Buyer shall contact the Agency for concurrence on each Change Order prior to issuance. All Contract Change Orders must be concurred on (signed) by Agency before they are effective.

ARTICLE 12—CLAIMS, DISPUTES, AND DISPUTE RESOLUTION

12.03 *Arbitration*

SC-12.03 Add the following new paragraph immediately after Paragraph 12.02:

12.03 *Arbitration*

A. All matters subject to final resolution under this Article will be settled by arbitration administered by the American Arbitration Association in accordance with its Construction Industry Arbitration Rules (subject to the conditions and limitations of this Paragraph SC-12.03). This agreement to arbitrate will be specifically enforceable under the prevailing law of any court having jurisdiction.

B. The demand for arbitration will be filed in writing with the other party to the Procurement Contract and with the selected arbitration administrator, and a copy will be sent to Engineer for information. The demand for arbitration will be made within the specific time required in Article 12, or if no specified time is applicable within a reasonable time after the matter in question has arisen, and in no event will any such demand be made after the date when institution of legal or equitable proceedings based on such matter in question would be barred by the applicable statute of limitations.

C. The arbitrator(s) must be licensed engineers, contractors, attorneys, or construction managers. Hearings will take place pursuant to the standard procedures of the Construction Arbitration Rules that contemplate in-person hearings. The arbitrators will have no authority to award punitive or other damages not measured by the prevailing party's actual damages, except as may be required by statute or the Procurement Contract. Any award in an arbitration initiated under this clause will be limited to monetary damages and include no injunction or direction to any party other than the direction to pay a monetary amount.

D. The arbitrators will have the authority to allocate the costs of the arbitration process among the parties, but will only have the authority to allocate attorneys' fees if a specific Law or Regulation or this Procurement Contract permits them to do so.

E. The award of the arbitrators must be accompanied by a reasoned written opinion and a concise breakdown of the award. The written opinion will cite the Procurement Contract provisions deemed applicable and relied on in making the award.

F. The parties agree that failure or refusal of a party to pay its required share of the deposits for arbitrator compensation or administrative charges will constitute a waiver by that party

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of the right to present evidence or cross-examine witness. In such event, the other party shall be required to present evidence and legal argument as the arbitrator(s) may require for the making of an award. Such waiver will not allow for a default judgment against the non-paying party in the absence of evidence presented as provided for above.

G. No arbitration arising out of or relating to the Procurement Contract will include by consolidation, joinder, or in any other manner any other individual or entity (including Engineer, and Engineer's consultants and the officers, directors, partners, agents, employees or consultants of any of them) who is not a party to this Procurement Contract unless:

1. the inclusion of such other individual or entity will allow complete relief to be afforded among those who are already parties to the arbitration;

2. such other individual or entity is substantially involved in a question of law or fact which is common to those who are already parties to the arbitration, and which will arise in such proceedings;

3. such other individual or entity is subject to arbitration under a contract with either Buyer or Seller, or consents to being joined in the arbitration; and

4. the consolidation or joinder is in compliance with the arbitration administrator's procedural rules.

H. The award will be final. Judgment may be entered upon it in any court having jurisdiction thereof, and it will not be subject to modification or appeal, subject to provisions of the Laws and Regulations relating to vacating or modifying an arbitral award.

I. Except as may be required by Laws or Regulations, neither party nor an arbitrator may disclose the existence, content, or results of any arbitration hereunder without the prior written consent of both parties, with the exception of any disclosure required by Laws and Regulations or the Procurement Contract. To the extent any disclosure is allowed pursuant to the exception, the disclosure must be strictly and narrowly limited to maintain confidentiality to the extent possible.

ARTICLE 13—PAYMENT

13.01 *Applications for Progress Payments*

SC-13.01.F Add new paragraph immediately after Paragraph 13.01.D:

F. The Application for Payment form to be used on this Project is EJCDC® C-620. The Agency must approve all Applications for Payment before payment is made.

SC-13.01.G Add new paragraph immediately after Paragraph 13.01.F:

G. By submitting an Application for Payment based in whole or in part on furnishing equipment or materials, Seller certifies that such equipment and materials are compliant with Build America, Buy America requirements. Manufacturer's Certification letter for materials satisfy this requirement. Refer to Manufacturer's Certification Letter provided in these Contract Documents.

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13.02 *Review of Applications for Progress Payments*

SC-13.02.A.2.d Add the following new paragraph immediately after Paragraph 13.02.A.2.c:

d. The materials presented for payment in an Application for Payment comply with Build America, Buy America requirements.

SC-13.05.G Add the following language at the end of paragraph:

No payments will be made that would deplete the retainage, place in escrow any funds that are required for retainage or invest the retainage for the benefit of the Contractor.

ARTICLE 14—CANCELLATION, SUSPENSION, AND TERMINATION

No suggested Supplementary Conditions in this Article.

ARTICLE 15—MISCELLANEOUS

SC-15.10 Add new paragraph immediately after Paragraph 15.09:

15.10 Tribal Sovereignty

A. No provision of this Agreement will be construed by any of the signatories as abridging or debilitating any sovereign powers of the [insert name of Tribe] Tribe; affecting the trust-beneficiary relationship between the Secretary of the Interior, Tribe, and Indian landowner(s); or interfering with the government-to-government relationship between the United States and the Tribe.

SC-16 Add the following new Article 16 immediately after Article 15:

ARTICLE 16 - FEDERAL REQUIREMENTS

16.01 *Agency Not a Party*

A. This Contract is expected to be funded in part with funds provided by Agency. Neither Agency, nor any of its departments, entities, or employees, is a party to this Contract.

16.02 *Contract Approval*

A. Buyer and Seller will furnish Buyer's attorney such evidence as required so that Buyer's attorney can complete and execute the "Certificate of Owner's Attorney and Agency Concurrence" (Exhibit A, Attachment 1 of RUS Bulletin 1780-26) before Buyer submits the executed Contract Documents to Agency for approval.

B. Agency concurrence is required on both the Bid and the Contract before the Contract is effective.

16.03 *Conflict of Interest*

A. Seller may not knowingly contract with a Supplier or Manufacturer if the individual or entity who prepared the Drawings and Specifications has a corporate or financial affiliation with the Supplier or Manufacturer. Buyer's officers, employees, or agents shall not engage in the award or administration of this Contract if a conflict of interest, real or apparent, would be involved. Such a conflict would arise when: (i) the employee, officer or agent; (ii) any member of their immediate family; (iii) their partner or (iv) an

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organization that employs, or is about to employ, any of the above, has a financial interest or other interest in or a tangible personal benefit from the Seller. Buyer's officers, employees, or agents shall neither solicit nor accept gratuities, favors or anything of monetary value from Seller or subcontractors.

16.04 *Gratutities*

A. If Buyer finds after a notice and hearing that Seller, or any of Seller's agents or representatives, offered or gave gratuities (in the form of entertainment, gifts, or otherwise) to any official, employee, or agent of Buyer or Agency in an attempt to secure this Contract or favorable treatment in awarding, amending, or making any determinations related to the performance of this Contract, Buyer may, by written notice to Seller, terminate this Contract. Buyer may also pursue other rights and remedies that the law or this Contract provides. However, the existence of the facts on which Buyer bases such findings shall be an issue and may be reviewed in proceedings under the dispute resolution provisions of this Contract.

B. In the event this Contract is terminated as provided in paragraph 16.04.A, Buyer may pursue the same remedies against Seller as it could pursue in the event of a breach of this Contract by Seller. As a penalty, in addition to any other damages to which it may be entitled by law, Buyer may pursue exemplary damages in an amount (as determined by Buyer) which shall not be less than three nor more than ten times the cost Seller incurs in providing any such gratuities to any such officer or employee.

16.05 *Small, Minority and Women's Businesses*

A. If Seller intends to let any subcontracts for a portion of the work, Seller will take all necessary affirmative steps to assure that minority businesses, women's business enterprises, and labor surplus area firms are used when possible. Affirmative steps will include:

1. Placing qualified small and minority businesses and women's business enterprises on solicitation lists;

2. Assuring that small and minority businesses, and women's business enterprises are solicited whenever they are potential sources;

3. Dividing total requirements, when economically feasible, into smaller tasks or quantities to permit maximum participation by small and minority businesses, and women's business enterprises;

4. Establishing delivery schedules, where the requirement permits, which encourage participation by small and minority businesses, and women's business enterprises;

5. Using the services and assistance, as appropriate, of such organizations as the Small Business Administration and the Minority Business Development Agency of the Department of Commerce.

16.06 *Anti-Kickback*

A. Seller shall comply with the Copeland Anti-Kickback Act (40 USC 3145) as supplemented by Department of Labor regulations (29 CFR Part 3, "Contractors and Subcontractors on Public Buildings or Public Works Financed in Whole or in Part by Loans or Grants of the

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United States"). The Act provides that Seller or subcontractor shall be prohibited from inducing, by any means, any person employed in the construction, completion, or repair of public facilities, to give up any part of the compensation to which they are otherwise entitled. Buyer shall report all suspected or reported violations to Agency.

16.07 Clean Air Act (42 U.S.C. 7401-7671q.) and the Federal Water Pollution Control Act (33 U.S.C. 1251-1387), as amended

A. Seller to agree to comply with all applicable standards, orders or regulations issued pursuant to the Clean Air Act (42 U.S.C. 7401-7671q) and the Federal Water Pollution Control Act as amended (33 U.S.C. 1251-1387). Violations must be reported to the federal awarding agency and the Regional Office of the Environmental Protection Agency (EPA).

16.08 *Equal Employment Opportunity*

A. The Contract is considered a federally assisted construction contract. Except as otherwise provided under 41 CFR Part 60, all contracts that meet the definition of "federally assisted construction contract" in 41 CFR Part 60-1.3 must include the equal opportunity clause provided under 41 CFR 60-1.4(b), in accordance with Executive Order 11246, "Equal Employment Opportunity" (30 FR 12319, 12935, 3 CFR Part, 1964-1965 Comp., p. 339), as amended by Executive Order 11375, "Amending Executive Order 11246 Relating to Equal Employment Opportunity," and implementing regulations at 41 CFR part 60, "Office of Federal Contract Compliance Programs, Equal Employment Opportunity, Department of Labor."

16.09 *Byrd Anti-Lobbying Amendment (31 U.S.C. 1352)*

A. Seller that applies or bid for an award exceeding $100,000 must file the required certification (RD Instruction 1940-Q Exhibit A-1). The Seller certifies to the Buyer and every subcontractor certifies to the Seller that it will not and has not used federal appropriated funds to pay any person or organization for influencing or attempting to influence an officer or employee of any agency, a member of Congress, officer or employee of Congress, or an employee of a member of Congress in connection with obtaining the Contract if it is covered by 31 U.S.C. 1352. The Seller and every subcontractor must also disclose any lobbying with non-federal funds that takes place in connection with obtaining any federal award. Such disclosures are forwarded from tier to tier up to the Buyer. Necessary certification and disclosure forms shall be provided by Buyer.

16.10 *Environmental Requirements*

A. When constructing a Project involving trenching and/or other related earth excavations, Seller shall comply with the following environmental conditions:
   1. Wetlands – When disposing of excess, spoil, or other Construction Materials on public or private property, Seller or subcontractor shall not fill in or otherwise convert wetlands.
   2. Floodplains – When disposing of excess, spoil, or other Construction Materials on public or private property, Seller or subcontractor shall not fill in or otherwise convert 100-year floodplain areas (Standard Flood Hazard Area) delineated on the latest Federal Emergency Management Agency Floodplain Maps, or other appropriate maps, e.g., alluvial soils on

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NRCS Soil Survey Maps.

3. Historic Preservation - Applicants shall ensure that Seller or subcontractor maintains a copy of the following inadvertent discovery plan onsite for review:
    a. If during the course of any ground disturbance related to any Project, any post review discovery, including but not limited to, any artifacts, foundations, or other indications of past human occupation of the area are uncovered, shall be protected by complying with 36 CFR § 800.13(b)(3) and (c) and shall include the following:
        i. All Work, including vehicular traffic, shall immediately stop within a 50 ft. radius around the area of discovery. The Seller or subcontractor shall ensure barriers are established to protect the area of discovery and notify the Engineer to contact the appropriate RD personnel. The Engineer shall engage a Secretary of the Interior (SOI) qualified professional archeologist to quickly assess the nature and scope of the discovery; implement interim measures to protect the discovery from looting and vandalism; and establish broader barriers if further historic and/or precontact properties, can reasonably be expected to occur.
        ii. The RD personnel shall notify the appropriate RD environmental staff member, the Federal Preservation Officer (FPO), and State Historic Preservation Office (SHPO) immediately. Indian tribe(s) or Native Hawaiian Organization (NHOs) that have an interest in the area of discovery shall be contacted immediately. The SHPO may require additional tribes or NHOs who may have an interest in the area of discovery also be contacted. The notification shall include an assessment of the discovery provided by the SOI qualified professional archeologist.
        iii. When the discovery contains burial sites or human remains, the Seller or subcontractor shall immediately notify the appropriate RD personnel who will contact the RD environmental staff member, FPO, and the SHPO. The relevant law enforcement authorities shall be immediately contacted by onsite personnel to reduce delay times, in accordance with tribal, state, or local laws including 36 CFR Part 800.13; 43 CFR Part 10, Subpart B; and the Advisory Council on Historic Preservation's Policy Statement Regarding treatment of Burial Sites, Human Remains, or Funerary Objects (February 23, 2007).
        iv. When the discovery contains burial sites or human remains, all construction activities, including vehicular traffic shall stop within a 100 ft. radius of the discovery and barriers shall be established. The evaluation of human remains shall be conducted at the site of discovery by a SOI qualified professional. Remains that have been removed from their primary context and where that context may be in question may be retained in a secure location, pending further decisions on treatment and disposition. RD may expand this radius based on the SOI professional's assessment of the discovery and establish broader barriers if further subsurface burial sites, or human remains can reasonably be expected to occur. RD, in consultation with the SHPO and interested tribes or NHOs, shall develop a plan for the treatment of native human remains.
        v. Work may continue in other areas of the undertaking where no historic properties, burial sites, or human remains are present. If the inadvertent discovery appears to be a consequence of illegal activity such as looting, the onsite personnel shall contact the appropriate legal authorities immediately if the landowner has not already done so.
        vi. Work may not resume in the area of the discovery until a notice to proceed has

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been issued by RD. RD shall not issue the notice to proceed until it has determined that the appropriate local protocols and consulting parties have been consulted.

vii. Inadvertent discoveries on federal and tribal land shall follow the processes required by the federal or tribal entity.

4. Endangered Species – Seller or subcontractor shall comply with the Endangered Species Act, which provides for the protection of endangered and/or threatened species and critical habitat. Should any evidence of the presence of endangered and/or threatened species or their critical habitat be brought to the attention of Seller or subcontractor, Seller or subcontractor will immediately report this evidence to Buyer and a representative of Agency. Construction shall be temporarily halted pending the notification process and further directions issued by Agency after consultation with the U.S. Fish and Wildlife Service.
5. Mitigation Measures – The following environmental mitigation measures are required on this Project: [Insert mitigation measures from the Letter of Conditions here].

16.11 *Contract Work Hours and Safety Standards Act (40 U.S.C. 3701-3708)*

A. Where applicable, for contracts awarded by the Buyer in excess of $100,000 that involve the employment of mechanics or laborers, the Seller will comply with 40 U.S.C. 3702 and 3704, as supplemented by Department of Labor regulations (29 CFR Part 5). Under 40 U.S.C. 3702 of the Act, the Seller will compute the wages of every mechanic and laborer on the basis of a standard work week of 40 hours. Work in excess of the standard work week is permissible provided that the worker is compensated at a rate of not less than one and a half times the basic rate of pay for all hours worked in excess of 40 hours in the work week. The requirements of 40 U.S.C. 3704 are applicable to construction work and provide that no laborer or mechanic will be required to work in surroundings or under working conditions which are unsanitary, hazardous or dangerous. These requirements do not apply to the purchases of supplies or materials or articles ordinarily available on the open market, or contracts for transportation or transmission of intelligence.

16.12 *Debarment and Suspension (Executive Orders 12549 and 12689)*

A. A contract award (see 2 CFR 180.220) must not be made to parties listed on the governmentwide exclusions in the System for Award Management (SAM), in accordance with the OMB guidelines at 2 CFR 180 that implement Executive Orders 12549 (3 CFR part 1986 Comp., p. 189) and 12689 (3 CFR part 1989 Comp., p. 235), "Debarment and Suspension." SAM Exclusions contains the names of parties debarred, suspended, or otherwise excluded by agencies, as well as parties declared ineligible under statutory or regulatory authority other than Executive Order 12549.

16.13 *Procurement of Recovered Materials*

A. The Seller will comply with 2 CFR Part 200.322, "Procurement of recovered materials."

16.14 *Domestic Preference*

A. Build America, Buy America Act (BABAA). All Iron and Steel Products, Manufactured Products, and Construction Materials used in this project must comply with the Build America, Buy America Act (BABAA) requirements mandated by Title IX of the

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Infrastructure Investment and Jobs Act (IIJA), Pub. L. 117-58, §§ 70901-70953. Aggregates such as stone, sand, or gravel do not apply to BABAA.

B. The following waivers apply to this Contract:
   1. BABAA De Minimis, Small Grants and Minor Components.
   2. [add project specific waivers as applicable].

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PART 6

PROJECT FORMS

BUYER'S ACKNOWLEDGMENT OF RECEIPT OF GOODS

Buyer: **Taylor Bay Beach Club HOA**
Engineer: Gray & Osborne, Inc.
Seller:
Project: **Procurement of Membrane Equipment System and Services**
Contract Name:

Buyer's Project No.:
Engineer's Project No.: 22848.01
Seller's Project No.:

This Buyer's Acknowledgment of Receipt of Goods (Acknowledgment) applies to:

☐ All Goods ☐ The following specified portions of the Goods: **[Specify]**

Date of delivery of the Goods to the Point of Destination: **[Date]**

Date of Buyer's visual inspection of the Goods: **[Date]**

Date of this Acknowledgment: **[Date]**

Buyer acknowledges:

1. The Goods to which this notice applies have been delivered to the Point of Destination.
2. Buyer has visually inspected such Goods pursuant to Paragraph 9.02.B.1 of the General Conditions of the Procurement Contract.
3. Based on the visual inspection, such Goods appear to comply with the requirements of the Procurement Contract Documents as to quantities and condition, subject to any exceptions and limitations in this Acknowledgment.
4. Such Goods are deemed received for purposes of Paragraph 9.02.B.2 of the General Conditions of the Procurement Contract.
5. Seller may submit its Application for Payment for the delivered Goods, subject to the terms of the Procurement Agreement.

Exceptions (if any) to this Acknowledgment: ☐ None ☐ As follows:

The responsibilities between Buyer and Seller for securing and storing the Goods, maintaining the Goods during storage, and for furnishing the Special Services, shall be as provided in the Procurement Contract.

The following documents are attached to and made a part of this Acknowledgement:

[List, if any, or indicate None]

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This Acknowledgment does not constitute an acceptance of any Goods not in conformance with the Procurement Contract Documents, nor is it a release of Seller's obligation to furnish all Goods and Special Services in accordance with the Procurement Contract.

	Buyer	**Engineer, on behalf of Buyer**
By (signature):		
Name (Printed):		
Title:		
Date:		

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BUYER'S NOTICE REGARDING CONFORMITY OF GOODS AND SPECIAL SERVICES

Buyer: **Taylor Bay Beach Club HOA**
Engineer: Gray & Osborne, Inc.
Seller:
Project: **Procurement of Membrane Equipment System and Services**
Contract Name:

Buyer's Project No.:
Engineer's Project No.: 22848.01
Seller's Project No.:

Notice Date:

Effective Date of the Procurement Contract:

Buyer hereby gives notice to Seller that, to the best of Buyer's knowledge, information, and belief, the Goods and Special Services:

☐ Are in conformance with the Procurement Contract Documents. Upon Seller's submittal of its final Application for Payment in accordance with the Procurement Contract Documents, Seller will be eligible for final payment, except as expressly indicated in the Procurement Contract.

☐ Are nonconforming with the Procurement Contract Documents for the following reason(s):

1. **[List reason(s) and clearly cite contractual provisions and factual circumstances of each]**

Seller's Special Services were completed on: **[fill in date]**

Buyer has consulted with and received Engineer's recommendation on conformity of the Goods and Special Services.

This Buyer's Notice Regarding Conformity of Goods and Special Services (Notice) is made expressly subject to the following terms and conditions to which all who receive and rely on said Notice agree: **[Edit the following to suit the specific procurement]**

1. This Notice is expressly subject to the terms and conditions set forth in the Procurement Contract.
2. This Notice is not a guarantee or warranty of Seller's performance under the Procurement Contract, an acceptance of Goods and Special Services that are not in accordance with the related Procurement Contract Documents, including but not limited to nonconforming Goods and Special Services discovered after final inspection, nor an assumption of responsibility for any failure of Seller to furnish the Goods and Special Services thereunder in accordance with the Procurement Contract, or to otherwise comply with the Procurement Contract Documents or the terms of any special guarantees specified therein.
3. This Notice does not relieve Seller of any surviving obligations under the Procurement Contract and is subject to Buyer's reservations of rights with respect to completion and final payment.

Buyer

By (signature): _____ Name (Printed): _____

Date: _____ Title: _____

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Contractor's Application for Payment

Owner:		**Owner's Project No.:**	
Engineer:		**Engineer's Project No.:**	
Contractor:		**Contractor's Project No.:**	
Project:			
Contract:			
Application No.:		**Application Date:**	
Application Period:	**From**	**to**	

1. Original Contract Price			$ -
2. Net change by Change Orders			$ -
3. Current Contract Price (Line 1 + Line 2)			$ -
4. Total Work completed and materials stored to date (Sum of Column G Lump Sum Total and Column J Unit Price Total)			$ -
5. Retainage			
a. _____ X	$ -	Work Completed =	$ -
b. _____ X	$ -	Stored Materials =	$ -
c. Total Retainage (Line 5.a + Line 5.b)			$ -
6. Amount eligible to date (Line 4 - Line 5.c)			$ -
7. Less previous payments (Line 6 from prior application)			
8. Amount due this application			$ -
9. Balance to finish, including retainage (Line 3 - Line 4 + Line 5.c)			$ -

Contractor's Certification

The undersigned Contractor certifies, to the best of its knowledge, the following:
(1) All previous progress payments received from Owner on account of Work done under the Contract have been applied on account to discharge Contractor's legitimate obligations incurred in connection with the Work covered by prior Applications for Payment;
(2) Title to all Work, materials and equipment incorporated in said Work, or otherwise listed in or covered by this Application for Payment, will pass to Owner at time of payment free and clear of all liens, security interests, and encumbrances (except such as are covered by a bond acceptable to Owner indemnifying Owner against any such liens, security interest, or encumbrances); and
(3) All the Work covered by this Application for Payment is in accordance with the Contract Documents and is not defective.

Contractor: _____

Signature: _____ **Date:** _____

Recommended by Engineer		**Approved by Owner**	
By:		**By:**	
Title:		**Title:**	
Date:		**Date:**	
Approved by Funding Agency			
By:		**By:**	
Title:		**Title:**	
Date:		**Date:**	

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Progress Estimate - Lump Sum Work **Contractor's Application for Payment**

Owner:		**Owner's Project No.:**	
Engineer:		**Engineer's Project No.:**	
Contractor:		**Contractor's Project No.:**	
Project:			
Contract:			

Application No.: **Application Period:** **From** **to** **Application Date:**

A	B	C	D	E	F	G	H	I
			Work Completed					
Item No.	Description	Scheduled Value ($)	(D + E) From Previous Application ($)	This Period ($)	Materials Currently Stored (not in D or E) ($)	Work Completed and Materials Stored to Date (D + E + F) ($)	% of Scheduled Value (G / C) (%)	Balance to Finish (C - G) ($)
			Original Contract					
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
	Original Contract Totals	$ -	$ -	$ -	$ -	$ -		$ -

EJCDC C-620 Contractor's Application for Payment
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Progress Estimate - Lump Sum Work

Contractor's Application for Payment

Owner:		**Owner's Project No.:**	
Engineer:		**Engineer's Project No.:**	
Contractor:		**Contractor's Project No.:**	
Project:			
Contract:			

Application No.: _____ **Application Period:** **From** _____ **to** _____ **Application Date:** _____

A	B	C	D	E	F	G	H	I
			Work Completed					
Item No.	Description	Scheduled Value ($)	(D + E) From Previous Application ($)	This Period ($)	Materials Currently Stored (not in D or E) ($)	Work Completed and Materials Stored to Date (D + E + F) ($)	% of Scheduled Value (G / C) (%)	Balance to Finish (C - G) ($)
Change Orders								
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
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						-		-
						-		-
						-		-
						-		-
						-		-
						-		-
	Change Order Totals	$ -	$ -	$ -	$ -	$ -		$ -
Original Contract and Change Orders								
	Project Totals	$ -	$ -	$ -	$ -	$ -		$ -

EJCDC C-620 Contractor's Application for Payment
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CHANGE ORDER NO.: [Number of Change Order]

Owner: **Taylor Bay Beach Club HOA**
Engineer: Gray & Osborne, Inc.
Contractor:
Project: **Procurement of Membrane Equipment System and Services**
Contract Name:
Date Issued:

Owner's Project No.:
Engineer's Project No.: 22848.01
Contractor's Project No.:
Effective Date of Change Order:

The Contract is modified as follows upon execution of this Change Order:

Description:

[Description of the change]

Attachments:**[List documents related to the change]**

Change in Contract Price	**Change in Contract Times [State Contract Times as either a specific date or a number of days]**
Original Contract Price: $ _____	Original Contract Times: Substantial Completion: _____ Ready for final payment: _____
[Increase] [Decrease] from previously approved Change Orders No. 1 to No. **[Number of previous Change Order]**: $ _____	**[Increase] [Decrease]** from previously approved Change Orders No.1 to No. **[Number of previous Change Order]**: Substantial Completion: _____ Ready for final payment: _____
Contract Price prior to this Change Order: $ _____	Contract Times prior to this Change Order: Substantial Completion: _____ Ready for final payment: _____
[Increase] [Decrease] this Change Order: $ _____	**[Increase] [Decrease]** this Change Order: Substantial Completion: _____ Ready for final payment: _____
Contract Price incorporating this Change Order: $ _____	Contract Times with all approved Change Orders: Substantial Completion: _____ Ready for final payment: _____

Recommended by Engineer (if required)	Accepted by Contractor
By: _____	_____
Title: _____	_____
Date: _____	_____
Authorized by Owner	Approved by Funding Agency (if applicable)
By: _____	_____
Title: _____	_____
Date: _____	_____

EJCDC® C-941, Change Order EJCDC® C-941, Change Order, Rev.1.
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ATTACHMENT A.4 – SAMPLE LANGUAGE FOR MANUFACTURER'S CERTIFICATION OF COMPLIANCE

Notes to User:

1. This attachment provides sample language for the Manufacturer's Certification of Compliance with Domestic Preference requirements.

2. Contractor should ensure that Engineer has an approved Manufacturers' Certification prior to any domestic preference item being delivered to the project site.

3. The Manufacturer's Certification must be on letterhead and should indicate the specific item being certified, reference which domestic preference requirement is being certified, and be signed by an authorized company representative.

4. The Manufacturer's Certification may include multiple domestic preference requirements. It is important for the governing domestic preference requirement (whether AIS, BABAA or other) to be clearly included within the certification.

Date:

Company Name:

Company
Address:

Subject: Domestic Preference Requirement Certification for {*Owner's Name* and *Project Name (City, State)},* and Contract Number

I hereby certify that the following product(s) and / or material(s) shipped or provided for the subject project are in full compliance with the Build America, Buy America Act (BABAA) requirements under Title IX of the Infrastructure Investment and Jobs Act (IIJA), Pub. L. 117-58, §§ 70901-70953.

[List common name of items, products and/or materials]

These products and/or materials were manufactured in [Provide location(s) of manufacturing]

[Include signature of authorized representative]

PART 7

TECHNICAL SPECIFICATIONS

TECHNICAL SPECIFICATIONS

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DIVISION 1

GENERAL TECHNICAL REQUIREMENTS

SECTION 01110

SUMMARY OF WORK

PART 1 GENERAL

1.1 SCOPE OF WORK

This Contract Document covers work necessary to provide Membrane Equipment System and Services for the treatment of domestic wastewater at the wastewater treatment facility (WWTF) to be constructed by the Owner as part of the Wastewater Treatment Facility (WWTF) Upgrade Project to be constructed at the existing WWTF site at the following address: 8220 178th Avenue Court SW, Longbranch, Washington 98351

The work to be provided by the Supplier includes, but is not limited to, the following for each Schedule of the Work:

A. PRECONSTRUCTION SERVICES

1. Submission of Design Submittals (Shop Drawings) and other descriptive information as described in Section 01300.

2. Design assistance and review of Construction Drawings.

3. Design and layout of the equipment.

4. Structural calculations as specified along with all data required to perform necessary structural calculations during the design effort.

5. Electrical load information to be used for plant power system and electrical calculations.

6. Attend two design meetings (total) in the Seattle area and participate in three design status conference calls per month for a duration of 5 months. The Supplier shall assume that each meeting shall require 1 full day and each conference call shall last 2 hours. The meetings and conference calls shall, as a minimum, be attended by the Supplier's project manager, the integrator responsible for control panel construction and programming, and the lead design engineer.

B. CONSTRUCTION SERVICES

1. Fabrication and delivery of equipment to the General Contractor at the project site or an approved storage location within 50 miles of the WWTF, including shipping and customs.

2. Factory testing.

3. Programmable Logic Controllers (PLCs)/Operator Interface (OI) hardware design and software programming.

4. Guidance to the General Contractor during installation of the supplier-provided equipment. All work to install the equipment will be completed by the General Contractor.

5. Equipment startup, calibration, and control system tuning.

6. Component and System Testing.

7. Control System Testing.

8. Initial Performance Testing.

9. Submission of Factory and Field Test Reports, PLC and OI Programming, Equipment O&M Manuals, and Manufacturers' Affidavits as specified in Section 01300.

10. Training of Owner's staff.

11. Equipment Operation and Maintenance Manuals.

C. POST-CONSTRUCTION SERVICES

1. Commissioning period assistance.

2. Warranties.

3. On-call performance optimization services.

D. EQUIPMENT SUPPLY

Equipment provided by the Supplier shall include, but not be limited to, the items listed below for the Wastewater Treatment Facility. Equipment to be installed in Hazardous Locations, as described in Division 16, shall be provided as suitable and labeled for the respective environment.

1. Immersed membranes, modules, cassettes, frames and rails, for installation in two membrane basins, as specified in Section 11500.

2. Systems required to withdraw permeate from the membranes, including air extraction systems and vacuum pumps, if required by the Supplier, as specified in Section 11500. If required, one vacuum pump shall be provided per membrane basin, and one additional uninstalled spare pump shall be provided.

3. Systems required to clean the membranes, including pumps, equipment, and control logic for air scouring, backpulsing, backwashing, maintenance or recovery clean systems, as required by the Supplier as specified in Section 11500. If required, one backpulse pump shall be provided for each membrane basin, and one uninstalled spare pump shall be provided.

4. Chemical bulk storage and feed systems, including tanks, pumps, valves, and control equipment as required by the Supplier for cleaning and maintaining the membranes, as specified in Section 11500. For each chemical service, two feed pumps or injectors (one duty, one installed spare) shall be provided.

5. Permeate pumps shall be rotary lobe pumps as specified in Section 11312. A minimum of one dedicated pump shall be provided per membrane basin, and one installed spare pump shall be provided.

6. Positive displacement blowers for air scour as specified in Section 11370. A minimum of one dedicated air scour blower shall be provided per membrane basin, and one installed spare blower shall be provided.

7. Piping located within the membrane basin, including air and permeate headers, as specified in Section 15050.

8. Valves required for the Membrane Equipment System, including valves outside the membrane basins, shipped loose, as specified in Section 15100.

9. Automatic valve operators, electric and pneumatic, as required for Membrane Equipment System control, shipped loose, as specified in Section 15110. Air compressors (one duty and one installed spare) and compressed air systems, if required by the Supplier, shall be provided as specified in Section 11500.

10. Instrumentation sensors, probes, and transmitters, as required for Membrane Equipment System control, as specified in Section 11500 and in Division 13.

11. Control panel for the Membrane Equipment System, including programmable logic controller (PLC) and Operator Interface Unit. Provide control system hardware and software, including programming, as required for Membrane Equipment System controls, as specified in Section 11500 and Division 16.

12. Network interface to the Owner's plant control system, including programming and configuration required to support communications, as specified in Division 16.

13. Lubricants for all supplied equipment as recommended by the manufacturer, in sufficient quantity for a 1-year supply.

14. All associated equipment for a complete and workable Membrane Equipment System as described herein.

1.2 WORK BY OTHERS

The following items will be supplied by others for the Wastewater Treatment Facility, as indicated, and will include:

A. DESIGN

Overall treatment plant process design (By Owner's Engineer).

B. STRUCTURAL (BY THE GENERAL CONTRACTOR)

1. Building for membrane equipment including permeate pumps, blowers, and chemical systems.

2. Partially below grade concrete membrane basins.

3. Equipment access platforms, walkways, ladders, and stairs.

4. Protective coatings for concrete.

5. Imbedded wall spools in concrete tank walls for the various process pipe connections into the membrane basins including sludge wasting, feed pump discharge, scouring air supply, permeate piping and tank drains.

6. Covers over process tanks.

7. Supply of equipment anchor bolts, which shall be sized by the Supplier.

C. MECHANICAL (BY THE GENERAL CONTRACTOR)

1. Influent pumps.

2. Process air blowers.

3. Process air diffusers.

4. Anoxic basin mixer.

5. Sludge recycling and wasting pumps

6. Solids treatment processes.

7. Fine screening equipment.

8. Process and utilities piping, pipe supports, and hangers including all interconnecting piping such as pump and blower piping manifolds, outside of the membrane tanks.

9. Single connection points will be provided by the General Contractor, unless otherwise noted, for each Membrane Basin for the following:

   a. Membrane Effluent (Permeate) Header.

      Each Membrane Basin will have a maximum of one permeate header.

   b. Maintenance clean chemical dilution water

c. Chemical solutions for Maintenance Clean/Recovery Clean:

1. Sodium hypochlorite.

2. Citric acid (or oxalic acid).

3. Other chemicals as required by Supplier.

d. Air Header

Each Membrane Basin will have a maximum of one air supply header.

10. Pipe supports, hanger, and anchor bolts for all piping and equipment located inside the membrane tanks.

11. Hoist and crane equipment above the process tanks and in the equipment building for installation and removal of the membrane cassettes and ancillary equipment. Lifting equipment will be supplied based on lifting weights provided by the Supplier.

12. Installation materials for instrumentation and automatic valves including, but not limited to, air/sample line tubing, fittings, and mountings.

13. Heating and ventilation, including odor control, ductwork and equipment.

D. ELECTRICAL (BY THE GENERAL CONTRACTOR)

1. Plant electrical distribution system including generators, switchboards, utility service equipment, panel boards, transformers, and other equipment necessary to provide power distribution and control for all equipment.

2. Motor controllers including motor control centers and adjustable speed drives.

3. Plant instrumentation, control and SCADA system elements that are not provided by the Supplier. Instrument calibrations and process control tuning for instruments and process equipment not provided by the Supplier. Connection of Supplier's control system to the Owner's plant control system.

4. Electrical wiring interconnections (including wiring, conduit and other appurtenances required to provide power connections as needed) from the electrical power source to the membrane PLC control panel.

5. Electrical wiring interconnections (including wiring, conduit and other appurtenances required to provide power connections as needed) from the plant power distribution and motor control equipment to the membrane system pumps, air blowers, and other membrane system electrical loads.

6. Electrical wiring interconnections (including wiring, conduit and other appurtenances required to provide power connections as needed) from the plant power distribution for lighting, HVAC, freeze protection, intrusion alarms, utility outlets, etc.

7. Instrumentation wiring, conduit, and other appurtenances required to provide connections as needed between the terminal boxes at the membrane equipment, pumps, blowers, etc., and the membrane PLC control panel.

E. OTHER

1. Receiving, unloading, and safe storage of equipment at the respective project site or a storage facility within 50 miles of the WWTF until ready for installation (by General Contractor).

2. Equipment installation (by General Contractor).

3. Raw materials, chemicals, and utilities during equipment startup and operation, excluding lubricants (by Owner and General Contractor).

4. Laboratory services and operating and maintenance personnel during equipment checkout, startup, and operations (by Owner and General Contractor).

5. Any on-site painting or touchup painting of equipment supplied (by General Contractor).

1.3 PROJECT BACKGROUND

A. SCOPE OF WORK

The Owner will construct a new wastewater treatment facility (WWTF) and demolish the existing WWTF. The project involving the demolition of the existing WWTF and construction of the WWTF is called the "Wastewater Treatment Facility Upgrade". The Owner has decided to employ membrane bioreactor (MBR) technology to provide a high level of wastewater treatment. Treated effluent will be discharged into the Puget Sound.

After Supplier selection, the Owner's consulting engineers will use the selected Membrane Equipment Systems as the basis of their wastewater treatment facility design.

The Owner will enter into a contract to purchase Membrane Equipment and Services. This contract will be assigned to the General Contractor prior to the start of construction.

B. ASSIGNMENT OF CONTRACT

The Owner will issue a Notice to Proceed to authorize purchase of the Membrane Equipment System and Services for the WWTF. The Owner will, on a date thereafter, assign portions of the contract for the Membrane Equipment System Supply, Construction Services and Post-construction Services to the Owner's General Contractor. Therefore, the Supplier will become a subcontractor to the General Contractor for the WWTF construction project. At that point in time, the Supplier shall assume toward the General Contractor all the obligations and responsibilities, with the exception of product warranties and extended service contract (if selected), that are assigned to the Owner under this Contract. After assignment to the General Contractor, with the exception of Preconstruction Services, all payments to the Supplier shall be made through the General Contractor.

The Equipment shall be furnished by the Supplier and delivered to the Owner's General Contractor at the WWTF site or an approved storage location within 50 miles of the WWTF for installation by the General Contractor. All workmanship, equipment, and materials incorporated in the work covered under this Contract Document shall be new and of the best available grade or quality.

It is the intent and purpose of these Contract Provisions to furnish the Membrane Equipment System and Services in good working order for the least practical cost to the Owner.

1.4 PROJECT INFORMATION

In Figure 1 a conceptual process flow diagram for the WWTF is provided, which includes the extent of the Supplier's scope of supply. The membranes will be installed in outdoor, covered concrete tanks constructed by others. The process and air scour blowers, permeate pumps, membrane system chemical storage and feed equipment, non-potable water pumps and UV disinfection system will be located in an Equipment Building, a maximum of 8 feet away from and 5 feet higher than the Membrane Basins.

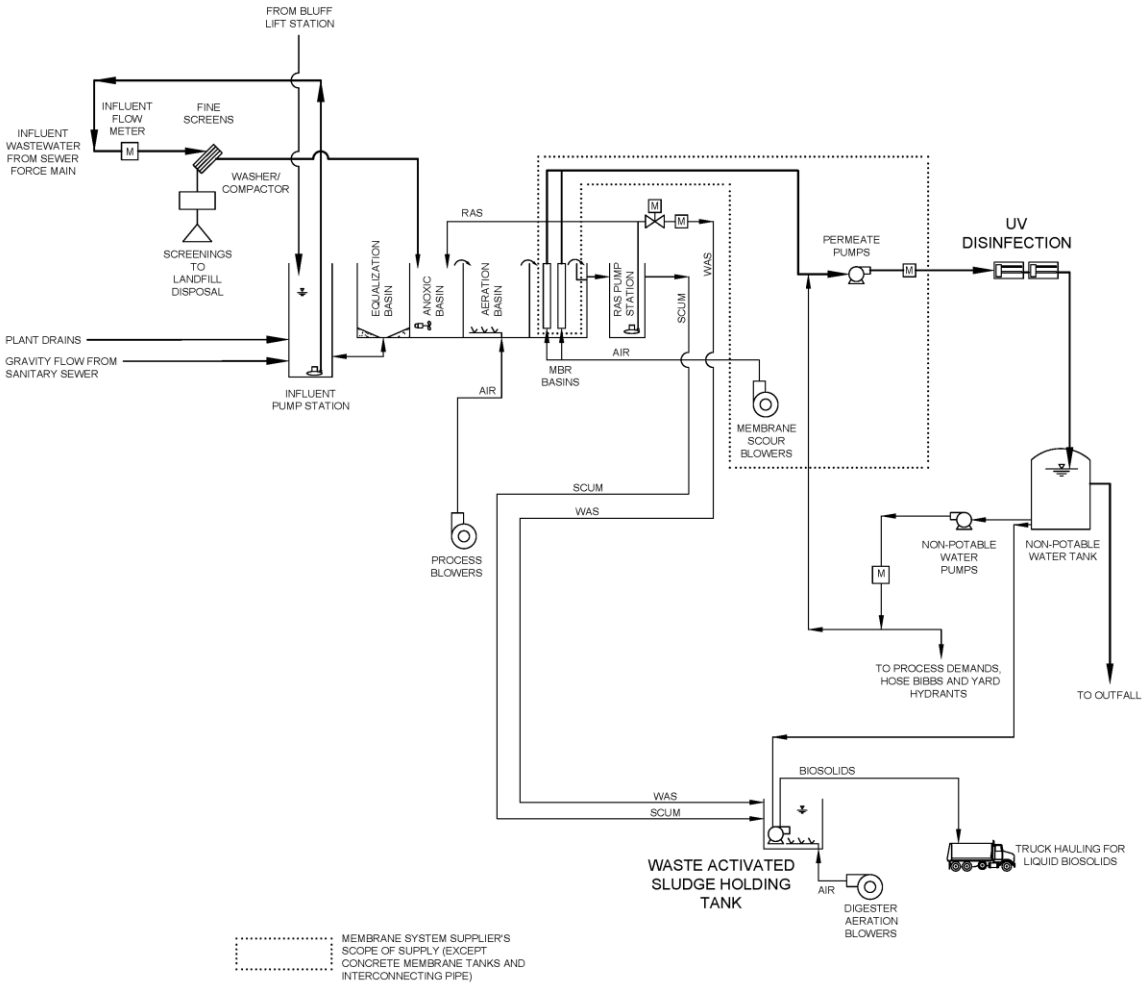


FIGURE 1

WWTF Process Flow Diagram

Wastewater from the service area will be conveyed to the new treatment facility, through one gravity main and one lift station force main. The influent wastewater will be raw wastewater. Upon reaching the treatment facility, the influent flow will enter the influent lift station, and the equalization basin during high flow events. Wastewater will be directed through influent pumps through the headworks facilities, consisting of flow measurement, sampling, and 2-mm fine screening. No flow to the membranes will bypass the screens. There will not be grit removal facilities or primary clarifiers. Screened influent will flow by gravity to an anoxic basin, where it will be mixed with return activated sludge from the return activated sludge (RAS) pump station.

Mixed liquor will then flow by gravity to the aeration basin where fine bubble diffusers will supply oxygen and mixing. It will flow by gravity into two membrane basins. Mixed liquor flow in excess of the membrane permeate flow will pass over the membrane bioreactor outlet weirs and be conveyed by gravity to the RAS pump station. Membrane permeate pumps shall be equipped with variable frequency drives allowing the recirculation and membrane flux rates to vary with the daily average flow rate. The water level in the process anoxic, aeration, and membrane basins will be relatively constant based on the overflow weir elevations.

The biological oxidation of both organic and nitrogenous material and biological denitrification will be performed by the activated sludge system. The aeration basins will be configured in a pre-denitrification mode of operation containing a single, common anoxic basin and one aerobic activated sludge zone. Aeration and mixing of the aerobic zones will be accomplished using fine bubble diffusers supplied with air by blowers, controlled automatically by a cascade loop control algorithm to maintain a specific dissolved oxygen concentration.

Waste activated sludge will be pumped from the RAS pump station to the WAS storage tank prior to being hauled offsite for disposal.

The permeate pumps will discharge filtered effluent through the in-vessel UV disinfection system units to an above grade non-potable water (NPW) tank. The disinfected effluent will flow to the outfall from the NPW tank.

Power will be supplied to the treatment facility via a new electrical service and plant electrical distribution system with a standby generator.

A non-potable water system will supply non-potable water from the NPW tank for various uses around the plant site including the maintenance clean chemical addition system. Non-potable water will be made available to the Supplier at the rate specified in the Supplier's submittals.

1.5 DELIVERY AND SCHEDULE

A. The Supplier shall provide submittals according to the schedule in Section 01300-3.4 for the Work.

B. The Owner will select a General Contractor for construction of the Wastewater Treatment Facility with an expected notice to proceed date of October 2025.

C. Provided that the Supplier receives written notification of approved final submittals 20 weeks prior to June 1, 2026, the Supplier shall deliver the Membrane Equipment System no later than June 1, 2026, to the General Contractor at the project site or an approved storage location within 50 miles of the WWTF. The equipment shall be delivered in a maximum of three separate shipments with all individual components clearly labeled with a reference identification number corresponding to shop assembly drawings and assembly instructions.

D. It is expected that the General Contractor will be required to achieve Substantial Completion by October 1 2027, and therefore, the warranty period for the Supplier shall be expected to begin no later than October 1 2027, and shall be for the time period specified in Section 11000-1.5. Final acceptance shall be expected to be obtained 3 to 6 months after substantial completion.

***** END OF SECTION *****

SECTION 01190

REFERENCE STANDARDS

PART 1 GENERAL

1.1 REFERENCED SPECIFICATIONS AND CODES

The following is a list of organizations and codes that are referenced in sections of these Contract Documents. The Supplier shall be responsible for conducting his work and operations and furnishing equipment in accordance with the current, applicable portions of these Specifications and codes referenced in these Contract Documents. Additional referenced specifications, codes, and standards are listed in related sections of these Specifications.

American Concrete Institute (ACI)
American Gear Manufacturing Association (AGMA)
American Institute of Steel Construction (AISC)
American National Standards Institute, Inc. (ANSI)
American Plywood Association (APA)
American Public Works Association (APWA)
American Society for Testing and Material (ASTM)
American Water Works Association (AWWA)
Anti-friction Bearing Manufacturing Association (AFBMA)
Build America Buy America Act (BABAA)
Concrete Reinforcing Steel Institute (CRSI)
Electrical Testing Laboratories (ETL)
Institute of Electrical and Electronic Engineers (IEEE)
Instrumentation Society of America (ISA)
Joint Industry Conference (JIC) Electrical Standards for Industrial Equipment
Manufacturer's Standardization Society of the Valve and Fitting Industry (MSS)
National Concrete Manufacturer's Association
National Fire Protection Association (NFPA)
National Electrical Code (NEC)
National Electrical Manufacturer's Association (NEMA)
National Plumbing Code (NPC)
Occupational Safety and Health Administration (OSHA)
Specifications and Illuminating Engineering Society (SIES)
Steel Structures Painting Council (SSPC)
Underwriters Laboratory (UL)
United States Department of Agriculture (USDA)
International Building Code (International Code Council) (IBC)
Washington Association of Building Officials (WABO)
Washington State Department of Labor and Industries (WSDL&I)

Washington State Department of Transportation, Standard Specifications for Road, Bridge and Municipal Construction (APWA/WSDOT)
Western Wood Products Association (WWPA)

Electrical equipment, wiring, and construction provided by the Supplier shall meet all labeling and other requirements of the State of Washington Department of Labor and Industries. Additional details of these requirements are included in Division 16.

***** END OF SECTION *****

SECTION 01200

MEASUREMENT AND PAYMENT

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section includes the contract price for each item, and constitutes full compensation for furnishing all equipment, labor, materials, appurtenances, and incidentals and performing all operations necessary to complete the various bid items in accordance with these Specifications. Payment for each item shall be considered as full compensation, notwithstanding that minor features may not be mentioned herein. The Owner reserves the right to make changes should unforeseen conditions necessitate such changes.

1.2 MEASUREMENT

Measurement for all items shall be as indicated in these Specifications for lump sum price items, and outlined in detail in this Section of the Specifications, and further are designated in the Proposal.

1.3 INDIVIDUAL BID ITEMS

Payment for all work will be made at the contract lump sum price as indicated in the Proposal, payment of which shall constitute full compensation, for a complete installation.

A. BASE BID

1. Preconstruction Services

   a. Measurement: Shall be measured by lump sum.

   b. Payment: The lump sum contract price shall include costs for the labor, materials, and equipment required to provide the Preconstruction Services in accordance with the Specifications.

2. Membrane Equipment System

   Supply, Construction Services, and Post-Construction Services

   a. Measurement: Shall be measured by lump sum.

b. Payment: The lump sum contract price shall include all costs for the labor, materials, and equipment required to provide a complete and operable Membrane Equipment System and shall also include all costs for the labor, materials, and equipment, including warranty, required to provide the Construction Services and Post-Construction services in accordance with the Specifications.

B. ALTERNATE A – GUARANTEED MEMBRANE MODULE REPLACEMENT COST

1. Measurement: Shall be measured by the lump sum per membrane module.

2. Payment: This bid item shall be the guaranteed membrane replacement price, for the total cost for all modules supplied with this contract. Supplier shall guarantee that all replacement modules (regardless of quantity), excluding shipping costs, may be purchased by the Owner at this price or lower any time until year 20 following successful completion of the Initial Performance Test except as modified below.

C. ALTERNATE B – EXTENDED WARRANTY FOR SUBMERGED MEMBRANE UNITS

1. Measurement: Shall be measured by lump sum.

2. Payment: The lump sum contract price for EXTENDED WARRANTY FOR SUBMERGED MEMBRANE UNITS shall include all additional costs for the Membrane System Supplier to the Base Bid to extend the repair or replace duration of the warranty on the submerged membrane units, as described in Section 11500 – 1.6 A, from 2 years to 5 years.

D. ALTERNATE C – 10-YEAR MEMBRANE SYSTEM SUPPLIER SERVICE CONTRACT

1. Measurement: Shall be measured by lump sum.

2. Payment: The lump sum contract price for 10-YEAR MEMBRANE SYSTEM SUPPLIER SERVICE CONTRACT shall include all additional costs to provide a 10-year service contract to all Membrane System Supplier, supplied equipment, instrumentation, and programming for plant performance and process optimization to include six site visits per year, unlimited

24/7 phone service, annual membrane inspection with inspection report and unlimited technical assistance via remote access. This item is in addition to site visits, service or technical assistance required elsewhere by the Plans and Specifications.

1.4 PAYMENT SCHEDULE

The Owner will pay the Supplier for Bid Item No. 1 in full upon receipt of the approved 100 percent design submittal.

Unless otherwise entitled to withhold payment, the Owner will pay the General Contractor, who is assigned the Contract, for Bid Item No. 2 according to the following schedule:

Activity	**Payment Percentage**
PLC and OIU Programming Submittal Approval by Engineer	5%
Equipment Delivery	70%
Successful Completion of Initial Performance Test	15%
Approval of Final O&M Manual	5%
Project Acceptance	5%

1.5 PROPERTY DAMAGE CLAIM WITHHOLDING

The Owner may, by its sole discretion, withhold amounts sufficient to pay any property damage claim against the Supplier for which the Owner may have knowledge. Regardless of the informalities of the notice of such a claim arising out of the performance of this contract, the term "property damage claim" shall not include any claim for personal injuries or any claim by persons furnishing supplies or materials or performing labor for the Supplier. The amount withheld will not be paid to the claimant by the Owner, but will be held until either the Supplier secures a written release from the claimant, obtains a court decision that such claim is without merit, or satisfies any judgment in favor of the claimant on such claim. The Owner reserves the right to make payment to the Supplier out of such amounts withheld if the Owner is of the opinion that the claim or claims are without merit.

***** END OF SECTION *****

SECTION 01300

SUBMITTALS

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section includes requirements that shall apply to all equipment and materials supplied on the Project.

The Supplier shall be responsible for the accuracy and completeness of the information contained in each submittal, and shall ensure that the material, equipment, or method of work shall be as described in the submittal. The Supplier shall verify that all features of all products conform to the requirements of the Specifications. Submittal documents shall be clearly edited to indicate only those items, models, or series of equipment that are being submitted for review. All extraneous materials shall be crossed out or otherwise obliterated. The Supplier shall ensure that there is no conflict with other submittals and notify the Engineer in each case where his submittal may affect the work of another contractor or the Owner. Where approved substitutions of specified equipment affect other materials or equipment, mechanical, structural, or electrical work, the Supplier shall ensure that there are no conflicts with the other submittals.

1.2 RELATED WORK SPECIFIED ELSEWHERE

Section	Item
01110	Summary of Work
11000	Equipment General Provisions
11010	Vibration and Critical Speed Limitations
Division 11	Equipment
Division 13	Special Construction
Division 15	Mechanical
Division 16	Electrical

1.3 WORK INCLUDED

Submittals required for this work shall include any or all of the following as required by the particular Specification section.

A. BID SUBMITTAL

As Specified in the Instructions to Bidders and Selection Process.

B. Design Submittals (60- and 100-percent submittals).

C. Factory and Field Test Reports.

D. PLC and Operator Interface Unit (OIU) Programming Submittal.

E. Equipment O&M Manual Submittal (Drafts and Final).

F. Manufacturer's Affidavits.

G. Manufacturer's Build America, Buy America Act Statements of Compliance or waivers.

1.4 SUBMITTAL INFORMATION

Shop, catalog, and other appropriate drawings and information shall be submitted to the Engineer for review prior to fabrication or ordering of all equipment and materials specified. The number of copies of submittal information to be submitted shall be as indicated below.

All submittal information shall be sent by the Supplier to the Engineer. The Supplier shall assign a separate submittal number to each item or group of items that relate to each Specification section. Submittal numbers shall be assigned in consecutive ascending order, with the first project submittal assigned the number "1." Resubmittals shall be numbered using the same number followed by an alphabetical suffix. All submittals shall bear the Supplier's certification that he has reviewed, checked, and approved the submittal information prior to transmitting to the Engineer. The submittal number and related specification section shall be marked on each submittal.

Submittals shall include electronic copy (pdf, Excel, AutoCad, or MS Word file formats). Only the final O&M Manual Submittal will also require a hard copy as specified herein. Electronic submittal drawings shall be formatted in pdf and AutoCAD format and hard copy submittals of drawings shall be to scale and 11" x 17" format. Submittals shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment and evaluation of compliance with the Contract. Where applicable, submittals shall include information on standards of construction and/or manufacturing and codes to which the individual component conforms.

PART 2 PRODUCTS

2.1 GENERAL

Except when hard copies are specifically required, when the Contract Documents require a submittal, the Supplier shall submit the specified information as PDF files via a secure FTP site or via CD, with a table of contents bookmarked to provide a navigation link to each section of the submittal. All drawings shall also be submitted as separate AutoCad files. Submittals shall be comprehensive and complete enough to enable review of all details of the system design. Bidders shall note that although some items listed herein are redundant to the bid submittal requirements, they shall be required to be submitted with the 60 percent submittal.

See Part 3.4 of this Section for the schedule of submittals and submittal review.

The Engineer shall review the submittal and provide written comments and marked-up submittal materials. The returned submittal shall indicate one of the following actions:

1. If the review indicates that the material, equipment, or work method complies with the project Specifications, submittal copies will be marked "NO EXCEPTIONS TAKEN." In this event, the Supplier may begin to implement the work method or fabricate or purchase the material or equipment covered by the submittal.

2. If the review indicates limited corrections are required, copies will be marked "MAKE CORRECTIONS NOTED." The Supplier may begin implementing the work method or fabricating or purchasing the material and equipment covered by the submittal in accordance with the noted corrections. Where submittal information will be incorporated in O&M data, a corrected copy shall be provided.

3. If the review reveals that the submittal is insufficient or contains incorrect data, copies will be marked "AMEND AND RESUBMIT." Except at his own risk, the Supplier shall not undertake work covered by this submittal until it has been revised, resubmitted, and returned marked either "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED."

4. If the review indicates that the material, equipment, or work method does not comply with the project Specifications, copies of the submittal will be marked "REJECTED – SEE REMARKS." Submittals with deviations that have not been identified clearly

may be rejected. Except at his own risk, the Supplier shall not undertake the work covered by such submittals until a new submittal is made and returned marked either "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED."

2.2 DESIGN SUBMITTALS

A. TYPES OF SUBMITTAL CONTENTS

1. Manufacturer's Literature

Where the contents of submitted literature include data not pertinent to the submittal, the portion(s) of the contents being submitted for the Engineer's review shall be clearly indicated.

2. Shop Drawings

Shop drawings shall be submitted in the form of blue-line or black-line prints of each sheet. Blueprint submittals will not be acceptable.

All shop drawings shall be accurately drawn to a scale sufficiently large enough to show pertinent features and method of connection or joining. On all shop drawings, figure dimensions shall be used as opposed to scaled dimensions.

3. Design Calculations

Where required in the Specifications, design calculations shall be submitted to the Engineer. Design calculations shall be complete, concise, and in an easy-to-read format. If required in the particular section to which the design calculations pertain, test data and calculations from previous full-scale pilot or treatment plant testing shall be submitted with the design calculations. All design calculations shall be stamped by a Professional Engineer.

4. Test Reports

Copies of all test reports shall be submitted to the Engineer.

5. Build America Buy America Compliance

Applicable submittals shall include a statement that the submitted item complies with the Build America, Buy America Act (BABAA) requirements. If an item has received a USDA approved

waiver exempting it from BABAA, that may be submitted instead where specified.

B. MINIMUM SUBMITTAL REQUIREMENTS

1. Submit the 100 percent design submittals as specified herein for Engineer's review. Items marked with an asterisk (*) must be submitted in the 60 percent design submittal.

2. Design submittals shall be submitted showing sizes and arrangement of equipment, and foundations required, performance characteristics, fan curves and pump curves, control diagrams, wiring diagrams, motor data sheets, methods of assembly, ductwork details, and connections to other work. Submittals shall be dated and signed as certified for use in construction of this Project. However, the manufacturer's drawings shall not deviate from the Specifications as to location, size, type, and design of equipment.

The following minimum requirements shall accompany all equipment submittals:

1. (*) Exceptions taken to the Specifications or to the proposed pretreatment and a detailed explanation as to why exception is being taken.

2. (*) Overall dimensions.

3. (*) Mounting arrangement and dimensions.

4. (*) Plan and section views of submerged membrane units, permeate pumps, and air scour blowers in both PDF and AutoCad format.

5. (*) Description of materials.

6. (*) Connection sizes and orientation.

7. Capacity and location of lifting eyes.

8. Motor arrangement showing location of electrical connections.

9. Rating data - Mechanical and Electrical as applicable.

10. Detailed electrical wiring diagrams, showing component designation and rating, and the connection points, associated terminals and cable identification for connection to the power supply and process control system. Diagrams shall include dimensioned elevation views of electrical control panels and enclosures, and shall clearly show conduit entry/exit locations. Diagrams shall clearly differentiate factory wiring from field wiring, and shall indicate minimum wire sizes and type of conductors required for field wiring circuits.

11. For all equipment which requires an electrical power supply or is connected to electrical control or sensing circuits, a certification that the component or components included in the submittal meet the requirements of Section 16010-1.6-E.

12. (*) Motor Data, including bearing and enclosure information.

13. (*) Electrical load data for all electrical components (if supplied separately) and for the overall system necessary to plant electrical load calculations. The data shall include information shown on the equipment nameplate and consist of horsepower for any motors, power consumption for resistive and other loads, and any other ratings depicting total power consumption under normal operating conditions.

14. For rotating mechanical equipment, provide manufacturer's certified calculations and data showing location of critical speeds in relation to operating speeds.

15. For equipment that is driven with a motor powered with a variable-frequency drive, the Supplier shall provide information on the limits and ranges of the vibration, torsion, mechanical, thermal, and similar characteristics of the driven equipment, where such limits or ranges may impact the speed, time, or ramp settings of the variable-frequency drive. These points and ranges shall be included as part of the submittal information for the driven item of equipment. The purpose of this requirement is to allow coordination of the variable-frequency drive configuration with the limitations of the driven equipment.

16. Seismic calculations: Submit calculations to demonstrate that the equipment meets the seismic design requirement of the 2021 *International Building Code* (IBC) and ASCE 7-05 *Minimum Design Loads for Buildings and Other Structures*, Seismic Design

for Nonstructural Components, as referenced and amended by the IBC.

17. Spare and Loose Parts Supplied: List of any special tools and/or spare parts required and being furnished, if any. Turn over inventory and parts to the Owner. The Owner's written acknowledgment of receipt is required for project completion. Loose parts are defined as items such as special tools, keys, safety equipment, and portable equipment.

18. Submittal shall include a PDF file of each Specification for each type of equipment submitted with comments embedded in red text to indicate where and how the submitted components differ from the Specification and the with a check mark next to each paragraph for which the submitted equipment will fully comply. Proof of compliance with the specification component and material requirements is also required with the submittal.

C. MEMBRANE EQUIPMENT SYSTEM

1. Detailed process and instrumentation diagrams (P&IDs). The detailed P&IDs shall include all flows, automated valves, pipe sizes, and instrumentation including measurement ranges. The detailed P&IDs shall also include all signal information and shall have functional descriptions of each item. P&IDs shall clearly identify equipment, pipes, electrical components, and instrumentation. The P&IDs shall show all equipment required for a complete and operational system and shall clearly indicate which equipment items, piping, and electrical connections are not included in the Supplier's bid price.

2. (*) A Scope of Supply List. The scope of supply list shall include a detailed list of all mechanical and electrical equipment items, including all instrumentation, programmable logic controller, operator interface, and gauges that are included in the Supplier's bid. The scope of supply list shall include the equipment manufacturer's name and model, electrical requirements and connected loads, motor size and type, and features and accessories.

3. (*) Process control narratives, including, but not limited to, start-up and shut-down procedures, cleaning procedures, and recommended maintenance procedures.

4. (*) A list of process discrete or analog inputs and outputs that are required to operate the Membrane Equipment System, but are not in the Supplier's scope of supply list.

5. (*) Proposed net, instantaneous and minimum flux rates, at maximum day flow and peak day flow, corrected for the temperature range provided in Part 2.3 of Section 11500.

6. (*) Title 22 Certification: Documentation that the membrane equipment has been recognized by the California Department of Public Health as being acceptable for compliance with the treatment requirements of the State of California Recycled Water Criteria (Title 22).

7. Mechanical Information

    a. (*) Plans and sections of the equipment in its proposed location in AutoCad and PDF format. Recommended size, depth, volume and arrangement of membrane basins.

    b. (*) Plan view of each component and/or skid showing all process connection and tie-in points and location and size of all utility connection points in AutoCad and PDF format.

    c. (*) All four section views of each component and/or skid, in AutoCad and PDF format, showing all process connection and tie-in points and location and size of all utility connection points.

    d. Details of equipment and components.

    e. Weights of each skid, including dry weight and operating weight. Weights of the heaviest removable pieces of equipment from each skid, weight of individual auxiliary pieces of equipment including but not limited to pumps, conveyors and storage tanks. Drawings showing the locations and loads associated with each bearing point.

    f. (*) Connection and interconnection diagrams and drawings showing connection points and piping required between component parts of equipment and/or between equipment and outside facilities.

    g. Fabrication details for any field fabricated items.

h. (*) Manufacturer's data, including catalog cut, materials of construction, identifying trade name and model designation, and equipment weight.

i. Information on codes to which the equipment conforms.

j. (*) Provide the required lifting capacity of hoists and cranes (for wet equipment) for all pieces of equipment to be provided including membrane cassette frames.

k. Paint and coating system for each equipment item.

l. Supplier's required membrane system handling procedures, including, but not limited to, protection of equipment prior to, and during, installation, removal of membrane preservatives, and extended out-of-service storage and handling.

8. Electrical Information

a. (*) Equipment list of power loads at 480V and 120V with the number of phases, ampacity, kVA, kW, and hp ratings shall be included on scope of supply list.

b. Electrical drawings, including power/wiring plans and details, one line diagrams, cable/conduit schedule, physical location of each device with electrical or wiring connections, terminal drawings for each device with electrical connection, indicating wiring to be provided by the Supplier and wiring to be provided by General Contractor, with clear indication of motor horsepower and electrical load.

c. Approximate footprint of expected individual control system enclosures.

d. For each motor to be supplied provide motor control wiring diagrams, quantities and sizes of variable speed drives required, and quantities and sizes of motor starters required to be supplied and installed by others.

e. Instrumentation and control drawings, including instrument location plans, instrument list (with manufacturer, model number, and calibrations), wiring diagrams, elementary

diagrams, loop diagrams, control system network diagrams, electrical motor control schematics.

f. Electrical panel schematics, panel fabrication drawings, and arrangement drawings.

g. Manufacturer's data including all manufactured equipment supplied by the Supplier showing dimensions, weights, and physical and electrical requirements.

h. Hazardous Location electrical classification rating.

D. INSTRUMENTATION EQUIPMENT

1. (*) Instrumentation equipment items shall be shown on the detailed Membrane Equipment submittal drawings and scope of supply list.

2. The pressure, level, flow, temperature and turbidity calibration ranges for each equipment item shall be provided in the form of a summary table. List pressure, flow or level switch activation setpoints, and identify as increasing or decreasing setpoints.

3. One manufacturer's O&M manual shall be provided for every instrument model number supplied for the project. If a single O&M manual covers multiple model numbers, then a single manual for those model numbers is satisfactory.

4. Provide design calculations for all flow meters to verify that meter size/selection meets the required accuracies stated in Division 13.

E. PIPING SYSTEMS

1. Submit data, catalog cuts to show that the following items conform to the Specification requirements:

a. Pipe, fittings, hoses, and accessories.

b. Valves and appurtenances.

c. Couplings and couplers.

d. Manual, electric and pneumatic valve operators.

2. The 100 percent design submittals must include a schedule of electric and pneumatic valve operators, including manufacturer, model, size, control functions, etc. For pneumatic valve operators, provide the air flow, pressure and quality requirements for each valve, and in total.

3. The Supplier shall furnish manufacturer's installation and operation manuals, bulletins, and spare parts lists for all piping system materials, valves and valve operators.

F. ELECTRICAL

1. Provide Electrical submittals as a single package, with proposed products and materials grouped according to the sections specified in Division 16.

2. Electrical Product Data

Provide manufacturer's product technical data, including, but not limited to:

a. Identification of the manufacturer.

b. Manufacturer's product descriptive bulletin.

c. Current, voltage, nameplate, load, impedance, and other electrical data pertinent to the Project and necessary to assure compliance with the Specifications and Drawings.

d. Electrical data for all equipment that uses electric power used by the Engineer to prepare load calculations, backup power calculations, and electrical service calculations for the facility. This includes the power consumption, voltage, phase, and motor starting arrangements.

e. Equipment dimensions.

f. For each product type indicate the method by which the product conforms to the requirements of 296-46B-010 (8) or meets the exceptions in RCW 19.28.

3. Electrical Shop Drawings

Submit Shop Drawings containing detailed drawings, diagrams and instructions for installing, operating and maintaining the material and equipment proposed for installation in the electrical work.

Provide technical drawings as follows:

a. Provide diagrams and drawings similar and named in a similar fashion for all technical drawings submittals.

b. Use diagrams and symbols for shop drawings that conform to Joint Industry Conference (JIC) Electrical Standards for Industrial Equipment and/or NEMA, Industrial Control Systems, ANSI and IEEE standards, latest revisions. Prepare drawings on size A, B or D sheets in a format similar to nationally recognized drawing standards.

c. Provide electrical elementary wiring diagrams for the electrical control systems showing the wiring of electrical control items, such as starters, control systems, interlocks, switches, programmable controllers, microprocessor controllers, and relays.

d. Provide scaled and dimensioned panel or enclosure face layout drawing; panel/subpanel material of construction, dimensions, and weight; conduit and wiring access locations; and material wiring and terminal block drawings for each control panel.

e. Provide schematic interconnection diagrams and/or Process Instrumentation Drawings (PID) diagrams for each separate control system or control panel. Each control diagram shall show a schematic representation of process equipment and locations of switches, meters, automatic valves, and indicators, controllers and recorders. Correct operating settings and ranges for each control instrument shall be marked on these diagrams.

4. PLC Shop Drawings

a. Drawings

i. System diagram showing the arrangement, connection and interconnection of PLC system components.

ii. Wiring diagrams for the PLC equipment in each control enclosure showing devices, wiring internal to the center, terminal blocks, and distinguishing field wiring from wiring internal to the enclosure.

b. Schedule of system I/O including the following data:

i. I/O point, with name, tag number, and indication of type and the characteristics of the I/O signal.

c. Listing of spare parts provided with the system.

d. Motor control diagrams depicting motor control circuits for all motors to be provided by the Supplier with the motor controller, starter or variable frequency drive to be provided by the General Contractor.

G. PLC AND OIU HARDWARE AND SOFTWARE

1. Product Data

a. Manufacturer's data sheets for each hardware component including specific model numbers for each device.

b. Manufacturer's information for software components including specific version or release numbers for each program, module, driver, or similar software.

c. List of Licenses required and limits for their application.

2. Manuals

a. Manufacturer's installation manual, operation, programming, and maintenance manual(s) for each component and/or device.

2.3 FACTORY AND FIELD TEST REPORTS

Factory and field testing shall be completed as required in Sections 01800 and 11000, and in the respective technical sections of the specifications. Where testing is required, a minimum of six copies of all test reports shall be submitted to the Engineer.

Note that factory tests are inherent in many reference standards. The requirement for a factory test in a referenced standard shall make that requirement a part of these Specifications. Conduct factory tests at the same speeds at which the equipment will operate in the field, except as noted.

Where specifically noted, performance tests may be witnessed by the Owner or its representative. The Supplier shall inform the Engineer 3 weeks prior to allow arrangements to be made for witness of such tests. When non-witnessed tests are performed, certified test results shall be supplied by the Supplier to the Engineer.

Factory testing of pumps shall be done in accordance with the requirements and standards of the Hydraulic Institute. Provide certified pump curves for all pumps. Tests of other equipment shall conform to the requirements set forth in these Specifications.

Each piece of equipment, for which certified witnessed or non witnessed performance tests are required, shall be accompanied by a completed form which will contain at least the following information:

1. Owner’s name and location of project.

2. Supplier’s name and subcontractor (if applicable).

3. Name of item being submitted.

4. Specification reference by section, paragraph, and page number.

5. Data on item (manufacturer, general descriptive data, dimensions, size of connections, speeds, performance curves, and serial number).

6. Motor data, type, voltage, frequency, phase, full load amperes, starter type, frame size, enclosure, insulation type, NEMA Code letter, dimensions, service factor, serial number.

7. Date and signature of person certifying performance.

2.4 PLC AND OIU PROGRAMMING SUBMITTALS

A. SCHEDULE

Provide to the Engineer subsequent to the acceptance of the 100 percent design submittal but no less than 3 months prior to the control systems test.

B. CONTENTS

The PLC and Operator Interface Unit (OIU) programming submittals shall contain the following information:

1. For each PLC, include the project files created by the PLC programming software. The PLC code shall include provisions for communications with the plant PLC control and SCADA system as described below and in Division 16. These project files shall be sufficient to reload the operating and editable code to the PLC using the PLC programming software. The project files shall include annotation and commenting (in the English language) sufficient to allow a reviewer to follow the PLC logic.

2. For each PLC, include PLC tag names exported to a tab or comma delimitated text file. This text file shall include all tag names accessible from a remote PLC, OIU, or HMI. For each tag name, the text file shall include the name, description, data type, and any additional information required to retrieve the data remotely. Data to be communicated shall include but is not limited to the following:

    a. Operational setpoints, biases, alarm settings.

    b. Process production and quality values (levels, flows, pressures, turbidity, etc.).

    c. Motor stops, starts, and run feedbacks.

    d. Membrane alarms, permissives, and interlocks.

    e. Communication error reporting (heartbeat and handshaking).

3. For each PLC, include a PDF of the PLC code. Create the PDF using the PLC programming software and a software-based PDF creator. (For this item, a PDF created from scanned documents is

not acceptable.) The PDF shall include the PLC configuration, a complete tag name cross-reference, and all of the PLC code.

4. For each PLC, include a separate cross reference list of PLC control tagname to the tagname used in the OIU and the physical equipment tag number.

5. For each Operator Interface Unit (OIU), include the project files created by the OIU programming software. These project files shall be sufficient to reload the operating and editable configuration to the OIU using the OIU programming software.

6. Provide PDF copies of all OIU screens developed.

7. For each OIU, include a separate cross reference list of OIU control tagname to the tagname used in the PLC and the physical equipment tag number.

8. The files included in submittal may be provided as:

    a. Four copies each recorded to a finalized, single session write once optical media.

2.5 EQUIPMENT O&M MANUALS

The Supplier shall submit the O&M Manuals as PDF files via a secure FTP site or via CD, with a table of contents bookmarked to provide a navigation link to each section of the submittal. Upon approval of the O&M manual, the Supplier shall provide one final set of the approved equipment O&M Manuals compiled as a complete set in a three ringed binder, neatly coordinated, tabbed, indexed with equipment specification numbers and a table of contents, as well a the PDF files and AutoCad files as specified herein.

Any field changes shall be documented in the final O&M Manual submittal, including final electrical wiring, control and PLC I/O diagrams. Provide final manuals with Record Drawings of the work upon completion of the work in both PDF and AutoCad format.

The following information shall be furnished for all items of equipment installed on the project requiring operational and/or maintenance procedures, and for any additional items indicated by the Engineer.

A. LUBRICATION INFORMATION

This shall consist of the manufacturer's recommendations regarding the lubricants to be used and the lubrication schedule to be followed.

B. WIRING AND CONTROL DIAGRAMS

Diagrams shall show internal and connection wiring along with all terminal numbers and designations for connection points to systems provided by others.

C. START-UP PROCEDURES

These instructions consist of equipment manufacturer's recommendations for installation, adjustment, calibration, and troubleshooting.

D. OPERATING PROCEDURES

These instructions consist of the equipment manufacturer's recommended step-by-step procedures for starting, operating, and stopping the equipment under specified modes of operation. These instructions shall include a description of operating the equipment via the OIU and descriptions of the screens and displays as well as alarm notification provided via the OIU.

E. CALIBRATION AND SETUP SHEETS FOR FIELD INSTRUMENTS

Provide a final installed calibration and setup sheet for each field instrument that requires setup and calibration. Document only those setup parameters that have been changed from the as-shipped (factory default) parameters.

F. PREVENTIVE MAINTENANCE PROCEDURES

These instructions consist of the equipment manufacturer's recommended steps and schedules for maintaining the equipment.

G. OVERHAUL INSTRUCTIONS

These instructions consist of the manufacturer's directions for the disassembly, repair, and reassembly of the equipment and any safety precautions that must be observed while performing the work.

H. PARTS LIST

This list consists of the generic title and identification number of each component part of the equipment.

I. SPARE PARTS LIST

This list consists of the manufacturer's recommendations of number of parts, which should be stored by the Owner and any special storage precautions, which may be required. Besides the specified spare parts, furnish a complete list of additional recommended spare parts and supplies, for each piece of equipment furnished with current prices and a source of supply.

J. EXPLODED VIEW

Exploded or cut views of equipment shall be provided if available as a standard item of the manufacturer's information. When exploded or cut views are not available, plan and section views shall be provided with detailed callouts.

K. SPECIFIC INFORMATION

Where items of information not included in the above list are required, they will be provided as described in the specifications for the equipment.

In addition, the following items of equipment shall be provided with Maintenance Information Summaries in each appropriate section of the equipment manuals, prepared according to the format specified herein:

- Membrane equipment
- Pumps
- Compressors
- Blowers
- Instrumentation
- Valves and automatic valve operators (larger than 1 inch in size)
- Electrical equipment, including local control panels
- Control panel including PLC and operator interface hardware and software

Maintenance information summaries shall be prepared on 8-1/2-inch x 11-inch paper only and shall contain the following information compiled from manufacturer's recommendations in the order shown.

1. Description or name of item of equipment.
2. Manufacturer.

3. Name, address, and telephone number of local manufacturer's representative.
4. Serial number (where applicable).
5. Equipment nameplate data including model number.
6. Recommended maintenance procedures:
    a. Description of procedures.
    b. Maintenance frequency required.
    c. Lubricant(s) or other materials required (where applicable), including type of lubricant, lubricant manufacturer, and specific compound.
    d. Additional information as required for proper maintenance.
7. Recommended spare parts (where applicable).

The maintenance information summaries shall be placed at the beginning of the manual.

All operation and maintenance information shall be comprehensive and detailed, and shall contain information adequately covering all normal operation and maintenance procedures.

For ease of identification, each manufacturer's brochure and manual shall be appropriately labeled with the equipment name and equipment specification number as it appears in the project Specifications. The information shall be organized in three-ring binders with a maximum 3 inch width per volume. The binders shall be provided with a table of contents and tab sheets to permit easy location of desired information.

All information shall be specifically for items of equipment installed as part of the Project. Material not directly applicable shall be removed or omitted from catalogs or other printed information. If manufacturer's standard brochures and manuals are used to describe operating and maintenance procedures, such brochures, and manuals shall be modified to reflect only the model or series of equipment used on this project. Extraneous material shall be crossed out neatly or otherwise annotated or eliminated.

Lubricants shall be described in detail, including type, recommended manufacturer, and manufacturer's specific compound to be used.

It shall be the responsibility of the Supplier to ensure that all operation and maintenance materials are obtained. Material submitted must meet the approval of the Engineer prior to project acceptance.

All costs of furnishing operation and maintenance materials, as herein specified, shall be merged into the prices bid for applicable items of equipment in the Proposal.

Only equipment and materials properly installed and operating in good order with approved Operational and Maintenance information will be recommended for acceptance in the final work.

Each O&M Manual shall include a 2-disc optical media 3-hole binder sleeve. The O&M Manual shall include a copy of the information from "PLC and OIU Programming Submittal" incorporating any revisions through the successful completion of the performance test. The optical media shall be written as a single session in disc at once mode.

2.6 MANUFACTURER'S AFFIDAVITS

Equipment manufacturers, or their authorized representatives, shall each submit a notarized written report with respect to operational startup of his equipment certifying that:

1. The equipment has been properly installed and lubricated;

2. The equipment is in accurate alignment;

3. The manufacturer was present when the equipment was placed into operation;

4. The manufacturer has checked, inspected, and adjusted the equipment as necessary;

5. The equipment is free from any undue stress imposed by connecting piping or anchor bolts;

6. The equipment is not imposing any undue stress on any connecting members;

7. The equipment has been operated satisfactorily under full load conditions;

8. The manufacturer has inspected his equipment during the operational demonstrations and system validation tests to the extent specified; and

9. The equipment is fully covered under the terms of the guarantee.

Equipment for which Affidavits shall be provided includes the following:

1. Membrane Equipment (11500)

2. Pumps (Division 11)

3. Blowers (Division 11)

4. Instrumentation (Division 13)

5. Automated Valves (Division 15)

PART 3 EXECUTION

3.1 IDENTIFICATION OF SUBMITTALS

A. GENERAL

Each submittal shall be accompanied by a letter of transmittal showing the date of transmittal, specification section to which the submittal pertains, submittal number, and a brief description of the material submitted.

B. RESUBMITTALS

When material is resubmitted for any reason, it shall be submitted under a new letter of transmittal and referenced to the previous submittal.

3.2 REVIEW OF SUBMITTALS

The Engineer shall review all submittals for general conformance with the design and other requirements of the Contract Documents. Markings or comments shall not be construed as relieving the Supplier from compliance with the Contract Documents. Submittals may be rejected based on inadequate information and/or not meeting the requirements of the Specifications. Rejection of submittals requires action on the part of the Supplier to correct the reason for the rejection. The Supplier remains responsible for details and accuracy, for confirming and correlating all quantities and dimensions, for selecting fabrication processes and for techniques of assembly and installation.

3.3 COORDINATION OF DESIGN SUBMITTALS

A. GENERAL

Prior to submittal for review by the Engineer, all data shall be fully coordinated by the Supplier, including the following:

1. All field dimensions and conditions.

2. All trades and public agencies involved, including necessary approvals.

3. All deviations from the Contract Documents.

B. GROUPING OF SUBMITTALS

1. All submittals shall be grouped with associated items, unless otherwise specifically permitted by the Engineer.

2. The Engineer may reject the submittals in their entirety or any part thereof, if not in accordance with the Contract Documents.

C. CERTIFICATION

Submittals shall be accompanied with a signed cover letter certifying that the Supplier has reviewed, checked, and approved the shop drawings prior to forwarding them to the Engineer.

3.4 TIMING OF DESIGN SUBMITTALS

Design submittals, as part of preconstruction services, shall be received by the Engineer according to the following schedule, subject to the Liquidated Damages listed in the Proposal:

A. 60-percent design submittals – 30 days following Notice to Proceed (NTP).

B. Receipt of Engineer's review comments – 45 days following NTP.

C. 100-percent design submittals – 75 days following NTP.

The following submittals shall be submitted by the Supplier as part of the equipment supply, construction services, and post construction services:

A. Factory and Field Test Reports.

B. PLC and OIU Programming Submittal.

C. Equipment O&M Manual Submittal (Drafts and Final).

D. Manufacturer's Affidavits.

No additional or separate payment will be made for costs of delays occasioned by tardiness of submittals on the part of the Supplier or the Engineer's requirement to amend submittals.

3.5 EQUIPMENT O&M MANUALS

All final manufacturers' equipment manuals submitted will be retained by the Engineer. Provide four copies of the final manuals. Prior to submittal, the Supplier shall check the manuals for accuracy and completeness in accordance with Part 2.5 of this Section. The Supplier shall verify the serial number(s) of the equipment actually installed with that described in the manual. The manual shall be bound in post binders, indexed to the Specifications, and be consistent with the final O&M manuals provided by the General Contractor.

Prior to the 95 percent payment for project work, the final equipment manuals shall have been submitted to and approved by the Engineer. Supplier shall maintain equipment manual files until final approval copies have been approved by the Engineer prior to 95 percent payment.

***** END OF SECTION *****

SECTION 01800

TESTING, COMMISSIONING, AND TRAINING

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section is the testing, commissioning, and training performed by the Supplier for all mechanical, electrical, and instrumentation systems included with the Membrane Equipment System, at the Taylor Bay Wastewater Treatment Facility, functioning as a completed facility and as the completed project. The Supplier must coordinate with the Owner and the General Contractor to perform the testing, commissioning and training.

See Sections 11000 and 11500 for additional mechanical equipment testing requirements. See also Section 16050 for additional electrical and instrumentation system testing requirements.

1.2 RELATED WORK SPECIFIED ELSEWHERE

Section	Item
11000	Equipment General Provisions
11500	Membrane Equipment
Division 11	Equipment
Division 15	Mechanical
Division 16	Electrical

1.3 TESTING

A. GENERAL REQUIREMENTS

All equipment and partially complete or fully completed portions of the work included in this Contract shall be tested and inspected by the Supplier to prove compliance with the Contract requirements. Unless otherwise specified, all costs of testing, including temporary facilities and connections, shall be borne by the Supplier. For the purpose of this Section, equipment shall mean any mechanical, electrical, instrumentation, or other device with one or more moving parts or devices requiring an electrical, pneumatic, or hydraulic connection.

No tests specified herein shall be applied until the item to be tested has been inspected and approval given by the Engineer for the application of such test.

Tests and inspection shall include:

1. Factory Tests and delivery acceptance tests and inspections.

2. Control Systems Tests (see Division 16 for additional information)

3. The Component and System Tests (see Section 11500 and other Division 11 Specification Sections).

4. Initial Performance Test of the Membrane Equipment System.

5. The commissioning of the completed Membrane Equipment System by Owner personnel.

Tests and inspections, unless otherwise specified or accepted, shall be in accordance with the recognized standards of the industry. The Supplier shall see that scheduling and performance of all tests are coordinated with the Owner, the General Contractor, involved subcontractors, and suppliers. The Supplier shall allow for up to two additional setpoint changes per adjustable system variable during testing. No extra costs or time allowances shall be provided as long as this setpoint allowance is not exceeded.

Prior to equipment start-up, the Supplier shall provide written certification that the Membrane Equipment System has been installed in accordance with the manufacturers' recommendations. The form of evidence of satisfactory fulfillment of delivery acceptance test and inspection requirements shall be at the discretion of the Engineer, either by tests and inspections carried out in his presence or by certificates or reports of tests and inspections carried out by approved persons or organizations. The Supplier shall provide and use forms that include all test information, including specified operational parameters. The content of the forms used shall be acceptable to the Engineer.

A master test log shall be maintained by the Supplier in either Word or Excel file, which shall cover all tests including piping, equipment, electrical, and instrumentation. The master test log shall be provided with weekly after updating for transmittal to the Engineer. The master test log shall be transmitted to the Engineer upon completion of the Project.

B. FACTORY TESTS AND DELIVERY ACCEPTANCE TESTS AND INSPECTIONS

The factory tests and delivery acceptance tests and inspections shall be at the Supplier's expense for any equipment specified herein and shall include the following:

1. The Supplier shall perform a factory test on the System prior to delivery of the System. The factory tests shall verify manufacturing quality and proper operation of all components. All corrections and adjustments necessary as a result of the factory test shall be made prior to shipment.

2. Supplier shall conduct a factory mechanical test of each piece of equipment. The factory mechanical tests shall demonstrate that each unit:

    a. Has no mechanical defect.
    b. Has no leaks.
    c. Is free of overheating of any parts.
    d. Is free of all objectionable vibration.
    e. Is free of overloading of any parts.
    f. Is free of excessive noise.
    g. Operates according to the Contract requirements.
    h. Has all interlocks operating correctly.
    i. Operates at correct belt speeds.
    j. Operates at correct oil pressure and flow capacity.
    k. Operates at correct air pressure, temperature, and flow rates.
    l. Operates at correct conveyor speed.
    m. Electrical, instrumentation, and control systems operate correctly.

3. Notify the Engineer of testing dates 3 weeks prior to testing. Certified test results shall be submitted to the Engineer by the Supplier.

4. Inspection of all items delivered at the site so that the Engineer may be satisfied that such items are of the specified quality and workmanship and are in good order and condition at the time of delivery. The Supplier shall be prepared to remove all coverings, containers, or crates to permit the Engineer to conduct his inspection. Should the Engineer find, in his opinion, indication of damage or deficient quality of workmanship, the Supplier shall provide the necessary documentation or conduct such tests deemed

necessary by the Engineer to demonstrate compliance. Compensation for tests and work related thereto arising out of this requirement shall be in accordance with the provisions of Section 3 of General Conditions.

C. CONTROL SYSTEM TESTS

The complete control system shall be tested to confirm that the system meets or exceeds the specified requirements prior to installation or shipment to site. Tests shall cover the full operational range or capability of the system and shall include, but not be limited to:

1. Signal verification (check or correct voltages, current polarity, contact "sensor," etc.).
2. Database verification (check for correct range, alarm limits, engineering units, message repairs, etc.).
3. Operator input to the controls system.
4. Verification of application software.
5. Alarm log and display generation.
6. Operator interface.
7. Verify the network interface from the membrane system PLC and OIU to the Owner's master plant control system.

All field instrumentation and controls that are an integral part of the equipment being testing shall also be tested.

Any defects in the equipment or operating controls or failure to meet the requirements of the specification shall be promptly corrected at no additional cost to the Owner.

D. COMPONENT AND SYSTEM TESTS

1. General

All equipment shall be calibrated and tested by the Supplier to the satisfaction of the Engineer before any facility is put into operation. The Supplier shall field calibrate all instruments where possible. Instruments that cannot be field calibrated will be checked for accuracy in the field.

The Component and System Tests shall be as specified in Section 11500 and other technical specifications, and shall be made to determine whether the equipment has been properly assembled, aligned, adjusted and connected. The purpose of the Component and System Tests shall be to demonstrate the proper

operation of the Membrane Equipment System components and features. The Supplier shall operate all valves, controls, and other devices to ensure they are functional and ready for performance and operational testing.

The Supplier shall work with the Contractor to conduct operational testing of the entire WWTF by processing clean water through the WWTF for a continuous period of 7 days. If the Supplier will not allow clean water to flow through the membranes for this time period, the Supplier shall coordinate with the Contractor to provide a temporary suction line from the MBR basins to the MBR cassette connections during the operational testing.

2. Procedures

Prior to startup of equipment the Supplier shall submit to the Engineer, details of the installed tests and inspection procedures he proposes to adopt for testing and start-up of all equipment to be operated singly and together, except when such procedures have been covered in the technical specifications.

Testing procedures shall be designed to duplicate, as nearly as possible, all conditions of operation and shall be carefully selected to ensure that the equipment is not damaged. Once the testing procedures have been reviewed and approved by the Engineer, the Supplier shall produce checkout, alignment, adjustment and calibration sign-off forms for each item of equipment to be used in the field by the Supplier and the Engineer jointly to ensure that each item of electrical, mechanical and instrumentation equipment has been properly installed and tested. The Supplier is advised that failure to observe these precautions may place the acceptability of the subject equipment in question.

It will be the responsibility of the Supplier to communicate with the Owner and the General Contractor to arrange the times for testing and startup activities.

The Supplier shall report to the Owner any changes, adjustments, or replacements required for the Membrane Equipment System to operate as specified. The Supplier must remedy any problems due to equipment, as determined by the Owner. The General Contractor must remedy any problems due to improper equipment installation, as determined by the Owner.

E. INITIAL PERFORMANCE TEST

1. General

After completion of the Component and System Tests and the Control System Tests with approval of the Engineer, and after the WWTF is started up treating raw wastewater, the Supplier shall conduct the Initial Performance Test. The General Contractor, with assistance from the Supplier, shall operate the Membrane Equipment System during the Initial Performance Test. In addition to the on-site services required in Section 11500-3.3B, the Supplier shall be on-call for the entire period of the Initial Performance Test.

All domestic water, oil, fuel, and chemical systems will be filled with the specified fluid. All process units will be brought to full operating conditions, including temperature, pressure, and flow. All costs for water, fuel, power, and chemicals required during the Initial Performance Test will be borne by the General Contractor.

Should the Initial Performance Test period be halted for more than 12 consecutive hours, or for more than 36 cumulative hours during the entire test, for any reason due to the failure of equipment provided by the Supplier, the testing program shall be repeated until the specified continuous period has been accomplished without interruption.

The Supplier shall submit the written Initial Performance Test Report, presenting all of the data listed below, within 7 days of completion of the test period.

2. Performance Requirements

To perform the test, the General Contractor, with assistance from the Supplier, shall operate system continuously over a 7-day test period. The Supplier shall collect and summarize data to demonstrate that the system meets the performance test requirements for the parameters listed below. In all cases, compliance with the requirements of this Specification shall be determined for each calendar day, and to successfully pass the test, Membrane Equipment System must comply with requirements for each of the 7 days of the Initial Performance Test.

a. Production Capacity

System meets production capacity requirements under conditions specified in Service Conditions and Performance Requirements (Specification Section 11500).

b. Pressure Limitations

System operates within the trans-membrane pressure (TMP) limit that is specified in the Supplier's Proposal.

c. Membrane Permeate Quality

Membrane permeate meets requirements under conditions specified in Service Conditions and Performance Requirements (Specification Section 11500).

d. Maintenance Clean

Perform Maintenance Clean at the frequency equal to or less than specified in Performance Requirements (Specification Section 11500).

F. COMMISSIONING

After completion of the Initial Performance Test, the commissioning period on the Membrane Equipment System will begin. The commissioning period shall be 30 days.

The Supplier shall remove all temporary piping that may have been in use during the Initial Performance Test and shall assist the Owner with the placement of the equipment into its fully operational mode. The Owner's operations and maintenance personnel will be responsible for operation of the equipment during this period of time.

The Supplier shall be available on-call at all times during commissioning period to provide assistance in case of failure of any portion of the system being tested. The Supplier shall be responsible for all costs in excess of the Owner's normal expected costs of Membrane Equipment System operations during the commissioning period. The Supplier shall provide the on-site services required in Section 11500-3.3C for this period, and shall bear the costs of all necessary repairs or replacements, including labor and materials, required to keep the Membrane Equipment System operational.

1.4 TRAINING

During the phase of the Component and System Tests, the Supplier shall make available experienced factory-trained representatives of the manufacturers of all the various pieces of equipment, to train the Owner's personnel in the operation and maintenance thereof. The time required for this training shall be as covered in the specifications for the specific piece of equipment. The Supplier shall notify the Engineer and the General Contractor of the time of the training at least ten days prior to the start time of the training. The Supplier shall submit a detailed outline of training activities to be performed by each manufacturer's representative ten days prior to the start time of the training. This outline shall indicate how the manufacturer's representative is going to allocate the required specified number of training hours to fulfill these contractual obligations.

PART 2 PRODUCTS

2.1 TESTING

A. GAUGES, METERS, RECORDERS, AND MONITORS

Gauges, meters, recorders, and monitors shall be provided by the Supplier as required by the Engineer to supplement or augment the instrumentation system provided under this Contract to properly demonstrate that all equipment fully satisfies the requirements of the Specifications. All devices employed for the purpose of measuring the performance of the facility's equipment and systems shall be specifically selected to be consistent with the variables to be monitored. All instruments shall be recently calibrated, and the Supplier shall be prepared at all times to demonstrate, through recalibration, the accuracy of all instruments employed for testing purposes. Calibration procedures shall be in accordance with applicable standards of ASTM, ISA, and IEEE. The adequacy of all gauges, meters, recorders and monitors shall be subject to review by the Engineer.

B. RECORDS

The Supplier shall submit completed sign-off forms for all installed and operational testing to be accomplished under this Contract. Sign-off forms shall be provided for each item of mechanical, electrical and instrumentation equipment provided or installed under this Contract and shall contain provisions for recording relevant performance data for original testing and not less than three retests. Separate sections shall be provided to record values for the preoperation checkout, as well as signatures of representatives of the equipment manufacturers, the Supplier, the General Contractor, and the Engineer.

PART 3 EXECUTION

3.1 TESTING

Testing shall proceed on a step-by-step basis in accordance with the Supplier's written testing procedures. The Supplier's testing work shall be accomplished by a skilled team of specialists under the direction of a coordinator whose sole responsibility shall be the orderly, systematic testing of all equipment, systems, structures, and the complete facility as a unit. Each individual step in the procedures shall be witnessed by a representative of the Engineer.

During the Initial Performance Test, all equipment and systems in operation shall be operated to the greatest extent practicable, at conditions that represent the full range of operating parameters as defined by this Contract Document.

3.2 TRAINING

Training of the Owner's personnel shall be done by experienced technical manufacturers' representatives. These representatives shall follow the outline presented below. See also the training requirements in Section 11000.

The Supplier shall video tape all training sessions and also provide the Owner with any audio-visual training materials the manufacturer utilizes (i.e., DVDs, video cassettes, PowerPoint presentations, etc.). Cost of instruction and audio-visual training materials shall be included in the bid price for the equipment.

GENERAL OUTLINE FOR MANUFACTURER PRESENTATIONS

A. FAMILIARIZATION

1. Overview explaining theory of operation.

2. Show catalog, parts lists, drawings, etc., in the plant files and O&M manuals.

3. Check out the installation of the specific equipment items.

4. Demonstrate the unit and show that all parts of the Specifications are met.

5. Answer questions.

B. SAFETY

1. Point out safety references.

2. Discuss proper precautions around equipment.

C. OPERATION

1. Point out reference literature.

2. Explain all modes of operation (including emergency).

3. Check out Owner's personnel on proper use of the equipment. (Let them do it.)

4. System operation via the OIU equipment.

D. PREVENTIVE MAINTENANCE (PM)

1. Pass out PM list including:

   a. Reference material.

   b. Daily, weekly, monthly, quarterly, semi-annual, and annual jobs.

2. Show how to perform PM jobs.

3. Show Owner's personnel what to look for as indicators of equipment problems.

4. Demonstrate use of any special tools required for maintenance.

E. CORRECTIVE MAINTENANCE

1. List possible problems.

2. Discuss repairs - point out special problems.

3. Open up equipment and demonstrate procedures, where practical.

F. PARTS

1. Show how to use parts list and order parts.

2. Check over spare parts on hand. Make recommendations on additional spare parts and tools.

G. LOCAL REPRESENTATIVES

1. Indicate where to order parts. Provide name, address, telephone, fax and e-mail address for spare parts supplier.

2. Service problems:

a. Indicate who to call.

b. Indicate how to get emergency help.

***** END OF SECTION *****

DIVISION 11

EQUIPMENT

SECTION 11000

EQUIPMENT GENERAL PROVISIONS

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section shall apply to all Sections of Divisions 11, 13 and 15, and portions of Division 16 unless specifically revised therein.

The Supplier shall direct the attention of all subcontractors and suppliers of equipment and related appurtenances for the work to the applicable provisions in the Contract Documents wherever they may occur.

1.2 RELATED WORK SPECIFIED ELSEWHERE

Section	Item
01300	Submittals
11010	Vibration and Critical Speed Limitations
Division 11	Equipment
Division 13	Special Construction
Division 16	Electrical

1.3 STANDARDS FOR THE WORK

For the items within the scope of the Suppliers supply, pipe, fittings, wiring, and supports shall be provided to produce complete, operable systems with all elements properly interconnected as shown in schematic diagrams or to provide specified operations.

Equipment and material shall be new and without imperfections. Equipment shall be located, as shown on the final shop drawings so that connecting and disconnecting piping and accessories can be readily done and so that all parts are easily accessible for inspection, operation, maintenance, and repair. Oil and lubrication fittings shall be located clear of and away from guards, base, and equipment and within reach from the operating floor. Indicating devices such as gauges, flow meter readouts, sight gauges, or glasses, and similar type devices shall be oriented to be easily read from the floor, slab, or ground surface at normal operating or maintenance locations without climbing, bending or crossing over piping or equipment. Remote located readouts shall be provided if required.

All equipment shall be designed for the service intended, of rugged construction, of ample strength for all stresses which may occur during fabrication, transportation, erection and during continuous or intermittent operation, and shall

be shown as adequately stayed, braced and anchored on the final shop drawings. Appearance and safety, as well as utility, shall be given consideration in the design of details. Materials of construction shall be cathodically compatible.

1.4 MANUFACTURER'S INSTRUCTIONS

The recommendations and instructions of the manufacturers of products used in the work are hereby made part of these Specifications, except as they may be superseded by other requirements of these Specifications.

1.5 WARRANTY

All equipment shall be provided with a warranty covering defects in material and workmanship for a minimum period of 2 years from the date of successful completion of the Initial Performance Test, unless a longer warranty period is required elsewhere.

PART 2 PRODUCTS

2.1 STANDARD REQUIREMENTS

A. MATERIALS

Design, fabricate, and assemble equipment and systems with new materials and in accordance with acceptable engineering and shop practices. Manufacture individual parts to standard sizes and gauges so repair parts can be installed in the field. Make like parts of duplicate units interchangeable. Do not place equipment in service at any time prior to delivery except as required for factory or shop tests.

B. UNIFORMITY

Unless otherwise specified, equipment or material of the same type or classification used for the same purpose shall be the product of the same manufacturer and shall be the same model with the same ratings, internal configuration, and wiring.

C. SEISMIC REQUIREMENTS

Supports and anchorage of equipments shall comply with the requirements of the 2021 *International Building Code* (IBC) Section 1613 and ASCE 7-16 *Minimum Design Loads for Buildings and Other Structures*, Chapter 13 Seismic Design for Nonstructural Components, as referenced and amended by the IBC. For the following design parameters:

- Risk Category: III.
- Site Class: D
- The component Importance Factor: Ip = 1.0.
- Design response acceleration coefficients:

S_{DS} = 1.15g
S_{D1} = 0.617g

D. STANDARDS

Provide equipment and materials suitable for service conditions and meeting standard requirements of ANSI, ASME, AWWA, ASTM, NEMA, NEC, IBC, NPC, UL, and OSHA.

2.2 LUBRICATION

The Supplier shall provide lubricants of types recommended by equipment manufacturers, in quantities sufficient for a minimum of 1-year consumption, prior to completion of the Component and System Test for the respective piece of equipment.

2.3 ANCHORS AND FASTENERS

All anchor bolts, nuts, and washers shall be sized by the Supplier, based on weight and arrangement information, and furnished and installed by the General Contractor.

2.4 SAFETY GUARDS

For belt or chain drives, fan blades, couplings, exposed shafts and other moving or rotating parts provide safety guards on all sides conforming to all Federal, State, and local codes and regulations pertaining; conform to the most restrictive requirement. Guards shall be designed for easy installation and removal, complete with necessary supports, accessories, and fasteners, and shall be hot-dip galvanized or painted. Guards in outdoor locations shall be designed to prevent entrance of rain and dripping water. Provide tachometer test opening in line with ends of shafts. Typically, guards shall be expanded metal on a structural steel frame except that outdoor guards may be of solid material. Provide spring loaded hinged doors with latch for service and lubrication access.

All pipes, manifolds, heaters, and other surfaces which have a surface temperature sufficient to burn human tissue shall be covered with a thermal insulating material or otherwise guarded against contact.

Guards shall comply with the requirements of these Specifications, WISHA Standards, and "The Principles and Techniques of Mechanical Guarding" (OSHA 2057), whichever is more stringent.

2.5 LIFTING EYES

All equipment weighing over 100 pounds shall be supplied with lifting eyes. Parts of equipment assemblies which are normally serviced separately, such as motors, shall have lifting eyes of their own.

2.6 NAMEPLATES/IDENTIFICATION

Each piece of equipment and its driver shall be furnished with a corrosion-resistant metal nameplate fastened to the item in an accessible position. This nameplate shall contain the manufacturer's name, equipment rating, capacity, size, model, serial number, and speed. Data for motors shall be NEMA standard. All information written or printed shall be in English. Each item of equipment shall bear a different serial number. Measurement units shall be given for ratings and capacity.

Nameplates for equipment requiring electrical supply, or which are connected to electrical control and sensing circuits, shall meet the requirements of the NEC and Washington State electrical codes referenced in Division 16. Equipment shall include marks, labels, and indications applied per governing standards indicating that the equipment meets the labeling, listing, and other requirements of Section 16010 1.6 E.

Nameplates for tanks and pressure vessels shall give working pressure, test pressure, vessel plate thickness, and ASME Code data.

Each piece of rotating equipment shall have a direction of rotation arrow.

Each piece of equipment shall be labeled using a plastic laminate label with the functional name and number of the equipment submitted by the Supplier and approved by the Engineer. Equipment number shall have the following format: zz xxx xx, where zz refers to the Site Area identification number, xxx is a two or three letter abbreviation for the equipment type, and xx is the serial number assigned to the specific piece of equipment. Name and number shall correspond to those used on Motor Control Centers and Panels.

Labels shall be fastened to the equipment base or other acceptable location. The letters shall be at least 1/2-inch high with a border trim on all sides not less than 1/4 inch. Color shall be black background with white letters. Fasteners shall be brass or stainless steel screwed into inserts, anchor shields, or tapped holes in equipment or base.

Units of measure shall be shown on the indicating and totalizing dials of all meters, gauges and other measuring devices.

2.7 PROTECTION AGAINST ELECTROLYSIS

Where dissimilar metals are used in conjunction with each other, suitable insulation shall be provided between adjacent surfaces so as to eliminate direct contact and any resultant electrolysis. The insulation shall be bituminous impregnated felt, heavy bituminous coatings, non-metallic separators or washers or other approved materials. Connections of dissimilar piping materials shall utilize dielectric unions, flanges, couplings, or bushings.

2.8 NOISE

Mechanical and electrical equipment shall not create sound levels in excess of that permitted by WISHA for 8 hours per day worker exposure unless otherwise noted for the specific piece of equipment involved.

2.9 PRESSURE GAUGE CONNECTIONS

For each pump, and other equipment required in the Specifications, provide tapped and plugged suction and discharge gauge connections on the nozzles or flanges. Where this is not possible, provide gauge connections on the piping immediately adjacent to the equipment. Pressure gauges shall be provided in accordance with Section 13422.

2.10 VIBRATION AND CRITICAL SPEED LIMITATIONS

Mechanical and electrical equipment shall meet the vibration and critical speed limitation requirements described in Section 11010.

PART 3 EXECUTION

3.1 STORAGE OF EQUIPMENT

Prior to final delivery to the General Contractor, storage of all equipment that includes electrical panels, controls, switches, contacts, motors, etc. shall be inside a heated and air conditioned enclosure to prevent condensation and moisture damage. The storage environment must meet the manufacturer's storage requirements of the most sensitive component of the assembly or group of equipment stored in a common area. This requirement includes all electrically actuated valve and gate operators and instrumentation items.

3.2 INSPECTION

Inspect each item of equipment for damage, defects, completeness, and correct operation at the point of delivery. Internally inspect equipment where access hatches or doors are provided for service and maintenance and provide access without disassembling the equipment.

3.3 INSTALLATION SUPPORT

A. EQUIPMENT STARTUP AND ADJUSTMENT

The Supplier shall arrange for authorized factory-trained representatives of the companies supplying the various items of equipment to check the installation, adjust, and test the equipment furnished before the acceptance of the work by the Owner. Said representatives shall be experienced and knowledgeable of the equipment being tested. Furthermore, they shall assist and instruct the Owner's operating staff in adjusting and operating the equipment during the initial start-up period.

All equipment shall be tested and demonstrated to the Engineer that proper operation and capacity has been achieved. For pumps, this shall include measurement of suction and discharge pressure at the pump and measurement of pumping rate by volumetric means, or through a suitably calibrated meter for two points on the performance curve. Current draw on the motor shall be measured for each pumping rate measurement. For two speed pumps, such tests shall be conducted at both speeds. The Supplier shall furnish any test equipment or measuring device (including portable flow meters) required which is not part of the permanent installation. Tests for variable speed pumps, fans and other equipment shall be performed at 60 Hz and at the initial anticipated flow or capacity levels.

If problems are found, the manufacturer's representative shall repeat the inspection and check and adjust until all troubles or defects are corrected, and the equipment installation and operation are acceptable.

In addition, the entire facility shall be demonstrated to be in full operating order prior to the acceptance of the work. Should any equipment or part thereof fail to operate as intended, it shall be immediately removed and replaced, all at the Supplier's expense.

Equipment startup and adjustment shall take place before instruction of Owner personnel is performed.

All startup and adjustment work shall be coordinated with the General Contractor.

B. SOUND LEVEL TESTING

The General Contractor will measure the sound level developed by all mechanical and electrical equipment provided by the Supplier under the Contract Documents. The General Contractor will use OSHA approved instrument and record the highest sound level developed when measured according to OSHA standards in each room and space, and deliver a certified copy of records to the Engineer. The Supplier shall remedy any problems due to supplied equipment, as determined by the Engineer.

C. INSTRUCTION OF OWNER'S PERSONNEL

Conduct an instruction program for up to six operations personnel designated by the Owner. Furnish the services of qualified instructors from the various equipment manufacturers for the duration specified in each specific Section. Include instruction covering basic system operation theory, routine maintenance and repair, and "hands on" operation of equipment. Equipment startup and adjustment shall be complete and the equipment shall be fully operational when instruction takes place. Instruction shall include both normal operation and control via the OIU as well as any equipment local displays and manual controls.

Provide the instruction program at the Owner's convenience before contract closeout. The Supplier shall video tape all training sessions and also provide the Owner with any audio-visual training materials the manufacturer utilizes (i.e., DVDs, video cassettes, PowerPoint presentations, etc.). Cost of instruction and audio-visual training materials shall be included in the bid price for the equipment.

***** END OF SECTION *****

SECTION 11010

VIBRATION AND CRITICAL SPEED LIMITATIONS

PART 1 GENERAL

1.1 SCOPE

This Section specifies vibration and critical speed limitations for rotating mechanical equipment. Individual equipment specification sections may specify more stringent requirements, which shall then govern. Field-testing and vibration measurements shall be taken on all rotating mechanical equipment.

1.2 RELATED WORK SPECIFIED ELSEWHERE

Section	Item
01200	Measurement and Payment
01300	Submittals
11000	Equipment General Provisions

1.3 VIBRATION LIMITATIONS

Vibration frequencies shall span the range from 5.0 to 5,000 Hz. Where specified, measurements shall be obtained while the installed equipment is operating within the specified speed range. These measurements shall be recorded and provided to the Engineer along with the Manufacturer's Affidavits.

A. CENTRIFUGAL

1. Machines with Sleeve Bearings

Unless otherwise specified, centrifugal machines with sleeve bearing shafts shall not exhibit unfiltered RMS readings for vibration displacement in excess of the following:

Shaft speed range, rpm	Displacement, peak to peak, mils
Up to 900	3.5
901 – 1,800	3.0
1,801 – 3,000	2.5
3,001 – 4,500	2.0
Above 4,500	1.6

Displacement measurements shall be taken radially on the shaft at two points at each bearing. Measuring points shall be 90 degrees apart.

2. Machines with Antifriction Bearings

Unless otherwise specified, centrifugal machines with antifriction bearing shafts shall not exhibit unfiltered RMS readings for vibration velocity in excess of 0.12 inches per second. Velocity measurements shall be taken on one point of each bearing housing.

B. POSITIVE DISPLACEMENT MACHINES

Unless otherwise specified, positive displacement machines of the rotary, reciprocating and controlled volume types shall operate without any lateral or torsional vibration characteristics that may accelerate wear of the equipment. The Supplier shall provide manufacturer's certification that the manufacturer has inspected the machine under operating conditions and found it to comply with the requirements of this paragraph.

1.4 CRITICAL SPEED REQUIREMENTS

Unless otherwise specified, rotating mechanical equipment shall not exhibit critical speeds within the specified range of operating speeds. Critical speeds for equipment with rigid rotor systems shall be at least 20 percent greater than maximum operating speed or impeller blade pass frequency, whichever is greater. Critical speeds for equipment with flexible shaft-rotor systems shall be at least 15 percent below minimum operating speed and 20 percent above maximum operating speed or impeller blade pass frequency, whichever is greater.

***** END OF SECTION *****

SECTION 11305

ROTARY LOBE PUMPS

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section shall consist of the Supplier providing rotary lobe, positive displacement pumps for use as permeate pumps and for backpulse service (if required for the Supplier's system) for the Membrane Equipment System, as specified herein and as specified in Section 11500. A minimum of 3 permeate pumps shall be supplied as specified in Section 11500.

1.2 RELATED WORK SPECIFIED ELSEWHERE

Section	Item
01200	Measurement and Payment
01300	Submittals
01800	Testing, Commissioning, and Training
09900	Painting
11000	Equipment General Provisions
11010	Vibration and Critical Speed Limitations
Division 16	Electrical

1.3 EQUIPMENT LIST

Equipment numbers are as follows:

Item	Equipment Number
Permeate Pump 1	01 PMP 01
Permeate Pump 2	01 PMP 02
Permeate Pump 3	01 PMP 03

1.4 PERFORMANCE REQUIREMENTS

The pumps shall be compatible with and coordinated with the requirements of the Membrane Equipment System. The Supplier shall submit proposed pump head capacity, flow capacity, design operating point, second operating point, and minimum speed. The permeate pump system shall be designed to provide capacity for the peak equalized flow through all basins.

The backwash pumps shall be compatible with and coordinated with the requirements of the Membrane Equipment System, if required to support the

membrane cleaning requirements. The Supplier shall submit proposed quantity, pump head capacity, flow capacity, design operating point, and minimum speed.

1.5 WARRANTY

The Supplier shall warrant the units being supplied to the Owner against defects in workmanship and material for the period described in Section 11000-1.5. The warranty shall be in printed form and apply to all similar units.

1.6 SUBMITTALS

Submittals shall be in accordance with Sections 01300 and 11000. In addition, the Design submittals shall include the following:

A. Manufacturer certification of Build America, Buy America Act (BABAA) compliance for pumps and all ancillary components.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

In order to assure uniform quality, product functionality, and ease of maintenance; all of the equipment specified in this Section shall be supplied by a single manufacturer. The rotary lobe pumps shall be Börger with a piggyback mounted integral gear motor, or equivalent by Lobepro or Vogelsang. No other manufacturers shall be accepted.

2.2 PUMPS

The pumps shall be of the positive displacement, rotary lobe type, designed to pump return activated sludge. All fluid-wetted parts including the mechanical seal shall be replaceable through the quick release front cover without disassembly of coupling, drive unit or the pipe system.

The pumps shall be designed to temporarily run dry and to operate in either direction. Oil-quench for protection of the mechanical seal is mandatory. Seal water flush systems are not acceptable.

The pumps shall be constructed with an oil-filled intermediate chamber between the pump casing and the gearbox with the following functions:

A. Oil-quench (lubrication and cooling) of the mechanical seals

B. Visual detection of seal failures

C. Buffer zone to the sealed timing gear

Oil drain of gearbox and intermediate chamber shall be easily accessible with side mounted drain screw. Oil drain under the pump is not acceptable. The rotor/shaft connection shall be oil-lubricated fed by an intermediate chamber and shall not come in contact with the pumped fluid.

2.3 CASING

The pump casing shall be manufactured in a single block construction, cast iron ASTM A48 grade 40, Brinell hardness 264 Brinell. Alternatively, adjustable, component housing segments may be used to compensate for wear of the pump casing.

The rear of the pump casing and the front cover and radial surfaces shall be protected with replaceable wear plates with a hardness of 550 Brinell. The front cover protection plate shall be reversible. Pumps offering the economy of front and rear reversible wear plates are approved.

The quick release cover shall be held in place by four eye nuts. The stationary threaded studs shall keep the front cover on the same level as the pump casing in the process of opening the pump for easy handling.

2.4 ROTORS

Rotors shall be tri lobe screw rotor design and shall consist of a non-sludge-wetted cast iron or machined steel core entirely coated with abrasion-resistant Buna-N. Pumps with entirely machined steel cores and a four wing lobe design are also acceptable. Stacking of lobes is not acceptable. Rotors shall be keyed to the shaft with one central screw to a cylindrical thread inside the shaft. The cast iron core of the rotor shall be equipped with a female thread to enable the removal of the rotor from the shaft with ease. Rotor/shaft designs with a cover disc and/or spring washers are not acceptable.

2.5 SHAFTS AND SLEEVES

The shafts shall be non-sludge-wetted; the rotor/shaft connection shall be lubricated with quench fluid of the intermediate chamber. Shafts shall be a minimum diameter of 35 mm. They shall be timed in their rotation by straight cut timing gears running in a separate oil chamber, which also contains the ball and roller bearings for each shaft. Sludge wetted rotor/shaft connections are not acceptable. The shafts shall be constructed from carbon steel AISI 4140.

2.6 MECHANICAL SEALS

The pumps shall be fitted with maintenance free, quenched mechanical seals with duronit seal faces. The seals shall be operating in a common oil-filled intermediate chamber. Purge systems for the seals are not acceptable. The rotating holding bush shall be locked in a fixed radial position by a keyway that also holds the rotor in the correct location. Seal designs that open during rotor replacement are not acceptable. Seals that require adjustments during installation are not acceptable. No sleeves shall be necessary for the mechanical seal setup. Design of the pump shall allow removal and replacement of the seal via the front cover.

2.7 MOUNTING

Pump and drive shall be fitted on common base, made from galvanized steel complete with all necessary guards and mounting hardware. The Pumps shall have a piggyback mounting arrangement complete with all necessary belts, guards, and sheaves. All pump bases shall be suitable for installation as shown on the Plans.

2.8 BEARINGS

Bearings and timing gear shall be located in a common oil-filled cast iron gearbox, fitted with a built in sight class to monitor oil level. The timing gear shall maintain non-contact between the rotors. Bearing life shall be designed for L-10 bearing life rating of 100,000 hours at design conditions.

2.9 GEARBOXES

The pumps shall be driven by a faced, parallel, in-line, helical geared motor. Connection to the pumps shall be belt drive with c-faced geared motor. Speed reducer design and rating shall be equal or exceed AGMA requirements, thrust bearing life shall be L10, and be selected for AGMA Class 2 service. Helical gearmotors shall be Nord Gear Corp., or approved equal. The pumps, gear reducers and motors shall be on a steel base plate complete with necessary couplings, guards, and mounting hardware.

2.10 GEAR MOTORS AND MOTORS

The Rotary Lobe Pumps shall be driven by an integral, parallel, in-line, helical gearmotor. Connection to the pumps shall be direct coupled with integral gearmotor. Speed reducer design and rating shall be equal or exceed AGMA requirements, thrust bearing life shall be L10, and be selected for AGMA Class 2 service. Helical gearmotors shall be Nord Gear Corp., or equal. The

pumps, gear reducers and motors shall be on a steel base plate complete with necessary couplings, guards, and mounting hardware.

The motors shall be standard horizontal, TEFC, inverter-duty electric induction motors meeting NEMA MG-1 and other applicable NEMA, ANSI and IEEE standards. Motors shall be constructed with Class F 1,600 volt insulated windings, B 30,000 anti-friction bearings, cast iron frame and end bells. The motors shall be rated at 460 volts AC, 3 phase, 60 Hz, 1,800 rpm synchronous speed (4 pole), continuous duty at 40 degrees C ambient air temperature with a 1.15 service factor, minimum efficiency of 90 percent. The motor horsepower shall be sufficient so that the pump does not load the motor beyond 90 percent of nameplate horsepower throughout its entire performance curve, from shut-off to run-out.

The motor windings for the pumps shall be provided with thermal detection switches (normally closed) embedded in each phase of the motor windings. Detectors shall be suitable for operation with 120 volt AC and 24 volt AC control circuits, Klixon or equal. These sensors shall have insulated conductor leads brought to the motor terminal box and shall be suitable for wiring as a permissive in the motor starting circuit.

Motors shall be recognized or labeled and listed by a recognized electrical testing laboratory approved by the Washington State Department of Labor and Industries.

Motors shall meet the efficiency requirements of the Washington State Energy Code (Washington Administrative Code, Title 51, Chapter 51-11) table 14-4, regardless of whether or not a particular motor is exempted from meeting this efficiency by the Washington State Energy Code.

If variable frequency drives are required for equipment operation, the motors for the pumps shall be suitable for operation with variable frequency drives per NEMA MG-1 Parts 30 and 31. The VFDs will be provided by others. The Supplier shall furnish specifications for the pumps and motors, including nameplate data, as required for properly-rated VFDs to be provided by others. The turndown ratio for the motors shall be as required for the flow range required for the pumps. The motors shall be capable of running throughout the operational speed range without supplemental cooling.

The pumps shall be supplied with motors capable of meeting the Supplier's design conditions at a maximum operating frequency of 60 Hz. Operating the motor and associated VFD at above 60 Hz to meet the design conditions is not acceptable.

Motors shall be manufactured by U.S. Motors, Baldor, Reliance, Toshiba/Houston, or General Electric. No other manufacturers shall be accepted.

If any motor fails during the warranty period, the Supplier shall replace the motor with a new motor. Rewinding a failed motor shall not be acceptable.

2.11 MOTOR PROTECTIVE DEVICE COORDINATION AND DOCUMENTATION

The Supplier shall maintain a list of motor characteristics that are necessary to size, select, and/or set the various motor protective devices, such as thermal overloads, breaker trip devices, motor protection relays, etc.

The Supplier shall record the size and/or settings of each motor protective device at the time of startup and after any subsequent adjustments on the motor characteristics list described in the preceding paragraph.

In addition, the Supplier shall take a digital photo of each motor nameplate when the motor arrives at the jobsite. Each digital photo shall be emailed to the Owner's Resident Engineer, noting any discrepancy between the motor nameplate data and the submitted motor data.

2.11 PUMP TESTS

A. FACTORY TEST

The pumps shall be fully tested on water at the manufacturer's plant before shipment. Tests shall consist of checking the unit at its rated speed, head, capacity, efficiency and brake horsepower, and at such other conditions of head and capacity to properly establish the performance curve. Certified copies of test curves and report shall be submitted to the Engineer prior to shipment. The Standards of the Hydraulic Institute shall govern the procedures and calculations for these tests.

2.12 SPARE PARTS

The Supplier shall provide the manufacturer's recommended spare parts and special tools. All parts and tools shall be suitably identified and packaged in hinge-covered, wooden boxes. At a minimum these spare parts shall include the following items:

Rotary lobes and o-rings .....one set
Axial protection plates .....one set
Radial protection plates.....one set
Mechanical seals and o-rings .....one set
Drive belts.....one

2.13 HARDWARE

All machine bolts, nuts, and cap screws shall be the hex head type and shall be 316 stainless steel. Hardware (or parts) requiring special tools or wrenches shall not be used.

2.14 VIBRATION

Vibration and critical speed limitations shall be in accordance with Section 11010 and as set forth in the Standards of the Hydraulic Institute, which shall govern.

2.15 DATA PLATES

All data plates shall be of stainless steel suitably attached to the pump. Data plates shall contain the manufacturer's name, pump size and type, serial number, speed, impeller diameter, capacity and head rating, and other pertinent data.

2.16 PAINTING

A. SURFACE PREPARATION

Commercial blast cleaning, SSPC-SP-6.

B. COATINGS

Shop Primer System:

Coat One	
Product:	Tnemec Omnithane Series 1
MDFT:	2.5 to 3.5 mils

Final field painting will performed by the General Contractor.

PART 3 EXECUTION

3.1 INSTALLATION

The Supplier shall furnish complete installation instructions and recommendations to the Owner and the General Contractor. The General Contractor will install the pump systems. Manufacturer's written installation instructions shall be included with the delivered pumps, one set of instructions with each pump.

3.2 FIELD TESTING

The Supplier shall perform the Component and System Testing described in Section 01800, in coordination with the General Contractor. In addition, the pumps shall be subjected to a field running test under actual operating conditions. The field test shall be made by the Supplier in the presence of and as directed by the Engineer. The field test shall demonstrate under all conditions of operation that the pump assembly:

A. Has not been damaged by transportation or installation.
B. Has been properly installed.
C. Has no mechanical defects.
D. Is in proper alignment.
E. Has been properly connected.
F. Is free of overheating of any parts.
G. Is free of vibration in excess of the limits in Section 11010
H. Is free of excessive noise.
I. Is free of overloading of any parts.
J. Shall operate as specified with the specified control system.
K. Is free of critical speeds as specified in Section 11010.

Any defects in the equipment or failure to meet requirements of the Specification shall be promptly corrected by the Supplier.

3.3 MANUFACTURER'S SERVICES

The services of a factory-trained representative of the pump manufacturer shall be provided by the Supplier. Services shall include 3 days (two visits) onsite for the supervision of equipment startup, testing, and instruction of the Owner's personnel in the operation and maintenance of the equipment. One visit shall be for installation inspection, certification, testing, and startup; and one visit shall be for training. Instruction and training of the Owner's personnel shall not take place until startup is completed and the pumps are fully operational. The training shall be at a time and location agreed to by the Owner. The cost of these services shall be included in the bid price. The representative shall be available for two additional service calls during the 2-year warranty period.

***** END OF SECTION *****

SECTION 11310

DRY-PIT NON-CLOG CENTRIFUGAL PUMPS (SELF-PRIMING)

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section includes furnishing and installing new dry-pit non-clog self-priming centrifugal pumps for use as permeate pumps and for backpulse service (if required for the Supplier's system) for the Membrane Equipment System, as specified herein and as specified in Section 11500.

1.2 RELATED WORK SPECIFIED ELSEWHERE

Section	Item
01200	Measurement and Payment
01300	Submittals
01800	Testing, Commissioning, and Training
11000	Equipment General Provisions
11010	Vibration and Critical Speed Limitations
Division 16	Electrical

1.3 PERFORMANCE REQUIREMENTS

The permeate pumps shall be compatible with and coordinated with the requirements of the Membrane Equipment System. The Supplier shall submit proposed pump head capacity, flow capacity, design operating point, second operating point, and minimum speed.

The backpulse pumps shall be compatible with and coordinated with the requirements of the Membrane Equipment System, if required to support the membrane cleaning requirements. The Supplier shall submit proposed quantity, pump head capacity, flow capacity, design operating point, and minimum speed.

1.4 SUBMITTALS

Manufacturer certification of Build America, Buy America Act (BABAA) compliance for pumps and all ancillary components.

1.5 WARRANTY

The Supplier shall warrant the units being supplied to the Owner against defects in workmanship and material for the period described in Section 11000-1.5. The warranty shall be in printed form and apply to all similar units.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

The dry pit, non-clog centrifugal pumps shall be Gorman-Rupp or approved equal.

2.2 PUMPS

The pumps shall be of the horizontal self-priming centrifugal solids handling type (non-clog) mounted on a structural steel base. The volute shall be equipped with a removable cover plate, allowing complete access to pump impeller without removal of other internal parts or disturbing suction and discharge connections. Pump interior passages shall be completely free of screening devises. The pump shall be fitted with replaceable suction check valve and replaceable wear plate.

The pump impeller shall be of the two-vaned, non-clog type and constructed of gray cast iron, ASTM A48, Class 30, 35B, or 40B. The impeller shall have pump out vanes on the impeller shroud to eliminate a buildup of foreign material behind the impeller. The pump shall be capable of passing non-compressible solids with a maximum diameter of 3 inches.

The pump shaft shall be sealed against leakage by an oil-lubricated mechanical seal. Rotating face shall be tungsten titanium carbide and the stationary seal face, cage and spring shall be Type 316 stainless steel.

2.3 MOTOR

The motors shall be standard horizontal, TEFC, inverter-duty electric induction motors meeting NEMA MG-1 and other applicable NEMA, ANSI and IEEE standards. Motors shall be constructed with Class F 1,600 volt insulated windings, B 30,000 anti-friction bearings, cast iron frame and end bells. The motors shall be rated at 460 volts AC, 3 phase, 60 Hz, 1,800 rpm synchronous speed (4 pole), continuous duty at 40 degrees C ambient air temperature with a 1.15 service factor, minimum efficiency of 90 percent. The motor horsepower shall be sufficient so that the pump does not load the motor beyond 90 percent of nameplate horsepower throughout its entire performance curve, from shut-off to run-out.

The motor windings for the pumps shall be provided with thermal detection switches (normally closed) embedded in each phase of the motor windings. Detectors shall be suitable for operation with 120 volt AC and 24 volt AC control circuits, Klixon or equal. These sensors shall have insulated conductor leads brought to the motor terminal box and shall be suitable for wiring as a permissive in the motor starting circuit.

Motors shall be recognized or labeled and listed by a recognized electrical testing laboratory approved by the Washington State Department of Labor and Industries.

Motors shall meet the efficiency requirements of the Washington State Energy Code (Washington Administrative Code, Title 51, Chapter 51-11) table 14-4, regardless of whether or not a particular motor is exempted from meeting this efficiency by the Washington State Energy Code.

If variable frequency drives are required for equipment operation, the motors for the pumps shall be suitable for operation with variable frequency drives per NEMA MG-1 Parts 30 and 31. The VFDs will be provided by others. The Supplier shall furnish specifications for the pumps and motors, including nameplate data, as required for properly-rated VFDs to be provided by others. The turndown ratio for the motors shall be as required for the flow range required for the pumps. The motors shall be capable of running throughout the operational speed range without supplemental cooling.

The pumps shall be supplied with motors capable of meeting the Supplier's design conditions at a maximum operating frequency of 60 Hz. Operating the motor and associated VFD at above 60 Hz to meet the design conditions is not acceptable.

Motors shall be manufactured by U.S. Motors, Baldor, Reliance, Toshiba/Houston, or General Electric. No other manufacturers shall be accepted.

If any motor fails during the warranty period, the Supplier shall replace the motor with a new motor. Rewinding a failed motor shall not be acceptable.

2.4 MOTOR PROTECTIVE DEVICE COORDINATION AND DOCUMENTATION

Motor overcurrent protection shall be sized by the motor manufacturer. The Contractor shall maintain a spreadsheet or database list of the motor characteristics that are necessary to size, select, and/or set the various motor protective devices, such as thermal overloads, breaker trip devices, motor protection relays, etc., for inclusion in the O&M manuals.

This list shall also include any additional information needed to setup, program or adjust the variable frequency drive, or solid state drive (soft start) which serves motor driven equipment.

The Contractor shall record the size and/or settings of each motor protective device and drive configuration.

In addition, the Contractor shall take a digital photo of each motor nameplate when the motor arrives at the jobsite.

Spreadsheet of motor nameplate information, motor settings, drives configuration (if applicable), and photo of each nameplate shall be included in the O&M manuals.

2.5 SPARE PARTS

The Contractor shall provide the manufacturer's recommended spare parts and special tools. All parts and tools shall be suitably identified and effectively protected from moisture and corrosion with appropriate wrappings or coatings or a combination thereof. All parts and tools shall be furnished in sturdy labeled boxes. At a minimum these shall include all special tools and appliances necessary to service, repair, and adjust the equipment, and the following spare parts items:

Gaskets	1 set per pump
Wear plate assembly	1 per pump
Impeller nut and shaft	1 per pump
Check valve	1 per pump
Shaft key	1 per pump
Bearings and shims	1 set per pump
Impeller shims	1 set per pump
Oil seal	1 per pump
Seal assemblies	1 set per pump
Shaft sleeve	1 per pump

2.6 PAINTING

The pump systems shall be painted with a primer system at the factory in accordance with the following:

A. SURFACE PREPARATION

Commercial blast cleaning, SSPC-SP-6.

B. SHOP PRIMER SYSTEM

Product: Tnemec Omnithane Series 1or equal.
Coats: 1
MDFT: 2.5 to 3.5 mils 3 to 5 mils

Final field painting shall be performed by the General Contractor.

2.7 FACTORY TESTING

The pumps shall be fully tested on water at the manufacturer's plant before shipment. Tests shall consist of checking the unit at its rated speed, head, capacity, efficiency and brake horsepower, and at such other conditions of head and capacity to properly establish the performance curve. Certified copies of test curves and report shall be submitted to the Engineer prior to shipment. The Standards of the Hydraulic Institute shall govern the procedures and calculations for these tests.

PART 3 EXECUTION

3.1 INSTALLATION

The Supplier shall furnish complete installation instructions and recommendations to the Owner and the General Contractor. The General Contractor will install the pump systems. Manufacturer's written installation instructions shall be included with the delivered pumps, one set of instructions with each pump.

3.2 FIELD TESTING

The Supplier shall perform the Component and System Testing described in Section 01800, in coordination with the General Contractor. In addition, the pumps shall be subjected to a field running test under actual operating conditions. The field test shall be made by the Supplier in the presence of and as directed by the Engineer. The field test shall demonstrate under all conditions of operation that the pump assembly:

A. Has not been damaged by transportation or installation.
B. Has been properly installed.
C. Has no mechanical defects.
D. Is in proper alignment.
E. Has been properly connected.
F. Is free of overheating of any parts.
G. Is free of vibration in excess of the limits in Section 11010

H. Is free of excessive noise.
I. Is free of overloading of any parts.
J. Shall operate as specified with the specified control system.
K. Is free of critical speeds as specified in Section 11010.

Any defects in the equipment or failure to meet requirements of the Specification shall be promptly corrected by the Supplier.

3.3 MANUFACTURER'S SERVICES

The services of a factory-trained representative of the pump manufacturer shall be provided by the Supplier. Services shall include three days (two visits) onsite for the supervision of equipment startup, testing, and instruction of the Owner's personnel in the operation and maintenance of the equipment. One visit shall be for installation inspection, certification, testing, and startup; and one visit shall be for training. Instruction and training of the Owner's personnel shall not take place until startup is completed and the pumps are fully operational. The training shall be at a time and location agreed to by the Owner. The cost of these services shall be included in the bid price. The representative shall be available for two additional service calls during the 2-year warranty period.

***** END OF SECTION *****

SECTION 11370

ROTARY POSITIVE DISPLACEMENT BLOWERS

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section shall consist of the Supplier providing positive displacement blowers and accessories to furnish scouring air to the membrane basins as specified herein and as specified in Section 11500. A minimum of 3 air scour blowers shall be supplied as specified in Section 11500.

1.2 RELATED WORK SPECIFIED ELSEWHERE

Section	Item
01300	Submittals
11000	Equipment General Provisions
11010	Vibration and Critical Speed Limitations
11500	Membrane Equipment
Division 16	Electrical

1.3 EQUIPMENT LIST

Equipment numbers are as follows:

Item	Equipment Number
Air Scour Blower 1	01 BLR 01
Air Scour Blower 2	01 BLR 02
Air Scour Blower 3	01 BLR 03

1.4 PERFORMANCE REQUIREMENTS

The scour air blower systems shall be designed to provide the Supplier's recommended air scour flow rates through all basins. The Supplier shall submit proposed blower discharge pressure, air flow capacity, design operating point, second operating point, and minimum speed.

The blowers shall have the following capacities and discharge pressures when operated at an elevation of 80 feet above sea level, inlet pressure of 14.7 psia, inlet air temperature of 20 to 100 degrees F, and relative humidity of 20 to 100 percent. The maximum blower rotational speed shall be 2,800 rpm.

The common discharge header from the scour air blowers will be connected to the aeration blower, which will be supplied by others. The Supplier shall provide

PLC and Operator Interface programming to allow the uninstalled spare air scour blower to be controlled by the WWTF PLC to also act as a backup to the aeration blowers.

The blowers shall each be complete with motor, V-belts and sheaves, base, inlet filter, inlet silencer, discharge silencer, check valve, butterfly valve, relief valve, OSHA coupling guard, expansion joints, vibration isolators, acoustical enclosure, and all associated equipment, including temperature and pressure gauges, for a complete and workable air blower system, as shown on the Plans and specified herein. The blowers shall be compact, frame-mounted units with the inlet and discharge configurations, specified herein and shown on the Plans.

The blower manufacturer shall provide and have complete responsibility for blower systems, which include blowers, motors, acoustical enclosures, and accessories. The entire blower package and its components shall comply with all applicable safety and environmental regulations.

The Supplier shall provide an automatic unloading valve for each blower if required for proper operation of the blower. Blowers shall be compatible with variable frequency drives.

1.5 SUBMITTALS

Manufacturer certification of Build America, Buy America Act (BABAA) compliance for blowers and all ancillary components.

1.6 DELIVERY, STORAGE AND HANDLING

All equipment shall be completely factory assembled, skid mounted, crated and delivered to protect against damage during shipment.

All exposed flanges shall be covered and sealed with shrink-wrap to prevent the entrance of moisture. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.

All equipment delivered to the site shall be stored as specified in accordance with the manufacturer's instructions.

1.7 WARRANTY

The Supplier shall warrant the units being supplied to the Owner against defects in workmanship and material for the period described in Section 11000-1.5. The warranty shall be in printed form and apply to all similar units.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

All blowers supplied shall be furnished by one manufacturer. The blowers shall be as manufactured by Aerzen, or Roots. No other manufacturers shall be allowed. Enclosure shall be manufactured by the blower manufacturer and factory installed.

Blower manufacturer's requiring a separate motor driven fan for enclosure cooling, in lieu of the shaft driven fan cooled models specified herein, shall indicate this in their bid proposal and the Supplier shall be responsible for any additional conduit, wiring, and instrumentation supply and installation required.

2.2 BLOWERS

Each blower shall be rotary lobe positive displacement type, of the tri-lobe involute design, and furnished by one manufacturer. The impellers, impeller casings, and end plates shall be on a close-grained, high strength cast iron and strongly ribbed internally.

Blowers shall be mounted in the horizontal position. Drive shaft extension and air discharge shall be as shown on the Plans. Maximum blower temperature shall be 275 degrees F.

A common base shall be supplied under each blower and motor. It shall be fabricated of deep section rigid steel, reinforced to withstand normal loading.

The casing and end plates shall be suitably ribbed for strength to prevent distortion under operating conditions.

The impellers shall be timed by a pair of AGMA 12 quality gears with hardened and ground teeth; minimum AGMA service factor of 1.70. Gears shall be mounted on the shafts with a tapered interference fit, and secured by a locknut. The impellers shall be balanced by metal removal and not by adding counter weights. To ensure smooth operation without vibration, balancing shall be at lobe weights not on outer profile to avoid weakening lobe. The shafts shall be of machined steel and shall run in four heavy-duty anti friction bearings, having a minimum B-10 life expectancy of at least 100,000 hours. Bearing holders shall have retainer allowing positive bearing containment and ground spacers to accurately and permanently locate rotor clearances within blower casing.

The rear bearings and gears shall run in a splash oil type housing. The drive end and bearings shall be splash oil lubricated and contained within one oil reservoir.

Front and rear covers to be removable for easy access for bearing and gear inspection.

Blowers shall have four piston ring type labyrinth seals at each end of each rotor and the cavity between the air side and oil side seals shall be vented through threaded ports to allow external purging or containment of any lubricating oil or process gas which may have migrated past the seals.

The end covers shall be cast iron complete with amply sized oil sight glasses for observation of the oil levels.

2.3 DRIVE

Each blower package shall be supplied with a V-belt drive that shall be of the high capacity type, oil and heat resistant. Drive shall be designed for a minimum service factor of 1.4 times operating power (bHp), or 1.1 times the motor nameplate Hp, whichever is larger to allow a minimum of 1.4-service factor based on the maximum blower bHp. Belt tensioning shall be automatic without the use of any devices or interaction on the part of the operator. Neither slide rails nor load-adjusting springs shall be used. Sheaves shall be dynamically balanced regardless of the operating speed.

The belt drive shall be guarded in compliance with OSHA regulations. Portions of the guard shall be easily removable allowing for belt inspection and replacement. Guard material shall be carbon steel.

2.4 INTAKE AIR FILTER SILENCERS

Each blower package shall be supplied with one combination inlet filter/silencer. The filter media efficiency must meet the requirements of ASHRAE 52.2 MERV7 50 to 70 percent at 3 to 10 microns corresponding to EN779 G4. The inlet filter/silencer shall be mounted directly to the inlet flange of the blower. The silencer portion shall be located upstream of the inlet filter. Filter and silencer performance losses shall be included in the blower performance calculation.

Vacuum gauge or other suitable device shall be supplied and mounted, for sensing of inlet vacuum and blinding of filter medium.

2.5 DISCHARGE SILENCERS

Each blower package shall be supplied with one combination base frame/discharge silencer. The silencer shall be a chamber type design for maximum sound attenuation and shall not use fibrous or absorption materials of any kind. Fabricated of a single shell of pressure vessel quality steel with continuous welds, the silencer must be subject to a pressure test for tightness and

strength at a minimum of 1.65 times the maximum blower operating pressure. The silencer shall have a machined inlet connection where the discharge flange of the blower stage bolts directly to, with no intermediary pieces. Discharge silencer performance losses shall be included by the blower vendor in the blower performance calculation.

The base frame shall be constructed from welded carbon steel or cast iron that shall be designed to maintain alignment of the blower internal components and the drive during operation. It shall be designed to resist distortion while being installed on vibration isolating mounts. The blower manufacturer shall supply a stainless steel grounding lug fully welded to the base.

2.6 FLEXIBLE CONNECTIONS

Each blower package shall be connected to the plant process air piping using a flexible connector located downstream of the discharge silencer to prevent transmission of noise and vibration from the blower package into the piping. The flexible connectors shall be Class 125 ANSI/ASA flange, single-arch type, multiple-ply rubber or synthetic elastomer, reinforced flexible connection, and shall be complete with steel backing rings.

2.7 CHECK VALVES

Each blower package shall be supplied with one check valve that shall be installed on the discharge line, designed for heavy-duty type shutoff service. It shall be of the full-bore, low pressure-drop, flapper type design with a steel body, Class 125 pressure rating, and steel flap embedded in EPDM with full-contact seal, for service to 275 degrees F. The valve shall be removable without disturbing the piping.

Pressure losses produced by the check valve shall be included in the blower performance calculation. Check valves shall be by Aerzen, Duo-Check, or equal.

2.8 BUTTERFLY VALVES

Provide butterfly valves on blower suction and discharge, suitable for use on air systems as shown on the Drawings and described herein. Discharge valves shall be double flanged or wafer with lever actuator. Butterfly valves shall have cast iron body, stainless steel shaft, aluminum bronze disc, Buna-N seal and liner, and all materials shall be suitable for operation at temperatures to 275 degrees F.

Butterfly valves shall be Milwaukee Valve MW Series or equal.

2.9 PRESSURE RELIEF VALVES

Each package shall be supplied with a single or multiple pressure safety valve(s) on the discharge side of the blower mounted downstream of the discharge silencer and upstream of the check valve. The safety valve(s) shall be set to protect the blower from exceeding its maximum pressure rating, and shall be sized to pass 100 percent of the design flow. The valve shall be field adjustable, spring loaded, and have a certificate of conformity to PED. The pressure relief valve shall also be housed by the sound enclosure and shall relieve into a segmented section of the sound enclosure.

2.10 PRESSURE AND TEMPERATURE INSTRUMENTATION

Pressure and temperature gauges shall be furnished and installed on the blower discharge header as shown on the Plans with an indicator mounted on the outside of the blower enclosure. The pressure gauges shall be glycerin-filled and have a range of 0 to 15 psig with a minimum 4-1/2-inch-diameter dial, with a pulsation snubber, Ashcroft or equal. The temperature gauge shall be a 90 degree back angle with a 4-1/2-inch aluminum scale with black etched figures graduated from 80 to 250 degrees C, a red reading, hand calibrated tube, a 3-1/4 inch stem, including a 3/4-inch male pipe thread and a stainless steel bulb. The brass case shall have a gray enamel finish, a rattle-proof glass front and shall be resistant to moisture, dust, and fumes.

Each blower discharge assembly shall also be equipped with a temperature switch. The temperature switches shall have a manual reset function. The temperature switches shall have a SPDT contact rated to switch at least 3A at 120 VAC and at least 1A at 24 VDC.

A vacuum gauge shall be furnished and installed on each blower inlet. The vacuum gauges shall be oil filled and have a range of 0 to 30-inches water (vacuum) and shall have a minimum of a 4-1/2-inch-diameter dial. Pressure and vacuum gauges shall be supplied with a bronze pressure snubber.

2.11 VIBRATION ISOLATION PADS

Each blower package shall be supplied with vibration isolating feet with a minimum efficiency of 80 percent. Blower manufacture shall be responsible for attenuating noise and vibration in the blower package such that no special installation base shall be required, nor shall any additional measures be required to reduce vibrations from the blower package being transmitted to the base or the piping.

2.12 ACOUSTIC ENCLOSURES

Each blower package shall be supplied with an acoustic enclosure covering the entire blower package. The enclosure shall be designed so as to allow side-by-side installation of blowers, with all maintenance done from the front or back of the package. The panels shall be made of galvanized steel sheet. The skid shall be of the same color. The sound enclosure acoustic material shall comply with UL 94 - HF1 for fire-retardant, self-extinguishing, non-dripping materials.

The enclosure and the blower package shall be both mounted on a skid/oil-drip pan designed for meeting environment protection standards. Fork lift channels shall be included to allow for easy transportation and installation.

A grounding strap shall be installed between the blower base and the package skid to bypass any vibration isolating mounts. Quick release panels, each less than 50 lbs. (as mandated by OSHA) must provide easy and quick access for routine maintenance of the blower and the package components.

A shaft driven, high efficiency, blower enclosure ventilation fan shall be included to provide ventilation and cooling integral to the sound enclosure. The cooling fan shall be sized for sufficient heat removal from the sound enclosure, even when the blower is operated with a VFD. Blower manufacturers requiring a separate motor driven fan for cooling shall indicate this in their bid proposal and the Contractor shall be responsible for any additional conduit, wiring, and instrumentation supply and installation required.

Electrical components, instrumentation and instrument connections shall not be mounted or interface with moving panels of the sound enclosure.

Both blower oil sumps shall be piped to a common fill and drain, located at the front of the package for easy maintenance. An oil level indicator shall be mounted on the outside of the enclosure, which gives an accurate oil level indication while the blower is in operation. All oil lines to be hydraulic hose with fittings. No plastic tubing with compression fittings are allowed.

The sounds attenuating enclosure external finish shall be applied as a powder coat rated for 4,000 hours direct salt spray.

The installed sound attenuating enclosure must be designed with hinged, lift-off panels to provide access to all maintenance points without disassembly of the enclosure. The panels must have fully retained closure fasteners.

2.13 MOTOR

Each motor shall be a standard horizontal, foot-mounted, TEFC, inverter-duty electrical induction motor meeting NEMA MG-1 and other applicable NEMA, IEEE, and ANSI standards. Motors shall be constructed with Class F, 1,600 volt insulated windings, B 30,000 antifriction bearings, cast iron frame and cast iron end bells. The motor shall be rated at 460 volts AC, 3-phase, 60 hertz, continuous duty at 40 degrees C ambient temperature with a 1.15 service factor. The ventilation fan motors (if required) shall be rated at 460 volts AC, 3 phase, 60 Hz, 1,800 rpm synchronous speed (4 pole), continuous duty at 40 degrees C ambient air temperature with a 1.15 service factor.

If variable frequency drives are required for equipment operation, the motors for the positive displacement blowers shall be suitable for operation with variable frequency drives per NEMA MG-1 Parts 30 and 31. The VFDs will be provided by others. The Supplier shall furnish specifications for the pumps and motors, including nameplate data, as required for properly-rated VFDs to be provided by others.

The motor windings shall be provided with three (total) thermal detection switches (normally closed) embedded in each phase of the motor windings, Detectors shall be suitable for operation with 120-volt AC and 24-volt AC control circuits, Klixon or equal. These sensors shall be series connected with insulated conductor leads brought to the motor terminal box and shall be suitable for wiring as a permissive in the motor starting circuit.

Motors shall be labeled and listed by a recognized electrical testing laboratory approved by the Washington State Department of Labor and Industries.

Motors shall meet the efficiency requirements of the Washington State Energy Code (Washington Administrative Code, Title 51, Chapter 51-11) Table 14-4, regardless of whether or not a particular motor is exempted from meeting this efficiency by the Washington State Energy Code.

Motors shall be manufactured by U.S. Motors, Baldor, Reliance, or Toshiba/Houston.

If any motor fails during the warranty period, the Supplier shall replace the motor with a new motor. Rewinding a failed motor shall not be acceptable.

2.14 MOTOR PROTECTIVE DEVICE COORDINATION AND DOCUMENTATION

The Supplier shall maintain a list of motor characteristics that are necessary to size, select, and/or set the various motor protective devices, such as thermal overloads, breaker trip devices, motor protection relays, etc.

The Supplier shall record the size and/or settings of each motor protective device at the time of startup and after any subsequent adjustment of the motor characteristics list described in the preceding paragraph.

In addition, the Supplier shall take a digital photo of each motor nameplate when the motor arrives at the jobsite. Each digital photo shall be emailed to the Owner's Resident Engineer, noting any discrepancy between the motor nameplate data and the submitted motor data.

2.15 DATA PLATES

Data plates shall contain the manufacturer's name, equipment size and type, serial number, speed, and other pertinent data in accordance with Section 11000-2.6. Data plates shall not be painted.

2.16 SPARE PARTS

The Supplier shall provide the manufacturer's recommended spare parts and special tools. All parts and tools shall be suitably identified and effectively protected from moisture and corrosion with appropriate wrappings or coatings or a combination thereof. All parts and tools shall be furnished in sturdy labeled boxes. At a minimum these shall include all special tools and appliances necessary to service, repair, and adjust the equipment, and the following spare parts items:

Shaft Bearings.....one set for each blower model
End Cover Oil Seal .....one set for each blower model
Main Oil Seals.....one set for each blower model
Complete Set of Gaskets and O-rings.....one set for each blower model
Inlet Filter Element .....one for each blower model
Drive Belts .....one set for each blower model

2.17 PAINTING

A. SURFACE PREPARATION

Commercial blast cleaning, SSPC-SP-6.

B. COATINGS

Shop Primer System:

Coat One

Product:	Tnemec Omnithane Series 1
MDFT:	2.5 to 3.5 mils

Final field painting will be performed by the General Contractor.

2.17 FACTORY TESTING

An actual performance bench test per ISO 1217 shall be performed on each blower at the factory prior to shipment. Blower manufacturer certification shall be submitted to the Engineer prior to delivery of the blowers.

PART 3 EXECUTION

3.1 INSTALLATION

The Supplier shall furnish complete installation instructions and recommendations to the Owner and the General Contractor. The General Contractor will install the blower systems. Manufacturer's written installation instructions shall be included with the delivered blower, one set of instructions with each blower.

A 1 psi slip test shall be performed on each blower at the factory prior to shipment. Blower manufacturer certification shall be provided to the Engineer.

3.2 FIELD TESTING

The Supplier shall perform the Component and System Testing described in Section 01800, in coordination with the General Contractor. In addition, the blowers shall be subjected to a field running test under actual operating conditions. The field test shall be made by the Supplier in the presence of and as directed by the Engineer. The field test shall demonstrate under all conditions of operation that the blower assembly:

A. Has not been damaged by transportation or installation.
B. Has been properly installed.
C. Has no mechanical defects.
D. Is in proper alignment.
E. Has been properly connected.
F. Is free of overheating of any parts.
G. Is free of vibration in excess of the limits in Section 11010
H. Is free of excessive noise.
I. Is free of overloading of any parts.

J. Shall operate as specified with the specified control system.
K. Is free of critical speeds as specified in Section 11010.

Any defects in the equipment or failure to meet requirements of the Specification shall be promptly corrected by the Supplier.

3.3 MANUFACTURER'S SERVICES

The services of a factory-trained representative of the blower manufacturer shall be provided by the Supplier. Services shall include 3 days (two visits) onsite for the supervision of equipment startup, testing, and instruction of the Owner's personnel in the operation and maintenance of the equipment. One visit shall be for installation inspection, certification, testing, and startup; and one visit shall be for training. Instruction and training of the Owner's personnel shall not take place until startup is completed and the blowers are fully operational. The training shall be at a time and location agreed to by the Owner. The cost of these services shall be included in the bid price. The representative shall be available for two additional service calls during the 2-year warranty period.

***** END OF SECTION *****

SECTION 11500

MEMBRANE EQUIPMENT

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section shall consist of the Supplier providing membrane equipment as described herein. The membrane equipment will be installed by others (the General Contractor) in covered concrete membrane basins and on a concrete pad, in an equipment building provided by others. The complete scope of supply for the Supplier is provided in Section 01110.

1.2 RELATED WORK SPECIFIED ELSEWHERE

Section	Item
01110	Summary of Work
01300	Submittals
01800	Testing, Commissioning, and Training
11000	Equipment General Provisions
Division 11	Equipment
Division 13	Special Construction
Division 15	Mechanical
Division 16	Electrical

1.3 PERFORMANCE REQUIREMENTS

A. DESIGN PRODUCTION CAPACITY:

1. Required design production capacities excluding facility drain recycle flow for the WWTF:

   a. 24,200 gpd at annual average flow rate (AAF).

   b. 37,700 gpd at maximum monthly flow rate (MMF).

   c. 61,900 gpd at maximum day flow rate (MDF).

   d. 111,700 gpd at peak hour flow rate (PHF).

   e. Flow at rates in excess of 111,700 gpd (peak hour equalized flow) will be equalized prior to the membrane system.

2. The influent wastewater flow pattern to the WWTF follows typical domestic diurnal flow patterns, with limited infiltration and inflow. The wastewater will enter the facilities via force mains on an intermittent basis from new and existing sewage pump stations. Influent flow will be constantly measured by a magnetic flow meter and all influent flow will be screened in an upstream headworks via 2-mm fine screens.

3. Screened influent wastewater flows will be equalized in a separate Equalization Basin provided by Others located upstream of the Membrane Equipment System. The maximum permeate flow required will not be required to exceed the peak equalized flow rate on a daily basis, except due to normal flow control variations. The Supplier is advised to consider the flow pattern and to recognize that diurnal varying flows will be equalized.

4. Provide sufficient membrane equipment for the WWTF to treat the maximum day flow rate for 24 hours and the peak hour equalized flow rate for a maximum of 3 hours **with all membrane basins in service**. **Provide sufficient membrane equipment for the WWTF to continuously treat the maximum month flow rate with one membrane basin out of service for 31 consecutive days.** If the submerged membrane units (SMU's) have integral air diffusers, clean-in place, and permeate systems, and are capable of being operated, isolated, and removed from a membrane basin individually, while continuing to operate all other SMUs in that basin, then the system shall be provided with **sufficient membrane equipment for the WWTF to continuously treat the maximum month flow rate with one SMU out of service for 31 consecutive days. The flux rates listed in the table below shall not be exceeded for all of the conditions listed above.** Provide sufficient permeate pumps and air scour blowers to treat the maximum day flow rate for 24 hours with one pump or blower out of service.

   The design net flux rates shall be based on Membrane System Supplier membrane type as follows:

Parameter	Membrane System A Maximum Flux at 10° C (Microfiltration)	Membrane System B Maximum Flux at 10° C (Ultrafiltation)
Net Flux Rate at Maximum Month Flow	12.0 gfd	8 gfd
Net Flux Rate Peak Day Flow	24 gfd	16 gfd

5. Provide membrane equipment to equip two membrane basins, including membrane cassettes, cassette frames, permeate pumps, air scour blowers, controls, piping, valves, etc. The total quantity of SMUs and associated membrane equipment provided shall be the Supplier's options, within the requirements of the Specifications of the Contract.

6. Design production capacities shall be met while also meeting all other requirements specified herein including cleaning frequency and membrane permeate quality.

B. MEMBRANE PERMEATE QUALITY:

1. Membrane permeate shall be capable of meeting the following requirements upon continuous sampling:

a. Turbidity

Must not exceed a monthly average of 0.2 NTU and shall never exceed 0.5 NTU.

C. MEMBRANE CLEANING:

1. Membrane modules shall be cleaned in place using chemical solutions, to meet production capacity and other performance requirements specified within this document.

2. Maintenance Cleans shall not be performed more frequently than every 90 days.

3. Recovery Cleans shall not be performed more frequently than every 90 days.

4. Supplier shall supply data to demonstrate that the minimum specified Maintenance Clean and Recovery Clean intervals can be achieved. Alternative cleaning frequencies will be considered provided Supplier can demonstrate the advantages of such alternative.

5. The following chemicals will be provided by the Owner for the chemical cleaning operation:

a. Sodium hypochlorite as 12.5 percent liquid solution by weight concentration.

b. Citric acid or oxalic acid as 50 percent liquid solution by weight concentration.

1.4 SUBMITTALS

Manufacturer certification of Build America, Buy America Act (BABAA) compliance for membranes and all ancillary components which meet these requirements.

1.5 EXPERIENCE REQUIREMENTS

The Supplier must have a minimum of four successful full-scale Publicly Owned Treatment Works with the proposed membrane units installations, with a maximum month design capacity greater than 100,000 gpd, not pilot or demonstration plants, each operating for at least 3 years, for which the Supplier has provided similar scope as this Contract, to include membranes, permeate pumps, air scour blowers, automatic valves, chemical feed systems, instrumentation, control panels, and control panel programming. The Supplier shall submit a reference list for full scale operating wastewater treatment plants, which shall include the names and telephone numbers of contacts.

1.6 GUARANTEE AND WARRANTY

A. Supplier shall, in the information submitted with the Proposal, provide documentation of warranty with a minimum 2-year duration. The warranty shall not be prorated. All warrantee and support shall be provided directly by the Supplier and not the local representative.

Supplier shall warrant membrane modules under the following terms:

1. Supplier shall repair or replace, at no cost to the Owner, one or more membrane modules if membrane modules fail before 2 years (24 months) from the date of successful completion of the Initial Performance Test. Failure is defined as any of the following:

   a. Inability to meet production capacity requirements under conditions specified in Service Conditions.

   b. Inability to meet the Performance Requirements after a cleaning as specified.

   c. Inability to meet membrane permeate quality requirements specified in Performance Requirements.

2. Operation outside of the target MLSS concentration range up to 20,000 mg/L shall not reduce or void the warranty.

3. Supplier shall warranty the performance of the membrane system to meet the requirements of the permeate quality, as listed in 11500-1.3, when the MLSS concentration of the system is between 2,500 mg/L and 18,000 mg/L.

4. Any instance where PLC communication is lost, or where one or more parameters is non-conforming per Contract Documents, for a period of 6 hours or less in each calendar month, shall not reduce or void the membrane performance warranty.

5. Any instance where PLC communication is lost for a period of more than 6 hours in each calendar month shall not reduce or void the membrane performance warranty provided the Owner can supply missing information and demonstrate conformance to Contract Documents.

6. If Supplier is unable to modify the system through addition of membranes or other elements, and cannot satisfy requirements of Initial Performance Test, or system fails to meet specified performance criteria within 24 months following the date of successful completion of the Initial Performance Test, then Supplier shall be responsible for complete removal of nonconforming system and subsequent installation of membrane products that are capable of meeting specified performance conditions.

B. Supplier shall also, in the information submitted with the Proposal, provide documentation of an extended warranty prorated as follows:

Year after the date of successful completion of the Initial Performance Test	**Percent of Equipment and Installation Cost**
3	85%
4	70%
5	55%
6	40%
7	25%
8	10%

All warrantee and support shall be provided directly by the Supplier and not the local representative. Supplier shall provide an extended warranty on the membrane modules under the following terms:

1. Supplier shall pro-rata repair or replace, one or more membrane modules if membrane modules fail before 8 years from the date of successful completion of the Initial Performance Test. Failure is defined as any of the following:

    a. Inability to meet production capacity requirements under conditions specified in Service Conditions.

    b. Inability to meet the Performance Requirements after a cleaning as specified.

    c. Inability to meet membrane permeate quality requirements specified in Performance Requirements.

C. Supplier shall guarantee that for components manufactured by the Supplier, replacement parts shall continue to be available to the Owner for a minimum of 20 years from date of successful completion of Initial Performance Test. Supplier shall guarantee that, if Supplier or Supplier's product line is sold, Supplier shall make provisions such that all guarantees, warranties, and bonds will remain in effect and that replacement parts and operational support continue to be available to the Owner for the time period specified above.

D. Guaranteed Membrane Module Replacement Cost: The Supplier shall guarantee that membranes may be purchased by the Owner at the price bid in the Proposal or lower, any time during the 20 years following successful completion of the Initial Performance Test.

1.7 DEFINITIONS

A. PRODUCTION CAPACITY

Equals the net production rate of treated effluent (permeate), in gallons per day (gpd), over a 24-hour period of continuous operation.

B. DESIGN FLOW

Design flow is equivalent to "production capacity." Refer to "production capacity" for definition.

C. NET FLUX RATE

Equals the total amount of permeate, in gallons per day, produced by the membrane system over a 24-hour period that is available for downstream discharge divided by the total membrane outside surface area in square feet. Units of "Flux Rate" are gallons per square foot per day (gfd).

D. INSTANTANEOUS FLUX RATE

Equals the permeate flow rate, in gallons per day, produced during the service cycle divided by the total membrane outside surface areas. Service cycle is defined as the period of continuous permeate production between the membrane relaxation, backwash, or backpulse. Units of "Flux Rate" are gallons per square foot per day (gfd).

E. PEAK FLUX

The maximum membrane flux rate that the system is permitted to operate at during a period when a portion of the membrane system is offline for maintenance or recovery cleaning operations. Units of Peak Flux are gallons per square foot per day (gfd).

F. TRANSMEMBRANE PRESSURE (TMP)

The pressure differential across the membrane. TMP should be adjusted for losses from membrane discharge to pressure gauge. Units of TMP are pounds per square inch (psi).

G. MICROFILTRATION

Membrane filtration pore size greater than 0.1 microns

H. ULTRAFILTRAION

Membrane filtration average pore size greater than 0.01 microns and less than or equal to 0.1 microns.

I. PERMEABILITY

Equals the instantaneous flux rate divided by the transmembrane pressure. The units of permeability are gfd/psi.

J. TEMPERATURE CORRECTED PERMEABILITY

Equals permeability multiplied by Supplier's Temperature Correction Factor (TCF) expressed in the following form:

$P_{20} = P_t \times TCF^{(20-t)}$

Where:
P_{20} = permeability at 20 degrees C (Celsius)
P_t = permeability at measured temperature t
t = temperature (degrees C)

K. BACKWASH OR BACKPULSE CLEAN

Any routine instance a membrane basin is taken offline for application of air, water, and/or chemical solution for the purpose of maintaining permeate production rate of membrane.

L. RELAXATION

Any routine instance a membrane basin is taken offline by temporarily stopping the permeate pump to maintain net flux rate of membrane system.

M. MAINTENANCE CLEAN

Any routine instance a membrane basin is taken offline for application of a chemical solution that is not considered part of the normal backwash cycle. Its purpose is to maintain design production capacity by reducing TMP and increasing permeability by oxidizing or solubilizing biological and non-biological matter within the membrane surface and in the membrane pores.

N. RECOVERY CLEAN

Any non-routine procedure, manual, automated or semi-automated, that uses one or more cleaning chemicals to reverse the effects of membrane fouling by reducing TMP and increasing permeability. This may involve removing a membrane tank from service and draining the tank, if required. The tank is then filled with cleaning solution. The membranes are soaked for a period of time then the chemical solution is drained from the tank. Its purpose is to remove all solids that have accumulated in membrane modules (including on membrane surface and within membrane pores) so that the design permeate production capacity and the temperature

corrected permeability directly following the cleaning are consistently restored to values required to meet Performance Requirements.

O. NSF refers to National Sanitation Foundation.

P. Days are defined as calendar days.

Q. MEMBRANE MODULE

Basic unit of membrane production system. The Module may be a single assemblage of fibers in a common potting (element) or a cartridge of flat plates bonded to a common support frame.

R. MEMBRANE CASSETTE

A submerged membrane unit, a group of membrane modules or multiple elements sharing common air and permeate connections. A cassette is the smallest assembled unit of a delivered system that is designed to be removed and replaced as a complete unit.

S. MEMBRANE BASIN

A membrane bank, or a grouping of membrane cassettes, located in a concrete tank, which share a common permeate header, pump, and air supply header, and that are removed from operation as an entity for backpulsing, relaxing, maintenance cleaning, or recovery cleaning.

PART 2 PRODUCTS

2.1 SUPPLIER

Membrane products Supplier shall be Kubota Membrane USA Corporation, Toray, or Mann + Hummel No other manufacturers shall be allowed.

2.2 MANUFACTURER

Membrane products supplied shall meet the Experience Requirements in Section 1.4 and the technical specifications. No manufacturers other than named in the technical specifications shall be accepted.

2.3 GENERAL

A. Membrane equipment shall be provided complete, with all necessary components, accessories, and appurtenances required to make a complete and operable system. Interconnecting piping between Membrane Basins

and interconnecting piping between ancillary systems, including air compressors, and air blowers will be provided by the General Contractor.

B. Membrane modules and equipment shall be prefabricated, pre-assembled, and tested before shipment to the site.

C. Supplier shall provide the equipment as described in these Specifications:

1. Items shall be new and unused, and shall be Supplier's most current product line at the time of product submittal.

2. Furnished as a complete and operable system including all required valves and in-basin piping.

D. All metal in contact with wastewater or chemicals shall be stainless steel. Any carbon steel components provided shall be painted as follows and shall only be for uses that do not come into contact with wastewater or chemicals.

1. Surface Preparation

Near-white blast cleaning, SSPC-SP-10.

2. Shop Primer System

Product:	Tnemec Omnithane Series 1 or equal
MDFT:	2.5 to 3.5 mils

E. Membrane equipment shall have been recognized by the California Department of Public Health as being acceptable for compliance with the treatment requirements of the State of California Recycled Water Criteria (Title 22).

F. Membrane equipment to be installed in Hazardous Locations, as described in Division 16, shall be of the type that is suitable and labeled for the environment. All equipment installed below the top of wall in the MBR basins and aeration basins (below the FRP covers) shall be suitable for Class I, Divisions 2 NFPA 820 classification, including all in-basin instrumentation and isolation valves.

2.4 SERVICE CONDITIONS

A. INFLUENT LOADING CONDITIONS

1. Design influent loading rates for the Taylor Bay Wastewater Treatment Facility are:

   a. 25 lbs/day at annual average BOD_5 loading rate.

   b. 38 lbs/day at annual average TSS loading rate.

   c. 7 lbs/day at annual average TKN loading rate.

   d. 72 lbs/day at maximum month BOD_5 loading rate.

   e. 74 lbs/day at maximum month TSS loading rate.

   f. 11 lbs/day at maximum month TKN loading rate.

B. Membrane Equipment System requirements specified herein shall be met when mixed liquor characteristics comply with the criteria listed below. Process design will be by the Owner's Engineer.

1. Wastewater Temperature

   Minimum of 10 degrees C; Maximum of 22 degrees C.

2. Average Membrane Basin Mixed Liquor Suspended Solids (MLSS) Concentration

   Between 8,000 mg/L and 15,000 mg/L. 10,000 mg/L at design conditions.

3. Biological Aerobic Solids Retention Time (SRT)

   Normally between 19 days and 25 days. Owner will design for 23 days at 10 degrees C and a diurnal peaking factor of 1.5, and may be adjusted downward during warmer temperatures while maintaining nitrification.

4. Wastewater to membrane bioreactor will be screened using a 2-mm fine screen provided by General Contractor as part of the overall facility design.

5. The recycle rate shall not exceed 400 percent of the 24-hour averaged influent flow rate (Maximum Day Flow rate).

6. Influent wastewater flows to the WWTF will be equalized in an Equalization Basin provided by Others located upstream of the Membrane Equipment System. The maximum permeate flow required will not exceed the peak equalized flow rate, except due to normal flow control variations. The Supplier is advised to consider the flow pattern and to recognize that diurnal varying flows will be equalized.

2.5 MEMBRANE TANKS

The membrane basins will be partially below grade concrete tanks with odor control covers, which will be designed and constructed by others.

2.6 MEMBRANE EQUIPMENT

A. MEMBRANES

1. Use polymeric flat plate membranes having a nominal pore size of 0.4 micron or less, intended for submerged operation in mixed liquor.

2. Flow shall pass from the outside to the inside of the sheet.

3. Membranes shall be constructed of chemically resistant materials suitable for exposure to the Supplier's proposed cleaning chemical solutions. At a minimum, the membrane materials shall be capable of being washed in high chlorine solutions (1,000 mg/L), low pH (range 2 to 3) wash solutions and high pH (range 9 to 10) wash solutions for 10 hours.

4. Membranes shall be physically strong enough to withstand the operating conditions associated with operation in an aerated tank of mixed liquor at concentrations up to 15,000 mg/L.

5. Membranes shall be able to withstand backwash/backpulse flow (from within lumen or the interior side of plate to outside), if proposed by Supplier, without any damage.

B. MEMBRANE CASSETTE

1. The membrane flat sheets or modules shall be assembled into a unit called a cassette.

2. Each cassette shall be supported within a frame manufactured of Type 304 stainless steel.

3. All non-steel components of the membrane cassettes or modules shall be UV resistant and have a chemical resistance at least equal to that of the membranes.

4. The base of each cassette shall contain diffusers to allow compressed air to escape and travel upwards past and between the membrane fibers or plates creating an agitation effect.

5. Provide manual isolation valves for the permeate and agitation air for each connection to each membrane cassette to provide means of isolating individual cassettes from the remainder of the system, enabling the system to produce permeate with one or more cassettes out of service.

6. Each frame shall be fitted with two lifting eyes (one at each end) or equivalent lifting system to allow the entire membrane cassette/rack to be lifted into and out of the basin/mixed liquor and transported away from the membrane basin.

7. All fasteners, including nuts, bolts, screws, cables, washers, and other appurtenances associated with the membrane cassette and housing shall be manufactured from Type 304 stainless steel.

C. PERMEATE SYSTEM

1. Permeate Suction Piping

a. Each membrane basin shall have a suction header for permeate collection. The header will have a connection for a pressure gauge at each end.

b. All cassettes in a membrane basin shall be connected to the common suction header. The pipe connections between the membrane cassettes and the manifold header pipe work shall be UV-resistant flexible pipe capable of operating at the positive and negative pressures expected for this system.

2. Permeate (Membrane Effluent) Pumps

a. Provide a pumped permeate collection system including pumps, controls, isolation valves, check valves, flow meters, and pressure gauges as required by Supplier to meet performance requirements.

b. Pumps shall be rotary lobe in accordance with Section 11305.

c. Pump capacity shall meet the requirements in this Section. There shall be one suction header from each MBR basin to a single common permeate pump suction manifold at the pump location, with Supplier provided isolation valves and check valves, to the dedicated and redundant permeate pumps. There will be one common discharge header from the permeate pumps to the in-vessel UV system and to the downstream Non-Potable Water Tank (NPW Tank). The permeate will flow by gravity from the NPW tank overflow to the outfall. The Supplier shall provide manual isolation valves, check valves, automatic modulating valves, and magnetic flow meters, shipped loose, for installation on permeate pump discharge lines as required to control the flow from each pump. The water surface elevation in the MBR basins will be 6 to 8 feet below the permeate pump suction inlet center-line elevation. The permeate pump discharge line will discharge to a water surface elevation of 10 to 12 feet above the pump centerline elevation. The length of pump suction line will be 150 to 200 feet and the length of pump discharge piping will be 100 to 150 feet. The connection point from the membrane cassette permeate isolation valve to the Contractor provided permeate suction piping shall be above the normal water surface elevation of the membrane tanks, and the remainder of the permeate suction piping to the permeate pumps will be designed to be installed at a slightly positive slope, such that no high point will be present in the suction line from the membrane cassette to the permeate pump. A high point in the permeate discharge, downstream of the common connection point from each of the permeate pump discharge headers, will be designed to include a Contractor provided air release valve.

3. Permeate Pump Priming System, if required:

   a. Provide automatic permeate priming system, including pumps, check valves, and automatic valves, if required, to allow the permeate pumps to start and stop automatically, without the need for manual priming at any time.

   b. An air extraction system shall be included, if required, to remove air bubbles generated during the permeate extraction process, unless the Supplier does not require an air extraction system.

   c. The system shall consist of air release valves on the permeate pump suction lines, connected to liquid reservoirs and vacuum pumps, to protect the permeate pumps, or as required for the Supplier's permeate system.

   d. Liquid Reservoirs, if required:

      1. Supplier shall size the liquid reservoirs to provide adequate residence time to ensure satisfactory air removal from the permeate.

      2. Column shall be Type 316 stainless steel.

      3. Provide a minimum of two reservoirs for the membrane system.

      4. The air outlet of the air separation column shall be connected to a vacuum generating system.

      5. Each reservoir shall be equipped with a level sensor. Apart from normal operating control loops, the level sensor shall include a Level-Alarm-Low level. Should the liquid level in the vessel drop to this level, an alarm will be generated, and the system will proceed to shut down.

   e. Vacuum Pumps, if required:

      1. Pumps shall be positive displacement type.

      2. Quantity: A minimum of two duty, and one installed spare.

3. Rated Capacity: As required by the Supplier.

D. AIR COMPRESSOR SYSTEM

1. If compressed air is required to operate any equipment, pneumatic valves or instrumentation provided by the Supplier, the Supplier shall design and provide a complete compressed air system.

2. Provide a minimum of two air compressors (one duty, one installed spare), if required for the Supplier's equipment.

   a. Reciprocating or rotary screw air compressor, single-stage or two-stage, with dedicated dryer, inlet air filter/silencer, flexible connections, air check valves, automatic drip trap and other components for a complete system.

   b. Cylinders shall be cast iron construction with cooling fins.

   c. Valve assemblies shall be individually removable without disturbing head and inlet or discharge piping.

   d. Adjustable tapered roller bearings mounted on each end of crankshaft to take both radial and thrust loading.

   e. Use V-belt drive, full-discharge size flexible discharge connection, air check valve, and an adequate number of vibration isolators.

   f. Provide oil filter, combination air intake filter/silencer, and discharge cushion chamber.

3. Dryers: Provide a minimum of two (one duty, one installed spare) electric heat regenerative desiccant air dryers or refrigerant air dryers.

4. Provide coupling guards and other features to fully comply with OSHA requirements.

5. Provide vertical air receiver, if required, constructed to ASME Section VIII, Division 1, rated for 150 psig, minimum.

6. Provide ASME-rated pressure relief valve, pressure gauge with gauge cock, automatic condensate drain valve, and miscellaneous fittings as required.

2.7 CLEANING SYSTEMS

A. GENERAL

1. All chemicals required for cleaning shall be indicated by Supplier. Sodium hypochlorite and citric acid (or oxalic acid) will be provided by the Owner in the concentrations listed in Part 1.3 of this Section.

2. Chemical metering pumps, chemical storage tanks, and all valves, level control instrumentation and accessories for a complete system shall be provided by the Supplier.

B. AGITATION AIR SYSTEM

1. Provide agitation air scour blower system as required by Supplier to meet Performance Requirements, including blowers, valves, air diffusers, instruments and accessories for a complete system. Blowers shall be positive displacement type in accordance with Section 11370. Air piping and valves shall be in accordance with Division 15 of the specifications.

2. Air scour blower capacity shall meet the requirements of Section 11370. There shall be one common discharge header from the air scour blowers to the MBR basins. The Supplier shall provide manual isolation valves, check valves, pressure transmitters (as required for warranty), and air flow meters (as required for warranty), shipped loose, for installation on air scour discharge lines as required to control each blower. The common discharge header from the scour air blowers will be connected to the aeration blower, which will be supplied by others. The Supplier shall provide PLC and Operator Interface Unit (OIU) programming to allow the uninstalled spare air scour blower to be controlled by the WWTF PLC to also act as a backup to the aeration blowers.

3. Provide automatic valves and piping in each of the MBR tanks to allow automatic reversal of flow through any membrane coarse bubble air scour diffuser systems to allow mixed liquor to flow through the diffusers and discharge to the MBR tank, if required. The valve operator shall be provided with a 4-foot minimum extension to allow it to be installed above the tank cover.

4. Provide solenoid valves for installation on the permeate piping and air scour piping as required for relax or backpulse operation as required.

C. MAINTENANCE CLEAN SYSTEM

1. Provide actuated valves, check valves, chemical injection connections, mixing systems, flow meters, backpulse pumps, Mazzei injectors, pressure reducing valves, chemical cleaning solution line high pressure overflow/relief line (to protect membranes from over-pressurization), chemical metering or backwash pumps, controls, and other components to provide manual maintenance clean and recovery clean flow systems as required for the Supplier's system.

2. Backwash and/or backpulse pumps, if provided, shall be horizontal end suction centrifugal pumps in accordance with Section 11310. The backwash and/or backpulse pumps shall deliver the required maintenance clean backwash flow and recovery clean flow at maximum system headloss and maximum transmembrane pressure. Alternatively, rotary lobe pumps may be used for backwash service.

3. Dilution water will consist of non-potable water at 80 to 100 psi.

4. The Supplier shall supply all the valves and control elements required to perform Maintenance Clean or Recovery Clean cycles, including switching from normal operation to cleaning operation, and from cleaning operation to normal operation. Backpulse clean cycles must be automatically initiated and controlled. The recovery clean cycle may be manually initiated, but must be automatically controlled. Maintenance clean cycles will be manually initiated and controlled.

D. CHEMICAL FEED SYSTEMS

1. For each chemical proposed by the Supplier to be used in the cleaning systems, the Supplier shall supply a complete and workable chemical storage and feed system.

2. Bulk Chemical Storage Tanks

The Supplier shall provide polyethylene tanks for the storage of cleaning chemicals that are rated for the storage of the respective chemical. The chemicals will be supplied by the Owner at the concentrations noted in Part 1.3 of this Section. The tanks shall be equipped with continuous level measurement instrumentation and alarms for low chemical level.

3. Chemical Make-down Systems

The Supplier shall provide equipment to make-down or dilute the bulk chemicals provided by the Owner for use in membrane cleaning. Potable or non-potable water connections to the make-down systems will be provided by others.

4. Chemical Feed Pumps

The Supplier shall provide two chemical feed pumps or Mazzei injectors (one duty, one installed spare) and appurtenances for each chemical service to deliver cleaning chemical and dilution water to the membranes. In all cases chemical feed pumps or injectors and appurtenances shall be approved by the manufacturer for the proposed chemical service. Pumps, if provided, shall be peristaltic or diaphragm pumps. The Supplier shall provide all valves and instrumentation required for a complete and workable chemical feed system.

2.8 PIPING AND VALVES

A. Provide piping and valves per requirements of Division 15.

B. All piping, hoses, and pipe appurtenances, including air, permeate, or other required headers for the Membrane Equipment located within the Membrane Basin, shall be provided by the Supplier. Piping shall be in accordance with Section 15050. The Supplier shall design and provide the permeate and air piping systems to extend above the normal water surface elevation in the membrane basins, each to a separate, Supplier provided, isolation valve located above the common wall between the membrane basins and the deoxygenation basin. Flexible connections to the membrane units shall be provided as required to allow the membrane units to be removed from the basins without removing rigid piping.

C. Flanged wall pipes through the Membrane Basin walls will be provided and installed by the General Contractor. In-basin piping supplied by the Supplier shall be drilled to meet ANSI 125-pound flanged bolt circles at the terminal connection point at the basin wall.

D. Provide all check valves, control valves, and isolation valves required for a completely functional system including chemical feed systems and compressed air systems (shipped loose). Each permeate pump shall be provided with a suction isolation valve, discharge isolation valve, and discharge check valve. Supplier shall provide valves suitable for intended

service and relevant chemical exposure. All control valves shall be automatically actuated. Valves shall be in accordance with Section 15100.

E. Provide automatic modulating valves on discharge of each permeate pump to control the permeate flow as required.

F. Provide automatic valves on each air scour discharge header and each permeate pump suction header to allow automatic switchover to the standby redundant pump or blower upon failure of any of the duty pumps or blowers. Alternatively provide manual operated valves for this purpose and provide HMI programming which allows operators to easily select which MBR basin is associated with the standby pump or blower, based on the operator adjusted position of the manual valves provided. All valves related to operation of backpulse shall be automatically activated.

G. Provide actuated valve operators in accordance with Section 15110, and as described herein, and where required by the Supplier for operation of automated systems.

1. Electric Actuators

Electric actuators can be used for typical OPEN/CLOSE application and modulating applications.

2.9 ELECTRICAL

A. Electrical components provided by the Supplier shall be provided in accordance with the requirements of Division 16, Electrical.

B. Three-phase, 480V AC power will be available for the Membrane Equipment System major equipment items and ancillary equipment and shall be used for any motor loads 1/2 hp and larger.

C. Three separate 120 VAC, 20 A single phase circuits will be provided to power the control panel. All power distribution for instruments, field devices, and control panel components shall be provided in the control panel using circuit breakers and fuses per Specification 16940.

D. Motor control centers, adjustable frequency drives, panel boards, transformers, and other equipment necessary to provide power distribution and motor control for all equipment will be provided by the General Contractor.

E. Pre-piped and skid-mounted components power and control wiring shall be prewired to separate terminal junction boxes located on the skid.

2.10 CONTROLS SYSTEM

Provide controls, PLC and Operator Interface hardware and software, Membrane Control System software package, and data links with the Owner's Plant Control System in accordance with Division 16. All equipment provided by the Supplier shall be controlled from a PLC located in a single control panel provided by the Supplier. The status of all equipment and instrumentation and the ability to change control parameters shall be provided by the Supplier shall be displayed on an operator interface mounted on the outside door of the control panel.

2.11 INSTRUMENTATION

A. GENERAL REQUIREMENTS

Provide instrumentation described herein in accordance with Division 13 and 16. Additional instrumentation may be provided as required by the Supplier's proposed system, and shall meet the technical requirements in accordance with Divisions 13 and 16.

B. TURBIDITY TRANSMITTERS

1. Function

Continuously measures, indicates, and transmits signals proportional to turbidity of membrane permeate from each basin.

2. Provide at least one turbidity transmitter for the common permeate pump discharge header. Turbidity transmitters shall comply with Specification Section 13414.

C. MAGNETIC FLOW METERS

1. Function

Continuously measures, indicates, and transmits signals proportional to flow of liquid services.

2. Provide one Magnetic Flow Meter and transmitter for each membrane basin permeate flow for installation on each of the pump discharge lines (one flow meter per pump), for each backwash connection to each cassette, and for chemical cleaning system dilution water or other liquid service as required by the Supplier's system, sized for respective flow rates, in accordance with Specification Section 13426.

D. THERMAL MASS AIR FLOW METERS

1. Function

Continuously measures, indicates, and transmits signals proportional to air flow from the agitation blower system.

2. Provide at least one flow meter and transmitter for the agitation air header to each membrane basin. Thermal mass air flow meters shall comply with Specification Section 13428.

E. PRESSURE GAUGES

Provide pressure gauges for the suction and discharge of each pump, compressor, and blower, at each end of each permeate header, upstream and downstream of each injector and pressure reducing valve, and elsewhere as specified or required by the manufacturer for process control. Pressure gauges shall comply with Specification Section 13417.

F. PRESSURE DIFFERENTIAL TRANSMITTERS

1. Function

Continuously measure, indicate, and transmit pressure in various pipes; provide a signal to the control system when low or high pressure setpoints are reached.

2. Provide pressure transmitters on compressed air header pipes, if compressed air is required for the Supplier's system, and elsewhere as required for control of the Supplier's system. Pressure transmitters shall comply with Specification Section 13419.

G. PRESSURE SWITCHES

1. Function

To provide a discrete signal to the control system when low or high pressure setpoints are reached.

2. Provide pressure switches at all process locations required for warranty or proper operation and/or alarming functions related to the Supplier's system. Pressure switches shall comply with Specification Section 13418.

H. LEVEL INDICATING TRANSMITTERS

1. Function

Continuously measure, indicate, and transmit liquid level in the Membrane Basins.

2. Provide a minimum of one pressure level indication transmitter in each membrane basin (if required for by warranty or control of the Supplier's system). Pressure level indicating transmitters shall comply with Specification Section 13424.

I. FLOAT SWITCHES

Provide a minimum of two float switches to monitor discrete liquid levels in the Membrane basins. Float switches shall comply with Specification Section 13422.

2.12 FACTORY TESTS

A. Prior to delivery, the Supplier shall test the membrane equipment actually furnished.

B. Test for proper alignment and operation, proper connection, pumping capacity, and satisfactory performance.

C. Notify the Engineer of testing dates as he may wish to witness pump tests.

D. Provide written certification of tests and test results to the Engineer.

E. Upon receipt of the Engineer's approval, the equipment shall be released for shipment to the job site.

2.13 SPARE PARTS

The Supplier shall provide the manufacturer's recommended spare parts and special tools as specified herein and as specified in each individual specification section. All parts and tools shall be suitably identified, provided with appropriate wrappings or coatings for effective protection from moisture and corrosion, and stored in durable boxes (not cardboard). At a minimum these shall include all special tools and appliances necessary to service, repair, and adjust the Membrane Equipment System, and the following spare parts items:

A. One spare set of expendable material such as gaskets, seals, and packing.

B. One set of new and unused special tools required for installation, operation, and maintenance.

C. One repair kit for sealing off damaged membrane fibers or sheets within the membrane cassettes.

D. All jigs, fixtures, clamps, lifting beams, hooks, and other instruments required for facilitating the removal, disassembly, reassembly, and installation of each item of equipment within the system.

E. Reagents/chemicals, calibration sets, and spare parts as specified for individual equipment items or instruments.

Guarantee availability of the recommended spare parts as listed above for a period no less than 20 years.

Provide a complete list of replaceable parts, including prices.

PART 3 EXECUTION

3.1 INSTALLATION

Supplier shall furnish installation instructions and recommendations to the Owner. Manufacturer's written installation instructions shall be included with the delivered equipment, one set of instructions with each piece of equipment. Each piece of equipment delivered to the site shall have an identification tag with the equipment identification number, or the packing slip shall identify the equipment identification number referencing the equipment serial number.

General Contractor will install the Membrane Equipment in accordance with Supplier's instructions and recommendations.

3.2 TESTING AND COMMISSIONING

A. PROCEDURES

Per Section 01800 and as specified herein.

B. CALIBRATION

Once written certification of proper installation has been issued, the Supplier shall field calibrate all instruments where possible, including pressure differential transmitters, process analyzers, and flow meters. Instruments which cannot be field calibrated shall be checked for accuracy by the Supplier in the field.

C. COMPONENT AND SYSTEM TESTS

1. Following the Supplier's calibration of instruments, the Supplier shall perform Component and System Tests on the Membrane Equipment System. It shall be the responsibility of the Supplier and General Contractor to communicate with each other to arrange the times for testing and startup activities; however, the General Contractor must confirm that these times are acceptable to the Owner and the Engineer.

2. To perform the Component and System Tests, the Supplier shall operate all valves, controls, and other devices to ensure they are functional and ready for performance testing.

3. Purpose of the Component and System Tests shall be to demonstrate the proper operation of the following system components and features:

    a. Automatic control, during Contractor's operation testing of the entire WWTF, of all membrane equipment with clean water as Specified in 01800.

    b. Automatic START/STOP and flow control of membranes using Plant Control System.

    c. Manual flow control using membrane basin OIU and PLC.

    d. Automatic relaxation or backpulsing/backflushing at various time intervals.

    e. Automatic shutoff and alarm for various failure modes for each membrane basin and for entire Membrane Equipment System.

    f. START, STOP, and cycling of air agitation system, including control valves.

    g. Determination of clean water permeability of each membrane basin and temperature correction of the clean water permeability for each basin.

    h. Monitoring and recovery of operating data.

    i. Monitoring and control from remote workstation.

j. Automatic switchover from normal power to standby power, and standby power to normal power.

k. All control functions, both at local system and remote workstation.

l. Operation of systems for Maintenance Cleans and Recovery Cleans.

m. Communication of all data to the main plant control panel.

n. Operation of all monitoring instruments.

D. INITIAL PERFORMANCE TEST

Following completion of the Component and System Tests, the Supplier, General Contractor, and Owner shall conduct the Initial Performance Test on the complete Membrane Equipment System. The requirements and procedures for the Initial Performance test are specified in Section 01800.

E. COMMISSIONING PERIOD

After completion of the Initial Performance Test, the commissioning period on the Membrane Equipment System may begin. Owner shall operate the plant during the Commissioning Period; however, Supplier and General Contractor shall provide on-site assistance as requested by the Owner. The requirements and procedures for the commissioning period are specified in Section 01800.

3.3 MEMBRANE EQUIPMENT MANUFACTURER'S SERVICES

A. PRECONSTRUCTION SERVICES

Provide preconstruction services for the Membrane Equipment Systems as described in Section 01110-1.1A.

B. CONSTRUCTION ON-SITE SERVICES

The Supplier shall provide the following on-site services at times designated by the Owner and General Contractor, for the minimum person-days listed below, travel time excluded. If the minimum person-days and trips listed below are insufficient in the opinion of the Supplier, the Supplier shall indicate the required number of person-days and trips in the Proposal. The cost of these services shall be included in the bid price.

Provide qualified individuals who have previously provided on-site services for the installation, testing, and startup of supplier's identical system of similar size. All field service shall be provided directly by the Supplier and not the local representative. Service time spent remedying equipment deficiencies/problems shall not count toward the listed service days and trips.

1. Two person-days (two trips) during unloading of Membrane Equipment System including attendance at a 1-day predelivery site meeting with the Owner.

2. Two person-days (two trips) for providing installation assistance for the Membrane Equipment.

3. Three person-days (three trips) for training of the Owner's operators including attendance at a 1-day pre-startup site meeting with the General Contractor and the Owner.

4. Twenty person-days (two trips) for assistance during startup and testing activities, including the Component and System Tests and the Initial Performance Test.

C. POST-CONSTRUCTION ON-SITE SERVICES

1. Four person-days (two trips) for commissioning and performance optimization services during the 12-month period following successful completion of the Initial Performance Test, such as instrument calibration, programming, fine tuning of equipment settings, and a 2-day review of operations at the end of the first year of operation.

2. Two person-day (two trips) for additional service calls during the 2-year warranty period.

3. Four person-days (four trips) for additional service calls during the 2-year warranty period.

4. 10 Person-days (ten trips) for the supplier programmer/integrator to be on site for trouble shooting.

D. REMOTE SUPPORT SERVICES

1. Provide toll-free telephone and internet-based support for a minimum period of 36 months following successful completion of the Initial Performance Test.

2. Provide a list of three or more names of individuals qualified to support operation and provide cellular phone numbers for these individuals, if available.

3. At least one of the listed individuals shall be available at all times including nights, weekends, and holidays in the event of an emergency.

***** END OF SECTION *****

DIVISION 13

SPECIAL CONSTRUCTION

SECTION 13414

TURBIDIMETERS

PART 1 GENERAL

1.1 SCOPE

The Supplier shall furnish turbidity transmitters and associated equipment as specified herein, and as listed in Section 11500 and as required for proper operation and/or monitoring/alarming functions related to the Membrane Equipment System.

1.2 RELATED WORK SPECIFIED ELSEWHERE

Section	Item
01300	Submittals
11000	Equipment General Provisions
11500	Membrane Equipment
Division 11	Equipment
Division 16	Electrical

1.3 PERFORMANCE REQUIREMENTS

Parameter	Performance Requirement
Range of measurement (NTU)	0.001 – 100
Accuracy between 0 – 40 NTU (percent, NTU)	2, 0.015
Accuracy between 40 – 100 NTU (percent)	5
Display resolution between 0 – 10 (NTU)	0.0001
Display resolution between 10 – 100 (NTU)	0.001
Repeatability (percent, NTU)	1, 0.002
Sample Flow Rate (gal/hour)	3.1-11.9

1.4 DELIVERY, STORAGE AND HANDLING

All equipment shall be completely factory assembled, skid mounted, crated and delivered to protect against damage during shipment.

All equipment delivered to the site shall be stored as specified in accordance with the manufacturer's instructions.

1.5 WARRANTY

The Supplier shall warrant the units being supplied to the Owner against defects in workmanship and material for the period described in Section 11000-1.5. The warranty shall be in printed form and apply to all similar units.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

The Turbidity Monitors shall be Hach Model 1720E with 2 channels SC200 Controller, or approved equal.

2.2 FACTORY TESTING

The equipment shall be fully tested at the manufacturer's plant before shipment. Tests shall insure that the equipment will operate as desired under anticipated field conditions. Certified copies of test report(s) shall be submitted to the Engineer prior to shipment.

2.3 TURBIDITY TRANSMITTER

A. The turbidity transmitter shall be microprocessor-based that operates as follows. Light shall be directed through the interface of the sample and the detector. The detector shall be immersed in the sample, eliminating glass windows and flow cells. Optical components shall be mounted in a sealed head assembly that can be removed easily for calibration or service without disturbing the sample flow. The turbidimeter body shall be constructed of corrosion resistant structural plastic and shall include an internal bubble removal system to vent entrained air from the sample stream. It shall be powered from the control unit and require no separate power source.

B. The turbidity transmitter shall allow user selectable signal averaging, bubble removal, alarm and recorder output hold, and self test diagnostics.

C. The control unit shall allow users to control sensor and interface functions with user friendly, menu-driven software, and shall provide data logging of measurement data from up to two turbidimeters. Each control unit shall have two analog 4 to 20 mA and three un-powered SPDT alarm contacts; one configured to indicate a fault with the turbidimeter(s). The control unit and the DC power supply shall be housed in an industrial enclosure suitable for the mounting location as shown in the project drawings and shall be powered by 120 VAC, 60 Hz.

D. Transmitters that will be installed in Hazardous Locations shall be properly rated and labeled for the classification of the area where they will be installed.

2.4 ELECTRICAL INSTRUMENTATION

A. The turbidity transmitter shall be of the solid-state type and of the manufacturer's latest design. The equipment shall have 4 to 20 mA standard DC (direct current) isolated floating outputs and shall conform to ISA Standard S 50.1.

B. Analog instruments shall operate without loss of loop accuracy due to electromagnetic interference, resistive or inductive losses or similar problems related to field interconnection of components when connected with shielded copper wire.

C. The display shall indicate the turbidity in real engineering units.

D. The DC power supply shall automatically accept input of 100 to 230 VAC, 50/60 Hz.

E. All mounting hardware, cable, and supports including 316 stainless steel fasteners shall be provided by the Supplier.

PART 3 EXECUTION

3.1 GENERAL

The Supplier shall furnish complete installation instructions and recommendations to the Owner and the General Contractor. This includes directions for Hazardous Location installations including separation of circuits or other requirements for intrinsically safe circuits.

Provide calibration kit for use with the turbidity transmitter provided, including a one-year supply of consumables utilized for calibration.

The General Contractor will install the turbidity transmitters as directed by the manufacturer and project documentation.

3.2 MANUFACTURER'S SERVICES

The services of a factory-trained representative of the turbidity transmitter manufacturer shall be provided. Services shall include a minimum of 2 days (two separate visits) on site for inspection of the installation, initial configuration, programming, startup, and adjustments and instruction of the Owner's personnel in operation and maintenance for each turbidity transmitter (or group of transmitters) ready to start at each stage of the project. The first visit shall be for the inspection of the installation, initial configuration, programming, testing, and startup. The second visit shall be for the instruction of the Owner's personnel and adjustments to the initial configuration and programming. Instruction and

training of the Owner's personnel shall not take place until startup is completed and the turbidity transmitters are fully operational and shall be at a time and location agreed to by the Owner. The cost of these services shall be included in the bid price. The representative shall be available for two additional service calls during the warranty period.

***** END OF SECTION *****

SECTION 13417

PRESSURE GAUGES

PART 1 GENERAL

1.1 SCOPE

There shall furnished by the Supplier pressure gauges as listed in Section 11500, and as required for operation and maintenance of the Supplier's system, for the Membrane Equipment System. The pressure gauges shall be complete with all necessary connectors and hardware for a complete and workable installation.

1.2 RELATED WORK SPECIFIED ELSEWHERE

Section	Item
01300	Submittals
11000	Equipment General Provisions
11500	Membrane Equipment
Division 11	Equipment
Division 15	Mechanical

1.3 PERFORMANCE REQUIREMENTS

Unless otherwise indicated, the discharge and other pressure gauge scales shall be selected so that the normal operating pressure falls between 50 and 80 percent of full scale.

The suction pressure gauges on pumps, blowers, and compressors shall be equivalent to the discharge pressure gauges with a lower range of 30 inches Hg.

1.4 SUBMITTAL REQUIREMENTS

Submittal data shall be supplied in accordance with Section 01300 of these Specifications.

Manufacturer certification of Build America, Buy America Act (BABAA) compliance for blowers and all ancillary components.

1.5 WARRANTY

The Supplier shall warrant the units being supplied to the Owner against defects in workmanship and material for the period described in Section 11000-1.5. The warranty shall be in printed form and apply to all similar units.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

The pressure gauges shall be Ashcroft Duragage 1279, or equal.

The diaphragm seals shall be Ashcroft Type 101, or equal.

2.2 GENERAL

The pressure gauges shall be glycerin filled type and shall have all internal parts immersed.

Pressure gauges shall be minimum 4 1/2-inch dial size, with non-metallic case, stainless steel bourdon tube with plastic bushings and pinion, and stainless steel selector.

Gauges shall be ANSI grade A or better with an accuracy of plus or minus 0.5 percent.

2.3 REQUIRED ACCESSORIES

Gauges measuring liquids shall be supplied with an Ashcroft Type 201 Viton diaphragm seal.

Diaphragm seals shall have silicone DC200 fluid fill and shall have 316 stainless steel body, with 1/4-inch flushing connection and 1/2-inch process connection.

All mounting hardware, cable, and supports including 316 stainless steel fasteners shall be provided by the Supplier.

PART 3 EXECUTION

3.1 GENERAL

The Supplier shall furnish complete installation instructions and recommendations to the Owner and the General Contractor. This includes directions for Hazardous Location installations including separation of circuits or other requirements for intrinsically safe circuits.

The General Contractor will install the pressure gauges and diaphragm seals (where required).

3.2 INSTALLATION

Pressure gauges shall be located on the suction and discharge piping of each pump, compressor, fan, or blower at a location where the gauges can be easily read.

The gauges shall be located upstream of the isolation valves, if possible.

***** END OF SECTION *****

SECTION 13418

PRESSURE SWITCHES

PART 1 GENERAL

1.1 SCOPE

The Supplier shall furnish pressure switches for all process locations required for proper operation and/or alarming functions related to the Membrane Equipment System. The pressure switches shall be complete with all necessary connectors and hardware for a complete and workable installation.

1.2 RELATED WORK SPECIFIED ELSEWHERE

Section	Item
01200	Measurement and Payment
01300	Submittals
01800	Testing, Commissioning, and Training
11000	Equipment General Provisions
11500	Membrane Equipment
Division 11	Equipment
Division 15	Mechanical
Division 16	Electrical

1.3 PERFORMANCE REQUIREMENTS

Unless otherwise indicated, the pressure switch calibration range shall be selected so that the system operating pressure falls between 50 and 80 percent of settable range.

Pressure switches shall meet the following minimum performance requirements:

Type and Medium	Parameter
Air-Service Pressure Switches	
Accuracy	+/- 0.5 psi
Measurable range	1 - 15 psig
Water-Service Pressure Switches	
Accuracy	+/- 2 psi
Measurable range	6 - 90 psig
Substance	Raw or treated domestic wastewater
Temperature range	40 – 80 degrees F

1.4 DELIVERY, STORAGE, AND HANDLING

All equipment shall be completely factory assembled, crated and delivered to protect against damage during shipment.

All equipment delivered to the site shall be stored as specified in accordance with the manufacturer's instructions.

1.5 SUBMITTAL REQUIREMENTS

Submittal data shall be supplied in accordance with Section 01300 of these Specifications.

Manufacturer certification of Build America, Buy America Act (BABAA) compliance for blowers and all ancillary components.

1.6 WARRANTY

The Supplier shall warrant the units being supplied to the Owner against defects in workmanship and material for the period described in Section 11000-1.5. The warranty shall be in printed form and apply to all similar units.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

The pressure switches shall be Barksdale or approved equal.

2.2 PRESSURE SWITCHES

Liquid-service pressure switches shall be diaphragm or Bourdon tube type with vibration isolators and pulsation dampers. Switch action shall be snap-acting to eliminate "dead-center" where contacts could chatter. Contact blocks shall be rated for 250 volts AC, 10 amps. Terminal screws shall be readily accessible for wiring. Wiring may be for cut-in or cut-out action as required for the specific application.

Enclosure and type of contacts shall be as shown on the Plans and as specified in Division 16, Electrical.

2.3 FACTORY TESTING

The equipment shall be fully tested at the manufacturer's plant before shipment. Tests shall insure that the equipment will operate as desired under anticipated field conditions. Certified copies of test report(s) shall be submitted to the Engineer prior to shipment.

2.4 REQUIRED ACCESSORIES

A. Switches measuring liquids shall be supplied with an Ashcroft Type 201 Viton diaphragm seal.

B. Diaphragm seals shall have silicone DC200 fluid fill and shall have 316 stainless steel body, with 1/4-inch flushing connection and 1/2-inch process connection.

C. All mounting hardware, cable, and supports including 316 stainless steel fasteners shall be provided by the Supplier

PART 3 EXECUTION

3.1 GENERAL

The Supplier shall furnish complete installation instructions and recommendations to the Owner and the General Contractor. This includes directions for Hazardous Location installations including separation of circuits or other requirements for intrinsically safe circuits.

The General Contractor will install the pressure switches and associated hardware as directed by the manufacturer and project documentation.

***** END OF SECTION *****

SECTION 13419

PRESSURE TRANSMITTERS

PART 1 GENERAL

1.1 SCOPE

Pressure transmitters include those applied to measure gauge pressure, absolute pressure, and differential pressure. These instruments are applied to measure pressure, level, flow, or other process quantities directly related to pressure.

There shall furnished by the Supplier pressure transmitters and switches, and associated equipment, as listed in Section 11500, and as required for operation and/or alarming of the Supplier's system, for the Membrane Equipment System.

1.2 RELATED WORK SPECIFIED ELSEWHERE

Section	Item
01200	Measurement and Payment
01300	Submittals
01800	Testing, Commissioning, and Training
11000	Equipment General Provisions
11500	Membrane Equipment
Division 11	Equipment
Division 16	Electrical

1.3 PERFORMANCE REQUIREMENTS

The pressure transmitter shall be provided with the following pressure range for the specified applications and locations.

Parameter	Value
Reference Accuracy (percent of span)	0.065%
Long Term Stability (2 year max, percent)	0.1% of URL
Span Drift (percent)	None measurable
Turndown Capacity	100:1
Total Response Time	100 ms
Pressure Range	0.4 – 5,800 psig
Measurement Media	Air
Maximum Media Temperature	280°F

If the manufacturer's rated maximum process temperature in the measuring cell is less than the Maximum Media Temperature listed above, the Supplier shall provide a process connection pipe/hose of sufficient length to provide ambient cooling so that the maximum measuring cell temperature is not exceeded.

1.4 WARRANTY

The Supplier shall warrant the units being supplied to the Owner against defects in workmanship and material for the period described in Section 11000-1.5. The warranty shall be in printed form and apply to all similar units.

1.5 SUBMITTAL REQUIREMENTS

Submittal data shall be supplied in accordance with Section 01300 of these Specifications.

Manufacturer certification of Build America, Buy America Act (BABAA) compliance for blowers and all ancillary components.

1.6 DELIVERY, STORAGE AND HANDLING

All equipment shall be completely factory assembled, crated and delivered to protect against damage during shipment.

All equipment delivered to the site shall be stored as specified in accordance with the manufacturer's instructions.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

The pressure transmitter shall be Emerson Rosemount Model 2051T, Siemens SITRANS P DS III, or Endress and Hauser Deltabar S PMD75, with a block and bleed valve manifold provided. No other manufacturers or models shall be accepted.

2.2 PRESSURE TRANSMITTER

The pressure transmitter shall be a digital transmitter with piezoresistive or capacitance-based sensor and Type 316 stainless steel diaphragm seal. The pressure sensitive element shall be Type 316 stainless steel, silicone oil filled, and shall be calibrated for the range as specified in the Performance Requirements.

The transmitter pressure sensor shall be protected from the effects of pressure swings and spikes up to the maximum working pressure (body rating) of the pressure capsule. The process connection shall be Type 316 stainless steel, ½-inch diameter, NPT 14 thread. The process connection shall be connected to a Type 316 stainless steel block-and-bleed manifold with a Type 316 stainless steel isolation valve and a bleed vent. The manifold shall permit removal of the sensor

for maintenance or replacement with minimal leakage of process air during compression removal of the sensor.

The transmitter shall be a true two-wire loop-powered device, 24 VDC, without the requirement of a separate power supply at the transmitter. The unit shall be modular plug-in design.

The transmitter shall be rated for a Class 1 Division 1 hazardous environment if required in the membrane basins.

The non-wetted transmitter housing shall be aluminum or stainless steel and shall meet NEMA 4X standards. The pressure transmitters shall display the measured pressure on the front of the unit enclosure and all units shall have a menu-driven keyboard on the front panel of the transmitter. The transmitter shall have an LCD display for indicating the pressure in real engineering units (psig). The display shall be rotatable in 90 degree increments. The unit shall be capable of recalibration in the field by the menu-driven keyboard. The keyboard shall allow for viewing control of results, the error messages, the operating modes, and the digital display.

The controller shall be supplied with one isolated 0/4-20 mA standard DC (direct current) analog output; with 0.004 mA (12-bit) resolution and capability to drive up to 500 Ω loads.

The digital information shall be evaluated in the microcontroller, its linearity and temperature response corrected and converted in a digital-to-analog converter into an analog output current.

The transmitter shall have the ability to electronically compensate for the effects of mounting position on the sensor. Furthermore, the transmitter shall be able to force the loop current to various values to aid in loop setup and testing.

The transmitter shall have online diagnostics and registers to detect and store various parameters such as min/max electronics temperature, min/max pressure, capsule temperature, and min/max process pressure to help diagnose process problems. The transmitter shall also have dual timer registers that allow the transmitter to signal when a settable time has elapsed for preventative maintenance or calibration.

Analog instruments shall operate without loss of loop accuracy due to electromagnetic interference, resistive or inductive losses or similar problems related to field interconnection of components when connected with shielded copper wire in the manner shown on the Plans.

The pressure transmitters shall be listed and labeled by an electrical testing laboratory recognized by the Washington State Department of Labor and Industries or be acceptable to the Washington State Department of Labor and Industries for installation on this project.

2.3 SPARE PARTS

The manufacturer shall provide the manufacturer's recommended spare parts and special tools. All spare parts and tools shall be suitably identified and effectively protected from moisture and corrosion with appropriate wrappings or coatings or a combination thereof. All parts shall be furnished in sturdy labeled boxes.

2.4 FACTORY TESTING

The equipment shall be fully tested at the manufacturer's factory before shipment. Tests shall insure that the equipment will operate as desired under anticipated field conditions. Certified copies of test report(s) shall be submitted to the Engineer prior to shipment.

2.5 REQUIRED ACCESSORIES

A. Gauges measuring liquids shall be supplied with diaphragm seal.

B. Diaphragm seals shall have silicone DC200 fluid fill and shall have 316 stainless steel body, with 1/4-inch flushing connection and 1/2-inch process connection.

C. All mounting hardware, cable, and supports including 316 stainless steel fasteners shall be provided by the Supplier.

PART 3 EXECUTION

3.1 GENERAL

The Supplier shall furnish complete installation instructions and recommendations to the Owner and the General Contractor. This includes directions for Hazardous Location installations including separation of circuits or other requirements for intrinsically safe circuits.

The General Contractor will install the pressure transmitters.

3.2 MANUFACTURER'S SERVICES

The services of a factory-trained representative of the pressure transmitter manufacturer shall be provided. Services shall include a minimum of 2 days (two separate visits) on site for inspection of the installation, initial configuration, programming, startup, and adjustments and instruction of the Owner's personnel in operation and maintenance for each pressure transmitter (or group of transmitters) ready to start at each stage of the project. The first visit for each installation shall be for the inspection of the installation, initial configuration, programming, testing, and startup. The second visit for each installation shall be for the instruction of the Owner's personnel and adjustments to the initial configuration and programming. Instruction and training of the Owner's personnel shall not take place until startup is completed and the pressure transmitters are fully operational and shall be at a time and location agreed to by the Owner. The cost of these services shall be included in the bid price. The representative shall be available for two additional service calls during the warranty period.

***** END OF SECTION *****

SECTION 13422

FLOAT SWITCHES

PART 1 GENERAL

1.1 SCOPE

There shall be furnished by the Supplier float switches and associated equipment as listed in Section 11500 and as required for proper operation and/or monitoring/alarming functions related to the Supplier's system, for the Membrane Equipment System.

1.2 RELATED WORK SPECIFIED ELSEWHERE

Section	Item
01300	Submittals
11000	Equipment General Provisions
11500	Membrane Equipment
Division 11	Equipment
Division 16	Electrical

1.3 PERFORMANCE REQUIREMENTS

All float switches shall be mercury-free tilt type.

Unless specified elsewise, all float switches shall be held in place by a supplier provided anchoring system consisting of either anchor or pole mounting support accessories.

1.4 DELIVERY, STORAGE AND HANDLING

All equipment shall be completely factory assembled, crated and delivered to protect against damage during shipment. All equipment delivered to the site shall be stored as specified in accordance with the manufacturer's instructions.

1.5 SUBMITTAL REQUIREMENTS

Submittal data shall be supplied in accordance with Section 01300 of these Specifications.

Manufacturer certification of Build America, Buy America Act (BABAA) compliance for blowers and all ancillary components.

1.6 WARRANTY

The Supplier shall warrant the units being supplied to the Owner against defects in workmanship and material for the period described in Section 11000-1.5. The warranty shall be in printed form and apply to all similar units.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

The switch(es) shall be Flygt Model ENM-10 or equivalent equipment manufactured by Warrick Controls, Hydr-O-Matic, or Anchor Scientific.

2.2 TILTING FLOAT SWITCHES

Tilting float switches shall be the tilting, non-mercury type. Mercury switches are not acceptable. The switch(es) shall be enclosed in a liquid-tight plastic casing with a cable of sufficient length to reach to the terminating device. Tilting float switches shall have either single pole double throw contacts, or single pole single throw contacts. Pole and throw contact number will be determined based on recommendations of the manufacturer as well as the application for which it will be used.

2.3 FACTORY TESTING

The equipment shall be fully tested at the manufacturer's plant before shipment. Tests shall insure that the equipment will operate as desired under anticipated field conditions. Copies of test report(s) shall be submitted to the Engineer prior to shipment.

PART 3 EXECUTION

3.1 GENERAL

The Supplier shall furnish complete installation instructions and recommendations to the Owner and the General Contractor. This includes directions for Hazardous Location installations including separation of circuits or other requirements for intrinsically safe circuits.

The General Contractor will install the float switches.

***** END OF SECTION *****

SECTION 13424

SUBMERSIBLE PRESSURE (LEVEL) TRANSMITTERS

PART 1 GENERAL

1.1 SCOPE

There shall furnished by the Supplier submersible pressure level transmitters as listed in Section 11500, and as required for operation and maintenance of the Supplier's system, for the Membrane Equipment System. The submersible pressure level transmitters shall be complete with all necessary connectors and hardware for a complete and workable installation.

1.2 RELATED WORK SPECIFIED ELSEWHERE

Section	Item
01200	Measurement and Payment
01300	Submittals
01800	Testing, Commissioning and Training
11000	Equipment General Provisions
11500	Membrane Equipment
Division 16	Electrical

1.3 PERFORMANCE REQUIREMENTS

The submersible level transmitter and transducer level signal shall indicate to ±0.2 percent of span.

The analog instrumentation shall have an accuracy of ± 0.5 percent of full scale output.

The pressure transmitter shall be provided with a pressure range of 0 to 20 feet.

1.4 DELIVERY, STORAGE, AND HANDLING

All equipment shall be completely factory assembled, crated and delivered to protect against damage during shipment.

All equipment delivered to the site shall be stored as specified in accordance with the manufacturer's instructions.

1.5 WARRANTY

The Supplier shall warrant the units being supplied to the Owner against defects in workmanship and material for the period described in Section 11000-1.5. The warranty shall be in printed form and apply to all similar units.

1.6 SUBMITTAL REQUIREMENTS

Submittal data shall be supplied in accordance with Section 01300 of these Specifications.

Manufacturer certification of Build America, Buy America Act (BABAA) compliance for blowers and all ancillary components.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

The Submersible Level Sensor shall be as manufactured by Endress and Hauser, Model FMX21 or equivalent equipment manufactured by Siemens or Contegra. No other manufacturers shall be accepted.

2.2 PRESSURE TRANSDUCER

The transmitter shall be loop-powered hydrostatic pressure sensor for submerged level measurement.

The transmitter shall consist of variable capacitance, gauge pressure sensing assembly enclosed in a 42-mm diameter submersible type 316 stainless steel housing with aluminum oxide ceramic sensor.

The transmitter shall provide analog 4-20 mA output signal and must be capable of being ranged in the field via the superimposed HART communication protocol.

The transmitter must have the ability to output temperature values via HART communication protocol.

The sensor shall measure the depth of water by comparing the pressure on the submerged ceramic cell to atmospheric pressure through a vented capillary tube which is protected from moisture intrusion by a Teflon or GORE-TEX ® filter.

The sensor shall be aluminum oxide with FKM Viton seal; body is 316 SS; cable material is polyethylene (PE), polyurethane (PUR) or fluorinated ethylene propylene (FEP) over shielded copper twisted pair and vent tube.

The process temperature rating shall be +14 deg to 158 deg F.

The transducer and manufacturer's filtered termination box shall be suitable for installation in a Class 1, Division 1, Group D (hazardous) location.

The level sensor shall be listed and labeled by a recognized electrical testing laboratory or be acceptable to the Washington State Department of Labor and Industries for installation on this project.

2.3 SPARE PARTS

The manufacturer shall supply one spare transmitter that will be identical to the equipment specified above. All spare parts shall be suitably identified and effectively protected from moisture and corrosion with appropriate wrappings or coatings or a combination thereof. All parts shall be furnished in sturdy labeled boxes.

2.4 FACTORY TESTING

The equipment shall be fully tested at the manufacturer's plant before shipment. Tests shall insure that the equipment will operate as desired under anticipated field conditions. Certified copies of test report(s) shall be submitted to the Engineer prior to shipment.

PART 3 EXECUTION

3.1 INSTALLATION

The equipment specified in this Section shall be installed as shown on the Plans and in accordance with the manufacturer's instructions and recommendations.

The level transducer shall be permanently mounted at the measuring site and positioned according to the Manufacturer's approved method. The bottom diaphragm face of the sensor shall be installed 6 inches above the bottom of the wet well/vessel, unless otherwise shown on the Plans. The sensor shall be mounted using the stainless steel cable system as shown on the Plans.

The electrical signaling cable, supplied by the sensor, shall be connected from the sensor to the transmitter housing with an additional length of 5 feet to be coiled at the access hatch. No splices shall be allowed to the manufacturer's cable.

3.2 FIELD TESTING

The Contractor shall perform the field testing described in Sections 01800 and 11000.

The field test shall insure that the equipment will operate as desired under field conditions. The manufacturer shall provide a formal test procedure and report forms for recording data. The Contractor shall submit the report forms to the Engineer prior to operational testing.

Any defects in the equipment or failure to meet requirements of the Specification shall be promptly corrected by the Contractor.

3.3 MANUFACTURER'S REPRESENTATIVE

The services of a factory-trained representative of the pressure transmitter manufacturer shall be provided. Services shall include a minimum of 1 day on site for each type of pressure transmitter. Services shall include inspection of the installation, initial configuration, startup, testing, adjustments and instruction of the Owner's personnel in operation and maintenance for the pressure transmitters. Instruction and training of the Owner's personnel shall not take place until startup is completed and the pressure transmitters are fully operational and shall be at a time and location agreed to by the Owner. The cost of these services shall be included in the bid price.

The representative shall provide for two additional service calls during the initial 2 years of equipment operation.

***** END OF SECTION *****

SECTION 13426

MAGNETIC FLOW METERS

PART 1 GENERAL

1.1 SCOPE

There shall furnished by the Supplier magnetic flow meters and associated equipment as listed in Section 11500, and as required for operation and/or monitoring/alarming of the Supplier's system, for the Membrane Equipment System.

1.2 RELATED WORK SPECIFIED ELSEWHERE

Section	Item
01300	Submittals
11000	Equipment General Provisions
11500	Membrane Equipment
Division 11	Equipment
Division 16	Electrical

1.3 PERFORMANCE REQUIREMENTS

The magnetic flow meters shall have an accuracy of plus or minus 0.5 percent of the actual flow rate at velocities of 1.5 ft/sec or greater.

1.4 SUBMITTAL REQUIREMENTS

Submittal data shall be supplied in accordance with Section 01300-2.2 D of these Specifications.

Manufacturer certification of Build America, Buy America Act (BABAA) compliance for blowers and all ancillary components.

1.5 WARRANTY

The Supplier shall warrant the units being supplied to the Owner against defects in workmanship and material for the period described in Section 11000-1.5. The warranty shall be in printed form and apply to all similar units.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

The magnetic flow meters and signal converters shall be Endress & Hauser Proline Promag W 400 or equivalent equipment manufactured by Siemens, meeting BABAA requirements. No other manufacturers shall be accepted.

2.2 GENERAL

The magnetic flow meters shall be of the low frequency and short form coil design. The field principle of electromagnetic induction shall produce a positive DC pulsed signal directly and linearly proportional to the liquid flow rate. The metering tube shall be constructed of stainless steel with ANSI flanged end connections. Electrodes can either be protruding (bullet nose) or flush for the meters, but shall be of 316 stainless steel, Hastelloy®, or zirconium construction. The material of construction of the liner shall be Neoprene rubber or Teflon. The meter shall secure its power from the signal converter. No electronics shall be mounted in the metering tube of the magnetic flow meter.

The signal converters shall be integral to the flow head where the transmitter location is specified to be integral. Provisions for remotely mounting the signal converter shall be provided where the transmitter is specified to be remote. Signal converters shall be interchangeable without reprogramming the meters or disconnecting the cables. The signal converters shall convert the output signal from the flow meters and transmit the signal via an isolated analog 4 to 20 mA signal directly proportional to flow rate. The signal converters shall have automatic zero correction. The signal converters shall be designed to operate from a 120 AC, 60 Hz, single phase, power source. The signal converters shall generate power for the magmeter.

The signal converter shall produce a totalization of flow dry contact output pulse signal or opto-isolated transistor pulse signal, which is directly and linearly proportioned to totalization of flow and which is suitable for use with a 24 VDC discrete input with an input impedance of at least 2 kΩ. The minimum pulse duty cycle shall be adjustable to be at least 250 ms.

The magnetic flow meter enclosure shall be NEMA 4X classified.

Each meter system shall be wet-calibrated at the manufacturer's facility against the master system. A calibration certificate shall be furnished for each meter.

Provide grounding rings or grounding electrodes with each flow meter as required to maintain the specified accuracy.

The flow meters shall be capable of accidental submergence to 3 feet for a period of 30 minutes.

2.3 ANALOG INSTRUMENTATION

The flow meters shall be of solid state type and of the manufacturer's latest design. The equipment shall have 4 to 20 mA standard DC (direct current) isolated floating outputs and shall conform to ISA 50.1. Each output shall be provided with adjustments for gain and bias. The resultant output shall be 4 to 20 mA DC into approximately 750 ohms. Accuracy shall be plus or minus 1.5 percent of full scale output.

Analog instruments shall operate without loss of loop accuracy due to electromagnetic interference, resistive or inductive losses or similar problems related to field interconnection of components when connected with shielded 2/conductor #18 gauge copper wire.

Transmitters and sensors to be installed in Hazardous Locations shall either be applied with intrinsically safe circuits or be of the type that is suitable and labeled for the environment.

All mounting hardware and cable shall be provided by the Supplier.

PART 3 EXECUTION

3.1 GENERAL

The Supplier shall furnish complete installation instructions and recommendations to the Owner and the General Contractor. This includes directions for Hazardous Location installations including separation of circuits or other requirements for intrinsically safe circuits.

The General Contractor will install the magnetic flow meters.

3.2 MANUFACTURER'S SERVICES

The services of a factory-trained representative of the magnetic flow meter manufacturer shall be provided. Services shall include a minimum of 2 days (two separate visits) on site for inspection of the installation, initial configuration, programming, startup, and adjustments and instruction of the Owner's personnel in operation and maintenance for each unit (or group of units) ready to start at each stage of the project. The first visit for each installation shall be for the inspection of the installation, initial configuration, programming, testing, and startup. The second visit for each installation shall be for the instruction of the Owner's personnel and adjustments to the initial configuration and programming. Instruction and training of the Owner's personnel shall not take place until startup

is completed and the units are fully operational and shall be at a time and location agreed to by the Owner. The cost of these services shall be included in the bid price. The representative shall be available for two additional service calls during the warranty period.

***** END OF SECTION *****

SECTION 13428

AIR FLOW METERS

PART 1 GENERAL

1.1 SCOPE

The Supplier shall provide heated probe-type mass flow meters and associated equipment as listed in Section 11500 and as specified herein and as required for proper operation and/or monitoring/alarming functions related to the Membrane Equipment System.

1.2 RELATED WORK SPECIFIED ELSEWHERE

Section	Item
01300	Submittals
11000	Equipment General Provisions
11500	Membrane Equipment
Division 11	Equipment
Division 16	Electrical

1.3 PERFORMANCE REQUIREMENTS

The air flow meters shall have a repeatability of plus or minus 0.5 percent over the range of flows and an accuracy of plus or minus 1 percent of full scale.

1.4 SUBMITTAL REQUIREMENTS

Submittal data shall be supplied in accordance with Section 01300 of these Specifications.

Manufacturer certification of Build America, Buy America Act (BABAA) compliance for blowers and all ancillary components.

1.5 WARRANTY

The Supplier shall warrant the units being supplied to the Owner against defects in workmanship and material for the period described in Section 11000-1.5. The warranty shall be in printed form and apply to all similar units.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

The air flow meters shall be FCI Model ST98, or equivalent manufactured by STI/Magnetrol or Endress and Hauser. No other manufacturers shall be accepted.

2.2 GENERAL

The air flow meters shall be of the heated probe type suitable for metering the mass flow of air. The meter shall be suitable for insertion mounting into the pipeline through a tapped, welded, or flanged connection. The unit shall be completely mounted in a single sensor element requiring a single pipe penetration. Bypass piping configurations shall not be required to remove the flow meter and maintain pressure in the air piping. The insertion probe shall be provided and installed through an open ball valve and compression fitting assembly. The 3/4-inch male NPT stainless steel compression fitting and stainless steel ball valve assembly shall be provided by the air flow meter manufacturer and for installation on the piping to permit removal of the sensor for maintenance or replacement with minimal leakage of process air during compression removal of the insertion probe.

The unit shall operate on the thermal dispersion detection design. It shall employ two precisely matched platinum resistance temperature detectors and a mass equalizer positioned in the sensor probe assembly along with a heating element that preferentially heats one of the RTDs. The elements shall be housed in an all metal 316 stainless steel/nickel brazed thermal weld. The unit shall create a temperature difference between the RTDs which is greatest at zero flow and which decreases as the flowing gas passes along the sensing element.

Changes in flow shall directly and incrementally affect the extent to which heat is dissipated from the probe. The difference in temperature between the heated and non-heated probes shall be electronically converted into a linearized signal providing an accurate and linear measurement of mass flow rate.

The probe shall be mounted separately from the electronics package and shall be housed with a connection box suitable for connecting a cable provided with the probe assembly by the manufacturer.

The transmitter shall provide a 4 to 20 mA current loop. The transmitter shall be designed to operate from a 120 AC, 60 Hz, single phase power source. The remote electronics package shall be field mounted. It shall be suitable for separation from the sensor by as much as 500 feet with a PVC jacketed interconnecting cable provided by the manufacturer for connection between the two units. Electronic circuitry shall be housed in a NEMA 4X (ICS6-1993)

enclosure with a flow rate indicator visible through an enclosure window. Flow rate shall be measured in SCFM and displayed on a 3-1/2-digit liquid crystal display. The totalizer shall be summed with an eight-digit liquid crystal display of total flow.

The unit shall be suitable for the range of flows and pipe sizes required. The insertion length shall be determined by the Supplier based on the actual piping to be installed at each location, the expected process temperature, and the manufacturer's recommendations. The flow range and pipe size shall be utilized in a factory calibration test to verify accuracy of the unit before shipment.

The unit shall be provided with a certified curve stating the calibration test results at the factory and demonstrating the capability of meeting the accuracy, linearity, and repeatability specification described above.

Transmitters that will be installed in Hazardous Locations shall be properly rated and labeled for the classification of the area where they will be installed.

2.3 ANALOG INSTRUMENTATION

The air flow meters shall be of solid state type and of the manufacturer's latest design. The equipment shall use 4 to 20 mA standard DC (direct current) isolated floating outputs and shall conform to ISA 50.1. Each output shall be provided with adjustments for gain and bias. The resultant output shall be 4 to 20 mA DC into approximately 750 ohms. Accuracy shall be plus or minus 1.5 percent of full scale output. The transmitters shall supply a 4 to 20 mA output signal which is directly proportional to the measured flow in SCFM.

Analog instruments shall operate without loss of loop accuracy due to electromagnetic interference, resistive or inductive losses or similar problems related to field interconnection of components when connected with shielded 2/conductor #18 gauge copper wire.

PART 3 EXECUTION

3.1 GENERAL

The Supplier shall furnish complete installation instructions and recommendations to the Owner and the General Contractor. This includes directions for Hazardous Location installations including separation of circuits or other requirements for intrinsically safe circuits.

The General Contractor will install the air flow transmitters.

3.2 MANUFACTURER'S SERVICES

The services of a factory-trained representative of the air flow meter manufacturer shall be provided. Services shall include a minimum of 2 days (two separate visits) on site for inspection of the installation, initial configuration, programming, startup, and adjustments and instruction of the Owner's personnel in operation and maintenance for each unit (or group of units) ready to start at each stage of the project. The first visit for each installation shall be for the inspection of the installation, initial configuration, programming, testing, and startup. The second visit for each installation shall be for the instruction of the Owner's personnel and adjustments to the initial configuration and programming. Instruction and training of the Owner's personnel shall not take place until startup is completed and the units are fully operational and shall be at a time and location agreed to by the Owner. The cost of these services shall be included in the bid price. The representative shall be available for two additional service calls during the warranty period.

***** END OF SECTION *****

DIVISION 15

MECHANICAL

SECTION 15050

PIPING SYSTEMS

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section shall consist of the Supplier providing process piping including pipe, hoses, fittings and accessories, including permeate headers, scour air headers and any other piping that will be located within the Membrane Basins.

Permeate, air and other piping outside of the Membrane Basins will be provided and installed by the General Contractor, including flanged wall pipes through the concrete membrane basin walls. In-basin piping provided by the Supplier shall be drilled to meet ANSI Class 150 flanged bolt circles at the terminal connection point at the basin wall. Pipe supports and anchor bolts will be provided by the General Contractor.

Piping and accessories provided by the Supplier will be installed by the General Contractor.

1.2 RELATED WORK SPECIFIED ELSEWHERE

Section	Item
01300	Submittals
11000	Equipment General Provisions
11500	Membrane Equipment
15100	Valves

1.3 STANDARDS FOR THE WORK

Pipe and fittings shall be provided to produce complete, operable systems with all elements properly interconnected as shown in schematic diagrams or to provide specified operations. If the approved submittal drawings do not detail all items such as complete venting, it is understood that this work shall be included as a part of this Section and all costs included in the lump sum price bid items.

Piping systems and materials shall be new and without imperfections. Piping will be designed to limit maximum liquid flow velocities to 8 feet per second (fps), and air flow velocities to 50 fps. If unable to meet these flow criteria, indicate and describe locations where velocities will be greater.

1.4 PIPE MATERIALS

The materials to be utilized for the various pipe sizes and applications on the project shall be as follows, unless otherwise noted herein:

Process		Material, Connection Type
Air High Pressure	AHP	Stainless Steel, BW
Air Low Pressure	ALP	Stainless Steel, BW (at discharge manifold)
		PVC, SW/FL (in membrane basins)
Chemical Solution	CS	PVC, SW
Drain	D	Ductile Iron, FL
Non-Pot Water (<3")	NPW	PVC, SW
Non-Pot Water (≥3")	NPW	Ductile Iron, FL
Permeate	PM	Stainless Steel, BW or PVC, SW
Potable Water (<3")	W	PVC, SW
Potable Water (≥3")	W	Ductile Iron, FL
Sodium Hypochlorite	SHC	PVC, SW

Notes: FL = Flanged, BW = Butt Welded, SW = solvent Welded

1.5 SUBMITTAL REQUIREMENTS

Submittal data shall be supplied in accordance with Section 01300 of these Specifications.

Manufacturer certification of Build America, Buy America Act (BABAA) compliance for blowers and all ancillary components.

PART 2 PRODUCTS

2.1 GENERAL

Pipe sizes are nominal inside diameter unless otherwise noted.

All materials delivered to the job site shall be new, free from defects, and marked to identify the material, class, and other appropriate data such as thickness for piping.

Acceptance of materials shall be subject to strength and quality testing in addition to inspection of the complete product. Acceptance of installed piping systems shall be based on inspection and leakage tests performed by the General Contractor as specified in Part 3.3 of this Section.

2.2 DUCTILE IRON PIPE AND FITTINGS

Ductile iron pipe shall be centrifugal cast pipe conforming to AWWA C151, Class 52, unless otherwise noted, bituminous coated and cement mortar lined in accordance with AWWA C104. All flanged spools shall be Class 53 as shall all piping where grooved couplings are used. Approved grooved couplings may be used instead of flanged.

Mechanical joints shall comply with AWWA C111.

Flanges shall comply with ANSI Bl6.1, Class 125. Flange gaskets shall be full face. Grooved couplings shall be Victaulic Style 31, Certainteed GB or equal and shall comply with AWWA C606. Adaptor flanges may be used instead of flanges where approved by the Engineer.

Fittings shall be ductile iron and shall comply with AWWA C110 or AWWA C153, bituminous coated exterior and cement mortar lined, 250 psi minimum pressure.

2.3 PVC PIPE AND FITTINGS

All PVC pipe 3 inch and smaller shall be Schedule 80 constructed of material, which meets or exceeds ASTM D2241 and D1784 and Commercial Standard CS 256. Joints shall be solvent weld with press fit, unless noted otherwise. Fittings shall conform to ASTM D2466 and D2467 for socket type and ASTM D2464 for threaded pipe.

All PVC pipe 4 inch and larger shall be PVC, Cast Iron pipe equivalent OD, Class 150, D.R. 18, conforming to the requirements of AWWA C900. Pipe joints shall be gasketed. Solvent-cement joints will not be acceptable. Fittings for PVC pipe 4 inches and larger shall be ductile iron, conforming to AWWA C110 or C153, 250 psi minimum pressure with Class 125 flanges.

Provisions for pipe expansion shall be as recommended by the pipe manufacturer.

Bolts for PVC pipe, where required, shall be 316 stainless steel, ASTM A193, Grade B8M, hex head with ASTM A194, Grade 8M hex nuts. Washers of the same material shall be supplied.

2.4 STAINLESS STEEL PIPE AND FITTINGS

All stainless steel air pipe larger than 2 inches in diameter shall be Type 316L Schedule 10S and conform to ASTM A778. All stainless steel air pipe 2 inches and smaller in diameter shall be fabricated from 316L stainless steel pipe conforming to ASTM A312, and shall be Schedule 40. Non-welded parts and

pieces such as nuts, bolts, washers, supports-, and follower flanges shall be made from 316 stainless steel.

All stainless steel threaded fittings shall be Type 316 and conform to ANSI B16.3, Class 150. All gaskets shall be 45 to 55 durometer (Shore A) neoprene.

After fabrication, all stainless steel piping shall be passivated by immersion in a pickling solution of nitric and hydrofluoric acid. Parts shall be free of iron particles or other foreign materials. A final neutralizing rinse will complete the cleaning.

All stainless steel pipe shall be butt-welded in accordance with the applicable standards. Field welding will not be acceptable. Approved grooved couplings, such as Victaulic IPS stainless steel grooved fittings may be used instead of butt-welding.

2.5 COPPER PIPE

Copper pipe and fittings shall be Type L (above ground), when used as water service lines, and Type L tube, when used as waste, vent or drainage lines.

Copper pipe shall be protected from reaction with dissimilar metals by installation of insulating materials and dielectric unions at contact points.

2.6 MISCELLANEOUS FITTINGS

A. FLEXIBLE COUPLINGS

Flexible couplings shall be as follows:

Steel to Steel:	Rockwell (Smith-Blair) Type 411, Dresser Style 38, or equal. Middle ring and follower shall have fusion bonded epoxy coating.
PVC to PVC:	General Rubber Corp. Spool-type expansion joint with straight through tube, single arch and flanged ends, or equal.

Harness lugs and tie bolts for harnessed joints shall comply with AWWA M-11, Third Edition

B. FLANGED COUPLING ADAPTERS

Flanged coupling adapters shall be Rockwell (Smith-Blair) Type 912, Dresser Style 127 or equal.

C. GROOVED PIPE COUPLERS

The couplers for steel pipe shall be Victaulic Style 44 for Type C collared end design, or Victaulic IPS stainless steel grooved fittings.

The gaskets shall be rated and be suitable for use in wastewater or high/low pressure air pressure systems.

D. CALDER-TYPE FLEXIBLE COUPLINGS

Calder-type flexible couplings shall consist of all elastomeric PVC sleeve secured to the pipes with stainless steel clamping bands. Adapter couplings shall be furnished for transitions between piping of different outside diameters as necessary.

Calder-type flexible couplings shall be as manufactured by Calder Co., Fernco, or approved equal.

E. FLEXIBLE CONNECTORS AND EXPANSION JOINTS

Flexible connectors and expansion joints shall be provided with 125 pound ASA flanges and be single arch-type multiple ply rubber or synthetic elastomers, complete with steel retaining rings, as manufactured by the Red Valve Company, Inc., the Metraflex Company, or equal.

F. DIELECTRIC INSULATED UNIONS

Dielectric insulated unions shall be used to connect dissimilar metals. They shall separate the metals so that the passage of more than 1 percent of the galvanic current, which would exist with metal to metal contact, is prevented. Unions shall be of the same material as the pipe to which attached, and pressure and temperature ratings shall be no lower than that of the piping system in which it is installed.

G. STAINLESS STEEL PIPE EXPANSION COUPLINGS

Stainless steel pipe expansion couplings shall allow for expansion. Expansion couplings shall be 304 stainless steel body with 316 stainless steel sealing plate and end rings. Sealing pad and O-rings shall be silicone (for air service) or isoprene (for liquid service), and all bolts shall be 316

stainless steel. Stainless steel pipe expansion couplings shall be Depend-o-Lok FxE Type 1.

PART 3 EXECUTION

3.1 HANDLING AND DELIVERY

Pipe and accessories shall be handled in such a manner as to insure delivery on site in sound, undamaged condition. Particular care taken not to injure pipe coating. No other pipe or material of any kind shall be placed inside of lined pipe or fitting after lining has been applied. All pipe and fittings shall be unloaded, stored, handled in such a manner as to insure against damage. Dropping of pipe or fittings shall be cause for rejection.

3.2 INSTALLATION

The Supplier shall furnish complete shop drawings, installation instructions and manufacturer's recommendations to the Owner and the General Contractor. The General Contractor will install all piping systems. Manufacturer's written installation instruction shall be included with the delivered materials.

3.3 FIELD TESTING

Pipe testing and disinfection will be performed by the General Contractor immediately following pipe installation. The General Contractor will submit a test report to the Owner and the Supplier, detailing any test failures due to defective material. The Supplier must deliver new material as needed to remedy any identified pipe failures due to defective material or design, to be installed and retested by the General Contractor.

***** END OF SECTION *****

SECTION 15100

VALVES

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section shall consist of the Supplier furnishing all valves and accessories (shipped loose) required for a complete and workable Membrane Equipment System.

1.2 RELATED WORK SPECIFIED ELSEWHERE

Section	Item
01300	Submittals
11000	Equipment General Provisions
11500	Membrane Equipment
15050	Piping Systems
15110	Valve Operators and Operator Appurtenances

1.3 PERFORMANCE REQUIREMENTS

The Supplier shall provide valves suitable for the intended service and relevant chemical exposure.

Valve size shall be fully equal to line piping in which the valve is installed. Provide supports for all valves where necessary. In case of conflict between these Specifications and a governing code, the more stringent standard shall prevail.

All valves of the same style or type shall be furnished by a single manufacturer.

At a minimum, automated valve operators must be provided for valves used in backpulse, maintenance clean and recovery clean systems. Provide all accessories necessary for proper valve operation as specified or required for the application.

Valves shall be located with the operator in a position for convenient operation. Particular care shall be taken to ensure that space is available for operation of lever or handwheel operated valves without interference to walls, piping or equipment. Any valve which is proposed to be located, in the opinion of the Engineer, in a manner that operation is inconvenient shall be modified in a manner suitable to the Engineer at the expense of the Supplier. Operations for manual valves shall be lever or handwheel as is standard with the manufacturer unless another type of operator is specified or required by the manufacturer.

For submerged valves, provide stem guides as recommended by the valve manufacturer on a spacing of 6'-0". As an alternate, provide valves with extended bonnets where practical. Provide supports for extended bonnets as required. Stem guides and supports shall be 316 stainless steel. All installation fasteners for submerged valves, guides, and supports (nuts, bolts and washers) shall be 316 stainless steel.

1.4 SUBMITTAL REQUIREMENTS

Submittal data shall be supplied in accordance with Section 01300 of these Specifications.

Manufacturer certification of Build America, Buy America Act (BABAA) compliance for blowers and all ancillary components.

PART 2 PRODUCTS

2.1 GATE VALVES

Gate valves shall be acceptable on all NPW and water lines only. Gate valves 3 inches and smaller shall be bronze, non-rising stem, wedge disc, 125-pound service, Crane No. 438, Kennedy Figure 427, Victaulic, or equal.

Gate valves larger than 3 inches shall be iron body, bronze mounted, resilient seat, wedge disc, left opening, high-strength bronze stem, O-ring with a 2-inch-square operating nut and complying with AWWA C509 or C515. Gate valves shall be non-rising stem unless noted otherwise.

Above ground gate valves shall be provided with handwheels.

2.2 PLUG VALVES

Plug valves shall be acceptable on permeate lines. All plug valves shall be flanged. Plug valves for general use shall be non-lubricated eccentric plug type, cast iron body, 80 percent or greater pipe area opening, 175-pound semi-steel resilient-faced neoprene or hycar plug surface, DeZurick Series 100 Eccentric, equivalent equipment manufactured by Victaulic, Milliken, or equal. All plug valves shall have 90 percent nickel seat. Valves shall be suitable for throttling service as well as open-closed service. Packing shall be externally adjustable multi-ring Chevron style.

Valves 4 inches and smaller shall have lever operators. Valves larger than 4 inches shall be gear operated with handwheels.

The Supplier shall furnish chain actuated operators for all valves with geared operators or lever operators that are located 6 feet or higher from finished floor. Chainwheels shall be equipped with operating chain and chain guide to permit rapid handling of operating chain without "gagging" the wheel and reasonable side pull of the chain. Chains shall be furnished with permanently attached double-acting lever. Operating chains shall be of heavily cadmium plated pintle chain looped to extend to within 3 feet of finished floor.

2.3 BUTTERFLY VALVES

Butterfly valves shall be acceptable for Air Low Pressure Lines. All butterfly valves shall be flanged. Butterfly valves for air service shall be cast iron body and disc, EPDM resilient seat, stainless steel shaft, bronze bearings, lug wafer body style, suitable for service in air to 200 degrees F. Butterfly valves shall be DeZurick BRS, Tyco/Keystone, Victaulic, Milliken, Bray or equal.

Butterfly valves shall be gear operated with infinitive position locking lever to hold the disc in any desired position from full open to full closed.

2.4 PVC BALL VALVES

PVC ball valves shall be acceptable for permeate lines. Ball valves shall be used only for liquid service less than 4 inches, and shall be PVC Class 1245 4-B, conforming to ASTM D1784, single union type, threaded per ANSI B1.20.1, full port design, rated 150 psi, Nibco Chemtrol Tru-Block, Asahi/America or equal.

2.5 CHECK VALVES

Check valves for liquid service 3 inches and smaller shall be swing check, bronze body, composition disc, 125-pound service. All check valves shall be flanged.

Check valves for liquid service larger than 3 inches shall be swing check, outside lever and spring, iron body, stainless steel shaft, bronze mounted with bronze and stainless steel fittings, 125-pound service, Millikin, Mueller A2600, Crane/Center Line or equal.

Check valves for submerged or intermittently submerged service shall be ball check valves. Manufacturer shall be Flowmatic or equal.

Check valves for air service, unless otherwise noted, shall be dual swing, springless, and seatless. Sealing members shall be Buna-N or Neoprene for service to 275 degrees F. Check valves for air service shall be Hoffman, Mission, Duo-Check or equal.

2.6 SOLENOID VALVES

Solenoid valves shall be two-way globe pattern, energize to open.

The principle of operation for valves 1 inch and smaller shall be direct acting valves, and for valves larger than 1 inch, internal pilot operated valves. Solenoid valves shall be rated for 200 psi.

For direct action valves, the body shall be brass or Type 316 stainless steel. The direct acting disc and seal shall be Teflon or as required for specific application.

For pilot operated valves, the body shall be cast iron, and the pilot body shall be brass.

Internal parts in contact with fluid shall be Type 316 stainless steel.

Solenoid enclosures shall be NEMA Type 4X, 7, and 9. The solenoid coil shall be rated for continuous duty at 40°C ambient temperature, Class H minimum.

2.7 AIR RELEASE VALVES

The air and vacuum release valves shall allow unrestricted venting or re-entry of air, through it, during filling or draining of the pipeline, to prevent water column separation or pipeline collapse during vacuum. The air-vacuum release valve shall incorporate one upper and one lower stainless steel float connected by a common stainless steel float guide, thereby maintaining an air gap between the bottom float and top shut-off float. The internal baffle shall be fitted with a guide bushing and act to protect the shut-off float from direct air flow. The baffle shall retain the 45 Durometer Buna-N seat in place, without distortion, for thigh shutoff. All internals shall be easily removed through the top cover without removing the main valve from the lines. Both floats shall withstand 1,000 psi or more. Valve shall be fitted with blow off valves, quick disconnect couplings and a minimum of 6 feet of hose, to permit backflusing after installation without dismantling the valve. The air-vacuum release valves shall be APCO or equal.

Each air release valve shall be provided with an isolation valve for isolation on the inlet side. A vent pipe shall be routed from the valve to within 12 inches of the floor. Orifice shall be sized for maximum system pressure. Valve body shall have a minimum pressure rating of 150 psi. Pins, levers, retaining rings, float ball and internal screws shall be stainless steel.

2.8 OTHER VALVES

Other specialized valves that are required and unique to the Membrane Equipment System will be evaluated by the Engineer for approval.

2.9 VALVE IDENTIFICATION TAGS

Each shutoff or control valve, shall be provided with a 1-1/2-inch minimum diameter heavy brass tag. Tags shall bear the identifying number of the valve and one or more identifying letter symbols of the service line.

Numbers and letters shall be block type with 1/2-inch-high numbers and 1/4-inch-high letters stamped on the tags and filled with black enamel.

Attach tags to the valves by split-key rings soldered so that the ring and tag cannot be removed.

The final submittals shall include a drawing and a neatly typed valve directory listing each valve number, type of valve and its location.

PART 3 EXECUTION

The Supplier shall furnish complete shop drawings, installation instructions and manufacturer's recommendations to the Owner and the General Contractor. The General Contractor will install the valves and accessories. Manufacturer's written installation instructions shall be included with the delivered materials.

***** END OF SECTION *****

SECTION 15110

VALVE OPERATORS AND OPERATOR APPURTENANCES

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section shall consist of the Supplier providing all valve operators and operator appurtenances required by the Supplier for automated operation of the Membrane Equipment System.

Automated valve operators shall be provided for valves used for the following applications, if required, as discussed in Section 11500: coarse bubble diffuser cleaning, membrane maintenance cleaning, automatic pump priming systems, permeate discharge flow modulation control, and automatic switchover to backup permeate pump and backup air scour blower.

The equipment will be provided loose by the Supplier and will be installed by the General Contractor.

1.2 RELATED WORK SPECIFIED ELSEWHERE

Section	Item
01300	Submittals
11000	Equipment General Provisions
11500	Membrane Equipment
15100	Valves

1.3 PERFORMANCE REQUIREMENTS

All valve operators on this project shall be furnished in accordance with the applicable AWWA Standards except as otherwise noted herein.

1.4 SUBMITTAL REQUIREMENTS

Submittal data shall be supplied in accordance with Section 01300 of these Specifications.

Manufacturer certification of Build America, Buy America Act (BABAA) compliance for blowers and all ancillary components.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

Manual valve operators shall be manufactured by the valve supplier.

The motor operated valve actuators shall as manufactured by AUMA, Limitorque, or Rotork Controls, meeting BABAA requirements. No other manufacturers or models shall be accepted.

Pneumatic valve operators shall be Tyco/Morin, Rotork, Bettis or an approved equal. Operators on valves less than 4 inches may be Chemline.

2.2 MANUAL VALVE OPERATORS

A. GENERAL

All manually operated valves shall open to the left. Unless otherwise directed all valves shall be set with the stems vertical. All packing glands shall be properly packed and adjusted.

B. NON-BURIED SERVICE

All plug valves 4 inch and smaller shall be lever operated (unless otherwise noted)

All plug valves larger than 4 inches shall be gear (handwheel) operated.

Exposed gate valves shall be handwheel operated.

Butterfly valves shall be gear operated to hold the disc in any desired position from full open to full closed.

2.3 ELECTRIC VALVE OPERATORS

A. GENERAL REQUIREMENTS

The electric motor operated valve actuators shall include a 120 Vac, 1-phase motor, reduction gearing, reversing contactor starter with local controls, turns and torque limitation with electronic logic and monitoring facilities all housed in a double-sealed water tight enclosure meeting the requirements of IEC IP68, suitable for submersion in water to a depth of 7 meters for 72 hours (NEMA 4 and 6). The electric operators shall include provisions to allow remote control via a dual channel Modbus/RTU 2 wire RS-485 fieldbus. The operators shall be supplied

with one hand held remote setting tool for infrared operation to open and close the actuator.

The actuator shall include a device to ensure that the motor runs with the correct rotation for the required direction of valve travel with either phase sequence of the three-phase power supply connected to the actuator. In order to maintain the integrity of the enclosure, setting of the torque level, position limits and configuration of the indication contacts, etc., shall be carried out without the removal of any actuator covers over an infrared interface. Sufficient commissioning tools shall be provided with the actuators and they must be weatherproof and intrinsically safe as standard. Commissioning tools shall not form an integral part of the actuator and must be removable for secure storage/authorized release. In addition, provision shall be made for the protection of configured actuator settings by a means independent of access to the commissioning tool.

The actuators shall include remote control capabilities for acceptance of open and close commands (dry contact inputs for each signal) and outputs (limit switches suitable for 2A, 120 Vac circuits) for indication of valve fully closed and fully open position as required for the duty type listed herein.

Actuators shall be recognized or listed and labeled by a recognized electrical testing laboratory or be acceptable to the Washington State Department of Labor and Industries for installation on this project.

B. MOTOR

The motors shall be squirrel cage electric induction motors of special high torque, low inertia design, meeting NEMA MG-1 and other applicable NEMA, ANSI, and IEEE standards. Motors shall be constructed with Class F insulated windings, B 30,000 anti-friction bearings, cast iron frame and end bells. The motors shall be 120 volts AC, 1-phase, 60 Hz power, continuous duty at 40 degrees C ambient air temperature with a 1.15 service factor. The motors shall be protected against burnout by embedded thermostats, with facilities for bypassing under emergency shutdown control.

Protection shall be provided for the motor as follows: The motor shall be de-energized in the event of stall when attempting to unseat a jammed valve. A thermostat to protect against overheating shall sense motor temperature.

C. TORQUE AND POSITION CONTROL

Torque and turns shall be adjustable a follows: Position setting range shall be 2.5 to 100,000 turns, with resolution of 15 degrees actuator output and torque setting shall be 40 to 100 percent rated torque.

Electronic latching shall be provided for the torque sensing system to inhibit torque off during unseating or during staring in mid-travel against high inertia loads. A "jammed valve" protection circuit shall de-energize the motor if no movement occurs after a few seconds from receipt of a signal to open or close.

When power to the actuator is isolated, all settings shall be retained in an EEPROM. In the event of manual operation of the valve during isolation or loss of the power supply a battery shall provide power to the internal position-monitoring transmitter to update the valve position data in the EEPROM. The battery shall also drive the LCD display, without back lighting, and the four latching contacts of the remote input/relay PCB while the power to the actuator is not available. Minimum battery life shall be seven years.

D. INTEGRAL CONTROL GEAR

The power module incorporates a mechanically and electrically interlocked reversing contactor starter, a control supply transformer fed from two phases of the incoming power supply and the Syncrophase circuit with single phasing protection. Local controls shall include two selectors, one for Local/Stop/Remote selection padlockable in each position and the other for Open/Close Control. The selectors shall give non-intrusive operation of internal reed switches.

Opto-isolator interfaces shall be provided for remote "positive switching" Open, Close, Stop, and ESD control signals, and Thermostat Bypass and Interlock functions. These shall be internally fed from the actuator 24V DC supply. Four latching contacts shall be provided, each independently configurable to signal one of the following:

Valve opening, closing, moving (continuous or pulsing signal), fully open, fully closed or intermediate positions, motor tripped on torque in mid travel, motor tripped on torque going open, or motor tripped on torque going closed, preset torque exceeded, motor stalled, battery low, actuator being operated by handwheel.

Each contact is selectable to either "normally open" or "normally closed" and rated 5A, 120 AC, 30V DC. The Emergency Shut Down (ESD)

facility provides for a remote, active high signal to open or close the valve, which will override any local Open or Close signals and the motor thermostat if suitably selected.

The main PCB shall incorporate the gate array control for the actuator together with infrared receiver for external non-intrusive settings.

E. LOCAL POSITION INDICATION

A backlit liquid crystal display shall give digital indication from fully Open to full Closed in one percent increments. Three LED's colored red, green, and yellow for indication of open, close, and intermediate positions respectively shall also be provided.

F. MONITOR RELAY

A relay with a volt-free changeover contact for monitoring actuator electrical availability shall be provided. Contact rating shall be 5 A 120V AC, 30V DC.

G. WIRING

Wiring shall be jib built harnesses of individually numbered stranded conductors, tropical grade PVC insulated, connecting internal components to the sealed terminal block. The remainder of the internal wiring shall be color-coded ribbon cable.

H. TERMINALS

Terminals shall be separately sealed compartment containing segregated metric thread M5 power and M4 control terminals. Terminal screws and washers shall be supplied with the actuator. All internal control connections to the printed circuit boards shall be via plugs and sockets. The terminal box cover shall carry a terminal identification code card. An instruction handbook and wiring diagram shall be enclosed with each actuator.

I. MANUAL OPERATION

A hand wheel shall be provided for emergency operation and engaged when the motor is declutched by a lever or similar means; the drive being restored to power automatically by starting the motor. The hand/auto selection lever should be padlockable in both "Hand" and "Auto" positions. It should be possible to select hand operation while the actuator

is running or start the actuator motor while the hand/auto selection lever is locked in "Hand" without damage to the drive train.

The hand wheel drive must be mechanically independent of the motor drive, and any gearing should be such as to permit emergency manual operation in a reasonable time. Clockwise operation of the hand wheel shall give closing movement of the valve unless otherwise specified.

J. STARTUP KIT

Each actuator shall be supplied with a startup kit comprising installation instruction, electrical wiring diagram, and sufficient spare cover screws and seals to make good any site losses during the commissioning period.

2.4 PNEUMATIC VALVE OPERATORS

Pneumatic actuators shall conform to AWWA C540; be sized and furnished by valve manufacturer and factory mounted, complete with actuator, air set, exhaust mufflers, speed controls, pilot solenoids, safety vented isolation valves, and accessories. Provide 120 VAC, 15A limit switches for OPEN/STOP/CLOSE indication, manual override, provision for accepting and monitoring remote LOCAL-OFF-REMOTE switch position, and valve position feedback when valve is in REMOTE. For modulating valves, provide position feedback and modulation based on 4-20 mA analog signal.

2.5 PAINTING

Exposed metal on motor operators shall be painted as specified herein.

A. SURFACE PREPARATION

Near-white blast cleaning, SSPC-SP-10.

B. COATINGS

Shop Primer System:
Coat One
Product: Omnithane Series 1
MDFT: 2.5 to 3.5 mils

Shop Finish System:
Coat One
Product: Hi-Build Epoxoline Tnemec Series N69
MDFT: 4 to 6 mils

Coat Two
Product: Endura-Shield III Tnemec Series 73
MDFT: 3 to 5 mils

Total MDFT: 10.0 mils

PART 3 EXECUTION

3.1 GENERAL

The Supplier shall furnish complete shop drawings, installation instructions, and manufacturer's recommendations to the Owner and General Contractor. The General Contractor will install the delivered equipment. Manufacturer's written installation instructions shall be included with the delivered equipment.

3.2 MANUFACTURER'S SERVICES

The services of factory-trained representatives of automated valve operator manufacturers shall be provided by the Supplier. Services shall include 1 day (one visit) onsite for electric valve operators and 1 day (one visit) onsite for pneumatic valve operators, for installation inspection, the supervision of equipment startup, testing, calibration, and instruction of the Owner's personnel in the operation and maintenance of the equipment. Instruction and training of the Owner's personnel shall not take place until startup is completed and the valve operators are fully operational. The training shall be at a time and location agreed to by the Owner. The manufacturer will submit to the Engineer a written report certifying that the equipment has been satisfactorily installed and calibrated. The cost of these services shall be included in the bid price. The representative shall be available for two additional service calls during the 2-year warranty period.

***** END OF SECTION *****

DIVISION 16

ELECTRICAL

SECTION 16010

BASIC ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section shall consist of the Supplier providing electrical work as specified herein as a part of the Membrane Equipment System and shall apply to all equipment, components, and electrical work performed onsite or provided as part of equipment delivered to the site.

1.2 RELATED DOCUMENTS

Section	Item
01300	Submittals
01800	Testing, Commissioning, and Training
11500	Membrane Equipment
Division 11	Equipment
Division 13	Special Construction

1.3 SUMMARY

A. SECTION INCLUDES

1. General requirements for electrical work:

    a. Systems Descriptions.

    b. Submittals.

    c. Records.

    d. Coordination.

B. Related Sections include, but are not necessarily limited to:

1. General Conditions.

2. Division 11 - Equipment.

3. Division 13 - Special Construction.

C. Installation of systems and equipment is subject to clarification as indicated in reviewed shop drawings and field coordination drawings.

1.4 SYSTEMS DESCRIPTIONS

A. Provide the labor, materials, and equipment necessary to furnish, test, and place into operation the instrumentation, control, alarm, and associated electrical systems of the Membrane Equipment System.

B. Installation of the Membrane Equipment System will be by others. The Supplier will be responsible for oversight of the installation, testing of the installed equipment and system, startup, and training.

C. Furnish complete process control systems including programmable logic controllers (PLCs), individual controllers, monitoring and/or metering equipment, instrumentation equipment, and associated raceways, wiring, control panels, enclosures, and similar items.

D. Test, adjust, and calibrate equipment and startup all electrical equipment, instrumentation equipment, and its associated mechanical attachments as necessary to place the Membrane Equipment into operation.

E. Mark and identify circuits, equipment, and enclosures with wire numbers, nameplates, and warning signs.

1.5 DEFINITIONS AND ABBREVIATIONS

A. SHOP FABRICATED

1. Manufactured or assembled equipment for which a NRTL test procedure has not been established.

B. NRTL: Nationally Recognized Testing Laboratory.

C. NEC: National Electrical Code.

1.6 QUALITY ASSURANCE

A. All electrical equipment and materials, and all equipment specified in or required by other Divisions including installation and testing, shall conform to the latest adopted versions of the following applicable codes:

1. National Electrical Code (NEC).

2. National Electrical Safety Code (NESC).

3. Occupational Safety and Health Act (OSHA) standards.

4. Applicable Washington State and local electrical and equipment safety regulations and codes including WAC 296-46B and RCW 19.28.

5. Washington Occupational Safety and Health Division (WISHA).

6. International Electrical Testing Association (NETA), Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

7. NFPA 820: Standard for Fire Protection in Wastewater Treatment and Collection Facilities.

B. When a specific code or standard has not been cited, the applicable codes and standards of the following code-making authorities and standards organizations apply:

1. American Association of State Highway and Transportation Officials (AASHTO).

2. American Iron and Steel Institute (AISI).

3. American National Standard Institute (ANSI).

4. American Society for Testing and Materials (ASTM).

5. ETL Testing Laboratories, Inc (ETL).

6. Insulated Cable Engineers Association (ICEA).

7. Institute of Electrical and Electronic Engineers (IEEE).

8. Instrument Society of America (ISA).

9. Joint Industrial Council (JIC).

10. National Electrical Manufacturers Association (NEMA).

11. National Fire Protection Association (NFPA).

12. Occupational, Health and Safety Administration (OSHA).

13. Underwriters Laboratories, Inc. (UL).

C. REFERENCE CODES AND STANDARDS

1. WAC 296-46B-999 Electrical Testing Laboratory Requirements.

2. WAC 296-46B Electrical safety standards, administration, and installation.

3. NETA Section 8, “Inspection and Test Procedures” and “System Function Tests” of the latest Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

D. In case of conflict or disagreement between codes, standards, laws, ordinances, rules, regulations, drawings and specifications, or within either document itself, the more stringent condition governs.

E. Conformance to acceptable standards, listing, or field inspection of all equipment and materials specified in Division 16 and all other Divisions is required when indicated by the NEC, applicable safety codes, Washington State electrical and safety codes (including WAC 296-46B-010 [8]) and RCW 19.28, state and local electrical codes and regulations, and meeting the requirements of the Authority Having Jurisdiction (AHJ).

1. Examples of possible methods for meeting this requirement include the use of Underwriters Laboratories (UL) listed products and the UL 508 and UL 698 labeling of custom control assemblies.

2. The General Contractor is responsible for determining whether the products and materials supplied meet these regulations and provide replacement with acceptable equipment, field inspection, and labeling, or engineering evaluation to the satisfaction of the AHJ.

3. In the case of equipment and materials specified in Division 16 and other Divisions with no substitutions allowed, the General Contractor is responsible to supply the equipment in a configuration that meets the requirements of the AHJ through listing, field labeling, or other methods deemed acceptable by the AHJ.

4. The General Contractor is responsible for all costs including modifications, engineering services, inspections, and labeling to satisfy the AHJ.

5. The terms Listed and UL Listed when used in this specification are requirements that the product be listed as defined in WAC 296-46B and meets all WAC, local, and AHJ requirements for listing by an approved Nationally Recognized Testing Laboratory (NRTL). Where the product is specified as Listed, substitution with products or materials that otherwise meet the requirement through field inspection or other means is not acceptable unless no listed product is available. The Listed specification requirement, where indicated, does not exempt other products and materials, where not indicated, from the requirements of this paragraph.

F. Series short circuit ratings for protective devices are not allowed.

1.7 SUBMITTALS

A. See Section 01300.

1.8 JOB CONDITIONS

A. OPERATIONS

1. Keep all power shutdown periods to a minimum.

2. Carry out shutdowns only after the schedule has been favorably reviewed by the Engineer.

B. STARTUP AND TESTING POWER

1. Make all arrangements for the required construction power.

2. When required, provide all equipment, materials, and wiring in accordance with the applicable codes and regulations.

3. Upon completion of the project, remove all temporary construction power equipment, material, and wiring from the site as the property of the General Contractor.

C. STORAGE

Provide adequate storage for all equipment and materials that will become part of the completed facility so that it is protected from weather, dust, water, or construction operations.

1.9 HAZARDOUS LOCATIONS

A. GENERAL

This project includes several areas classified as Hazardous Locations requiring particular construction methods or materials to mitigate issues associated with hazardous fumes, liquids, and vapors. It is the responsibility of the Membrane Equipment System supplier to provide equipment and systems that are approved as suitable for the hazardous locations as determined by NFPA 820 and meeting the requirements of the AHJ.

B. Membrane Equipment Tank

Covered process tank (by others) containing Membrane Equipment (by Supplier):

1. NFPA 820 Reference: Table 5.2, Row 8b.

2. Interior of Tank: NEC Class I, Division 2, Group D.

3. Exterior of Tank: Unclassified.

C. Operations Building

Ventilated Building (by others) containing Membrane Equipment (by Supplier):

1. NFPA 820 Reference: Table 5.2, Row 19.

2. Classification: Unclassified.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Refer to individual Division 16 sections.

1. Provide equipment, which is of a similar type, made by one manufacturer throughout the project unless otherwise noted in the Specifications.

B. Submit requests for substitution in accordance with Specification Section 01300.

2.2 MATERIALS

A. Except as otherwise indicated, provide new materials and equipment which are standard products of manufacturers regularly engaged in production of such equipment. Provide similar items of equipment of the same manufacturer and quality. Where systems are specified, provide components of the system from one manufacturer.

B. Where voltage, current, power, temperature or other ratings are specified that do not correspond to standard ratings of the manufacturer selected by the General Contractor, furnish the next rating level which increases the capacity of the device or material in question.

C. Furnish materials, devices, equipment or supplies of materials that are inherently non-corrosive or are coated or covered in a manner, acceptable to the Engineer, which renders them non-corrosive. Material that may cause rusting or streaking on a building surface shall not be used.

D. When equipment is shop fabricated for the Project, use electrical devices and enclosures which are NRTL listed and labeled or recognized.

E. The serving electric utility requires that motors larger than 7.5 hp not be started across-the-line. Where the scope of supply for the Membrane Equipment includes motor starting equipment, provide electronic solid-state soft-starts, variable frequency drives, or other means to comply with this requirement.

F. SHOP OR FACTORY FINISHES

1. Interiors of painted equipment shall be either white or light gray.

2. Repair any final finish that has been damaged or is otherwise unsatisfactory using touchup materials approved by the manufacturers, to the satisfaction of the Engineer.

2.3 MATERIAL FOR ENCLOSURES AND OTHER COMPONENTS

A. Unless otherwise noted to provide a higher degree of protection, provide enclosures as follows:

1. Dry Locations: NEMA Type 1.

2. Wet Locations (outdoor, non-hosedown): NEMA Type 3R, 304 Stainless Steel.

3. Wet Locations (outdoor, subject to hosedown): NEMA Type 4, 304 Stainless Steel.

4. General Process Areas (indoor, subject to hosedown): NEMA Type 4 or better for equipment installed at or below 6 feet above finished floor, NEMA Type 12 or better for equipment installed higher than 6 feet above finished floor.

5. Damp Locations: NEMA Type 12.

6. Corrosive Locations: (Storage or use of corrosive agents, within 10 feet of open process vessels or channels) NEMA Type 4X, 316L Stainless Steel.

B. Unless otherwise noted to provide a higher grade of material, provide materials as follows:

1. Dry Locations

Cadmium plated or hot-dip galvanized.

2. Wet Locations

316L Stainless Steel.

3. General Process Areas (subject to hosedown)

Same material as wet locations for equipment installed at or below 6 feet above finished floor, same material as for dry locations for equipment installed higher than 6 feet above finished floor where the area above 6 feet meets code requirements for dry locations.

4. Damp Locations

Same as wet locations.

5. Corrosive Locations

316L Stainless Steel or non-metallic material including fiber-reinforced plastics.

C. Hosedown locations include those locations likely to be cleaned or washed during normal operations. These locations include chemical storage and loading areas and other areas where hose bibs are installed (or will be installed) to facilitate hosedown. The Engineer will provide information on the locations where provisions for hosedown will be included in the installation.

D. Provide all associated materials that come into direct contact of the same quality and material where possible. Provide compatible materials or take measures approved by the manufacturer of the material likely to be damaged by corrosion or galvanic activity to protect equipment, fasteners, supports, and other materials.

E. Provide the same type of material for all similar components in any area or portion of the work.

PART 3 EXECUTION

3.1 INSTALLATION

A. The Supplier shall furnish complete installation instructions and recommendations to the General Contractor. The General Contractor will install the Membrane Equipment and associated devices furnished by the Supplier.

B. The Supplier shall check and approve the installation of the Membrane Equipment in accordance with Section 11000.

C. The Supplier shall test and adjust the Membrane Equipment after approval of the installation in accordance with Section 01800.

D. The Supplier shall startup the Membrane Equipment in accordance with Section 01800.

E. The Supplier shall provide training to the Owner for the Membrane Equipment. Training shall meet the requirements of Section 01800.

3.2 CONDUCTOR IDENTIFICATION

A. Identify all wires and cables in conformance with the requirements of Section 16120, “Conductors and Cables.” This requirement applies to all equipment provided under this Contract, regardless of division, as well as to all conductors provided or worked on during this Contract.

B. Identification markings on cables shall match or contain the identification of associated terminals or be shown within the Final O&M Manual Record Drawings including terminal markings and conductor identification markings.

***** END OF SECTION *****

SECTION 16050

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section shall consist of the Supplier providing electrical basic materials and work as specified herein and as required for proper operation and/or monitoring/alarming functions related to the Membrane Equipment System.

1.2 RELATED DOCUMENTS

Section	Item
01300	Submittals
01800	Testing, Commissioning, and Training
Division 11	Equipment
Division 13	Special Construction
16010	Basic Electrical Requirements

1.3 SUMMARY

A. This Section includes the following:

1. Supporting devices for electrical components.

2. Electrical identification.

3. Cleaning and finish touchup painting.

4. Testing.

1.4 SUBMITTALS

Submit according to Section 01300.

1.5 QUALITY ASSURANCE

A. Comply with NEC for components and installation.

B. LISTING AND LABELING

1. See Section 16010.

PART 2 PRODUCTS

2.1 SUPPORTING DEVICES

A. Provide channel and angle support systems, hangers, anchors, sleeves, brackets, fabricated items, and fasteners for secure support of electrical components.

1. Material

See Section 16010.

2. Manufacturer

Where available, use supporting devices provided by the manufacturer of the equipment to be supported. If supporting devices are not available from the manufacturer, use the type and style recommended in the material required by Section 16010.

B. CONDUIT CLAMPS

1. One Hole or Beam Clamps

a. Rigid Steel Conduit in dry areas: cast iron clamps with cast iron "foot."

b. Rigid Steel Conduit in damp or wet areas: 316 stainless steel.

c. EMT: stamped steel clamps.

C. ANCHORS

1. Cadmium plated or galvanized steel in dry areas; 316 stainless steel in damp or wet areas.

a. Clamps or U-bolts for structural steel.

b. Hanger rods: 1/4-inch diameter or larger threaded steel.

2.2 ELECTRICAL ENCLOSURES

A. ENCLOSURES FOR USE WITH ELECTRICAL EQUIPMENT

1. Standards

a. NEMA ICS-6, Enclosures for Industrial Controls and Systems.

b. UL 508, Industrial Control Equipment.

c. Environmental rating: See Section 16010 for minimum rating or as indicated.

B. SHOP OR FACTORY FINISHES

1. Exteriors of painted enclosures shall be ANSI gray.

2. Interiors of painted enclosures shall be white.

2.3 ELECTRICAL IDENTIFICATION

A. MANUFACTURER'S STANDARD PRODUCTS

1. Where more than one type is listed for a specified application, selection is Supplier's option, but provide single type for each application category. Use colors prescribed by ANSI A13.1, NEC and these Specifications.

B. COLORED ADHESIVE MARKING TAPE FOR RACEWAYS, WIRES, AND CABLES

1. Self-adhesive vinyl tape, not less than 3 mils thick by 1 inch wide.

C. TAPE MARKERS

1. Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.

D. COLOR-CODING CABLE TIES

1. Type 6/6 nylon, self-locking type. Colors to suit coding scheme.

E. ENGRAVED, PLASTIC-LAMINATED LABELS, SIGNS, AND INSTRUCTION PLATES

1. Engraving stock, melamine plastic laminate punched for mechanical fasteners 1/16-inch minimum thick for signs up to 20 square inches, 1/8-inch thick for larger sizes. Engraved legend in white letters on black face.

F. FASTENERS FOR PLASTIC-LAMINATED AND METAL SIGNS

1. Self-tapping stainless-steel screws or stainless-steel No. 10/32 machine screws with nuts and flat and lock washers.

G. WIRE MARKERS

1. Machine printed, black ink, alpha-numerical identifiers on yellow polyolefin shrink tubing. Kroy K4350 Shrink Tube, or approved equal.

2.4 TOUCHUP PAINT

A. FOR EQUIPMENT

1. Provided by equipment manufacturer and selected to match equipment finish.

B. FOR NON-EQUIPMENT SURFACES

1. Matching type and color of undamaged, existing adjacent finish.

C. FOR GALVANIZED SURFACES

1. Zinc-rich paint recommended by item manufacturer.

PART 3 EXECUTION

3.1 INSTALLATION

A. The Supplier shall furnish complete installation instructions and recommendations to the General Contractor. The General Contractor will install the Membrane Equipment System and associated devices furnished by the Supplier.

B. The Supplier shall check and approve the installation of the Membrane Equipment System in accordance with Section 11000.

C. The Supplier shall test and adjust the Membrane Equipment System after approval of the installation in accordance with Section 01800.

D. The Supplier shall startup the Membrane Equipment System in accordance with Section 01800.

E. The Supplier shall provide training to the Owner for the Membrane Equipment System. Training shall meet the requirements of Section 01800.

3.2 CONDUCTOR IDENTIFICATION

A. Except for interior lighting and receptacle circuits, identify each wire or cable at each termination and in each pull box, junction box, handhole, and manhole using numbered and lettered wire markers. All electrically common conductors shall have the same number. Each electrically different conductor shall be uniquely numbered. Identify panelboard circuits using the panelboard identification and circuit number. Identify motor control circuits using the equipment identification number assigned to the control unit by the motor control center manufacturer and the motor control unit terminal number. Identify other circuits as shown in the circuit schedule or as favorably reviewed by the Engineer.

B. Conductor numbering shall be coordinated with the Interconnection Diagrams.

C. Conductors between terminals of different numbers shall have both terminal numbers shown at each conductor end. The terminal number closest to the end of the wire shall be the same as the terminal number.

***** END OF SECTION *****

SECTION 16410

ENCLOSED SWITCHES, FUSES AND CIRCUIT BREAKERS

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section consists of individually mounted switches and circuit breakers used for the following:

A. Feeder and equipment disconnect switches

B. Feeder and branch-circuit protection

C. Motor safety disconnect switches

1.2 RELATED WORKS SPECIFIED ELSEWHERE

Sections	Item
01300	Submittals
16050	Basic Electrical Materials and Methods

1.3 SUBMITTALS

Submit under the provisions of Section 01300.

Manufacturer's Product Data for disconnect switches, circuit breakers, and accessories specified in this Section.

Maintenance data for tripping devices to include in the operation and maintenance manual specified in Section 16050.

1.4 QUALITY ASSURANCE

See Section 16050.

Obtain disconnect switches and circuit breakers from one source and by a single manufacturer.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. AVAILABLE MANUFACTURERS

Subject to compliance with requirements, manufacturers offering disconnect switches and circuit breakers that may be incorporated into the work include the following:

1. General Electric Co.; Electrical Distribution and Control Division.

2. Siemens Energy & Automation, Inc.

3. Square D Co.

4. Eaton, Cutler Hammer.

2.2 DISCONNECT SWITCHES

A. MOTOR SAFETY DISCONNECT SWITCHES

Motor safety disconnect switches shall be provided when the motor starter is not in sight of the associated motor or when shown on the Plans. Motor safety disconnect switches shall be provided with the following specifications.

1. Separately Enclosed Knife Type Switches

   a. Switches shall not be fused unless specifically shown otherwise on the Plans.

   b. Switches shall include pad lockable handles, lockable in both the open and closed positions.

   c. Switches shall be rated at 600 V.

   d. Switches shall include two auxiliary contacts, rated at 10 A at 250 Vac each, connected to the switch pivot arm that are open when the switch is open, closed when the switch is closed.

   e. Switches shall be rated at motor horsepower or as per the Plans, whichever is the larger.

f. Switch enclosures shall be NEMA 4X stainless steel unless specifically stated otherwise in the Plans or through the approval of the Engineer.

2. Switches Incorporated into a Field Control Panel

a. Three Phase Switches, 15 HP and Smaller.

Switches shall be 2-position, OFF-ON, 90 degree, 600 VAC, 20 A, 32 A, or 40 A rating, 4-pole, front door installation; Allen Bradley 194L-E**aa**-1754 or equal,

where:

aa = 20 for motors less than 10 HP,
aa = 32 for a 10 hp, 460 VAC motor,
aa = 40 for a 15 hp, 460 VAC motor.

The 4th pole is reserved for switch position sensing.

Associated switch actuators shall be OFF-ON, 90 degree, front/door installation, IP66 rated, 22.5 mm central hole mount, square, grey/black handle with padlock provision, 64 mm x 64 mm; Allen Bradley 194L-HC6E-175I or equal.

b. Single Phase Switches.

Reference Specification 16940, Control Panels.

B. ENCLOSED, FUSIBLE SWITCH, 800 A AND SMALLER

1. NEMA KS 1, Type HD, Class R rejection fuse clips, enclosure consistent with environment where located, handle lockable with two padlocks, and interlocked with cover in CLOSED position.

2. Switches shall be horsepower rated when used in motor circuits.

3. Switches shall include pad lockable handles, lockable in both the open and closed positions.

4. Switches shall be rated at 600 V.

5. Switches shall include two auxiliary contacts, rated at 10 A at 250 Vac each, connected to the switch pivot arm that are open when the switch is open, closed when the switch is closed.

6. Switch enclosures shall be NEMA 4X stainless steel unless specifically stated otherwise in the Plans or through the approval of the Engineer.

2.3 DISCONNECT PLUGS

A. MOTOR DISCONNECT PLUGS AND RECEPTACLES

Motor safety disconnect plug and receptacle shall be provided as shown on the Plans and shall be provided to the following specifications:

1. Plugs and receptacles shall be motor rated and UL 2682 listed.

2. Plugs and receptacles shall have an integral mechanism to ensure the load is broken before the plug can be removed.

3. Plugs and receptacles shall be rated at 600 V.

4. Receptacles shall have a dead front construction.

5. Plugs and receptacles must be able to close at least once on a conditional short-circuit current of 65,000 amps.

6. Plug and receptacle wire terminals shall be spring assisted to prevent loosening due to conductor yielding, shocks, vibrations, or thermal cycling.

7. Plug and receptacle shall be able to withstand ambient temperatures between -40 degrees C to +60 degrees C.

2.4 ENCLOSED CIRCUIT BREAKERS

A. ENCLOSED, MOLDED-CASE CIRCUIT BREAKER

NEMA AB 1, with lockable handle in both the open and closed positions.

B. CHARACTERISTICS

Frame size, trip rating, number of poles, and auxiliary devices as indicated on the Plans with interrupting rating to meet available fault current.

1. Main and feeder breakers shall be molded case breakers with thermal magnetic trip.

2. Motor circuit breakers shall be magnetic only trip with adjustable trip setting.

3. Branch circuit breakers shall be molded case, thermal-magnetic trip, trip-free with non-interchangeable, non-adjustable trip unless otherwise noted.

C. APPLICATION LISTING

Appropriate for application, including switching fluorescent lighting loads (SWD) or heating, air-conditioning, and refrigerating equipment (HACR).

D. CIRCUIT BREAKERS, 200 A AND LARGER

1. Trip units shall be interchangeable within frame size.

2. Provide trip units with separate field-adjustable settings of instantaneous trip, short-time trip, short-time delay, long-time trip, and long-time delay. Commonly known as an LSI breaker.

E. CIRCUIT BREAKERS, 400 A AND LARGER

The same features as 200A and larger, and adjustable ground fault pickup. Commonly known as an LSIG breaker.

F. CIRCUIT BREAKERS, 1000 A AND LARGER

The same features as 400 A and larger, with LCD display.

G. MOLDED-CASE SWITCH

Where indicated, molded-case circuit breaker without trip units.

H. LUGS

Mechanical lugs and power-distribution connectors suitable for copper conductors of the number and size indicated.

I. SHUNT TRIP

Where indicated.

J. ACCESSORIES

As indicated.

NEMA AB 1, Type 4X stainless steel unless stated otherwise in the Plans.

PART 3 EXECUTION

3.1 COORDINATION OF ELECTRICAL PROTECTION DEVICES

A. The Contractor shall provide coordination of circuit breakers, fuses, and other associated protective devices.

1. For adjustable breakers, provide the values for continuous, short-time, instantaneous, ground fault, and other relevant trip and delay settings. Adjust breakers as per 3.4.

2. Provide to the Owner and Engineer calculations, plots, and overlays that clearly show proper coordination of protection circuits.

3.2 INSTALLATION

A. Install the disconnect switches and circuit breakers level and plumb in locations as indicated, according to manufacturer's written instructions.

B. Install wiring between disconnect switches, circuit breakers, control, and indication devices.

C. Connect disconnect switches and circuit breakers and components to wiring system and to ground as indicated and as instructed by manufacturer.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

D. Identify each disconnect switch and circuit breaker according to requirements specified in Section 16050.

3.3 FIELD QUALITY CONTROL

A. TESTING

1. Prior to Energization

After installing disconnect switches and circuit breakers, perform visual and mechanical inspection of enclosure and devices.

Check connections and mounting for proper torque.

Remove any burrs, filings, or other foreign materials from enclosure. Completely wipe down and vacuum enclosure.

2. After Energization

After electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

Correct malfunctioning units on site where possible and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

3.4 ADJUSTING

Set field-adjustable disconnect switches and circuit-breaker trip ranges as indicated.

Provide fuses for fused disconnect switches to coordinate with manufacturer's listed maximum fuse size for equipment supplied by the disconnect switch.

***** END OF SECTION *****

SECTION 16460

LOW VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section consists of dry-type distribution and specialty transformers rated 1000 V and less.

1.2 RELATED WORKS SPECIFIED ELSWHERE

Section	**Item**
01300	Submittals

1.3 SUBMITTALS

Submit under the provisions of Section 01300.

A. PRODUCT DATA

Submit the following:

1. Nameplate ratings
2. Mounting methods
3. Dimensioned plans, sections, elevation views and minimum clearances

B. WIRING DIAGRAMS

Submit manufacturer's wiring diagrams and clearly identify terminals for tap changing and connecting field-installed wiring.

C. FIELD TEST REPORTS

Indicate and interpret test results for tests specified in Part 3.

D. MAINTENANCE DATA

Include in the maintenance manuals specified in Division 1.

1.4 DELIVERY, STORAGE, AND HANDLING

Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit throughout periods during which equipment is not energized and is not in a space that is continuously under normal control of temperature and humidity.

PART 2 PRODUCTS

2.1 MANUFACTURERS

Subject to compliance with requirements, provide transformers by one the following:

A. Cutler-Hammer/Eaton Corp.

B. GE Electrical Distribution & Control.

C. Siemens Energy & Automation, Inc.

D. Square D; Schneider Electric.

E. Federal Pacific.

2.2 TRANSFORMERS, GENERAL

A. DESCRIPTION

Factory-assembled and -tested, air-cooled units of types and sizes specified, designed for 60-Hz service.

B. CORES

Grain-oriented, nonaging silicon steel.

C. COILS

Continuous copper windings without splices, except for taps.

D. INTERNAL COIL CONNECTIONS

Brazed or pressure type.

E. ENCLOSURE

Class complies with NEMA 250 for the environment in which installed.

F. SOUND LEVELS

Manufacturer shall guarantee not to exceed the following:

1. Up to 9 kVA: 40 dB.

2. 10 to 50 kVA: 45 dB.

G. EFFICIENCY

Ventilated, dry type, 15 kVA and larger: Energy efficient meeting DOE 2016 requirements.

2.3 GENERAL-PURPOSE DISTRIBUTION AND POWER TRANSFORMERS

Comply with NEMA ST 20 and list and label as complying with UL 1561.

A. CORES

One leg per phase.

B. WINDINGS

One coil per phase in primary and secondary.

C. ENCLOSURE

As follows unless otherwise indicated.

1. Indoor, ventilated.

D. INSULATION CLASS

185 or 220 degrees C class for transformers 15 kVA or smaller;
220 degrees C class for transformers larger than 15 kVA.

1. Rated Temperature Rise

150 degrees C maximum rise above 40 degrees C for 220 degrees C class insulation; 115 degrees C maximum rise for 185 degrees C class insulation.

E. TAPS

For transformers 3 kVA and larger, full-capacity taps in high-voltage windings are as follows:

1. Taps, 3 through 25 kVA

Two 5-percent taps below rated high voltage.

2. Taps, 25 through 500 kVA

Six 2.5-percent taps, 2 above and 4 below rated high voltage.

F. WALL-MOUNTING BRACKETS

Manufacturer's standard brackets for wall mounted transformers up to 75 kVA.

2.4 CONTROL AND SIGNAL TRANSFORMERS

A. Units comply with NEMA ST 1 and are listed and labeled as complying with UL 506.

B. RATINGS

Continuous duty. If rating is not indicated, provide capacity exceeding peak load by 50 percent minimum.

C. DESCRIPTION

Self-cooled, 2 windings.

2.5 FINISHES

A. INDOOR UNITS

Manufacturer's standard paint over corrosion-resistant pretreatment and primer.

B. OUTDOOR UNITS

Comply with ANSI C57.12.28.

2.6 SOURCE QUALITY CONTROL

Design and routine factory tests comply with referenced standards.

PART 3 EXECUTION

3.1 INSTALLATION

Comply with safety requirements of IEEE C2.

Arrange equipment to provide adequate spacing for access and for circulation of cooling air.

Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.2 GROUNDING

Comply with NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near the transformer.

Comply with Division 16 Section "Grounding and Bonding" for materials and installation requirements.

3.3 FIELD QUALITY CONTROL

Test to ensure transformer is operational within industry and manufacturer's tolerances, is installed according to the Contract Documents, and is suitable for energizing.

A. TESTS

Include the following minimum inspections and tests according to manufacturer's written instructions.

1. Inspect accessible components for cleanliness, mechanical and electrical integrity, and damage or deterioration. Verify that temporary shipping bracing has been removed. Include internal inspection through access panels and covers.

2. Inspect bolted electrical connections for tightness according to manufacturer's published torque values or, if not available, those specified in UL 486A and UL 486B.

3. Insulation Resistance: Perform megohmmeter tests of primary and secondary winding to winding and winding to ground.

B. TEST FAILURES

Compare test results with specified performance or manufacturer's data. Correct deficiencies identified by tests and retest. Verify that transformers meet specified requirements.

3.4 CLEANING

On completion of installation, inspect components. Remove paint splatters and other spots, dirt, and debris. Repair scratches and mars on finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.

3.5 ADJUSTING

After installing and cleaning, touch up scratches and mars on finish to match original finish.

Adjust transformer taps to provide optimum voltage conditions at utilization equipment throughout normal operating cycle of facility. Record primary and secondary voltages and tap settings and submit with test results.

***** END OF SECTION *****

SECTION 16910

MEMBRANE EQUIPMENT PROGRAMMABLE LOGIC CONTROLLER (PLC) HARDWARE, SOFTWARE AND PROGRAMMING

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section shall consist of the Supplier providing electrical work as specified herein and as required for proper operation and/or monitoring/alarming functions related to the Membrane Equipment System.

1.2 RELATED WORK SPECIFIED ELSEWHERE

Section	Item
01300	Submittals
01800	Testing, Commissioning, and Training
Division 11	Equipment
11500	Membrane Equipment
16010	Basic Electrical Requirements
16050	Basic Electrical Materials and Methods
16920	Membrane Equipment Operator Interface Hardware, Software, and Programming
16940	Membrane Equipment PLC Control Panel

1.3 WARRANTY

The warranty shall be provided in accordance with Section 11000-1.5.

1.4 SUMMARY

A. SECTION INCLUDES

1. Programmable logic controller (PLC) control system(s), including:

   a. PLC and communications hardware installed in control panels.

   b. Factory testing.

   c. Field testing and demonstration.

   d. Training.

2. PLC Programming to provide the required functionality for operation of the Membrane Equipment System.

1.5 REFERENCES

A. REFERENCED STANDARDS

1. National Electrical Manufacturers Association (NEMA)

a. ICS 1, General Standards for Industrial Control and Systems.

b. ICS 1.1, Safety Guidelines for the Application, Installation and Maintenance of Solid State Control.

c. ICS 4, Terminal Blocks for Industrial Use.

d. ICS 6, Enclosures for Industrial Controls and Systems.

e. Publication No.250, Enclosures for Electrical Equipment (1000 V maximum).

2. National Fire Protection Association (NFPA)

3. National Electric Code (NEC)

1.6 SYSTEM DESCRIPTION

A. DESIGN REQUIREMENTS

1. The PLC will provide the primary source of control for the Membrane Equipment System.

2. The system includes racks, central processing units (CPUs), input/output (I/O) modules, communication modules, power supplies, and associated accessory items to provide a complete and functional control system for the Membrane Equipment System.

3. Communicate control data via Ethernet IP to a central plant PLC control system. Data transfer shall be polled by the plant PLC control system.

B. PLC PROGRAMMING

Programming of the PLC shall be provided by the Supplier.

C. PERFORMANCE REQUIREMENTS

The installed system performs the functional and operational algorithms required for control of the process.

1.7 SUBMITTALS

A. See Section 01300-2.4.

B. SHOP DRAWINGS

1. Drawings

   a. System diagram showing the arrangement, connection, and interconnection of PLC system components.

   b. Wiring diagrams for the PLC equipment in each control enclosure showing devices, wiring internal to the center, terminal blocks, and distinguishing field wiring from wiring internal to the enclosure.

2. Schedule of system I/O including the following data:

   a. I/O point, with name, tag number, and indication of type and the characteristics of the I/O signal.

3. Listing of spare parts provided with the system.

1.8 QUALITY ASSURANCE

A. SHOP TESTING

The PLC hardware and interconnection wiring will be tested by the Supplier in conjunction with the control panel shop test specified in Section 16940.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the additional requirements of this section, provide products by one of the following manufacturer:

1. Allen-Bradley – CompactLogix family.

No other manufacturers or models shall be accepted.

2.2 EQUIPMENT

A. Conform to NEMA ICS 1.1 for installation and application of the PLC system.

B. The equipment consists of fully integrated microprocessor units specifically designed for operation in unconditioned audible noise and high vibration areas.

1. Includes analog, digital, and communications interfaces for interface directly with ISA or other industry standard transducers, actuators, and communications equipment without the need for intervening conditioning devices.

2.3 COMPONENTS

A. CENTRAL PROCESSOR UNIT (CPU)

1. CPU card:

Allen Bradley P/N 1769-L36ER, no exception.

Memory:	2.0 MB
Ethernet ports:	2 ports (single address)
Modules supported:	30
I/O supported:	512

B. ANALOG INPUT/OUTPUT (I/O) MODULES

1. Analog Input Cards (all PLC racks).

Allen Bradley P/N 1769-IF4I, no exception.

Channels:	4
Input type:	4-20 mA
Resolution:	16 bit or +/-15 bit
Differential?	Yes
Isolated?	Yes

2. Analog Output Cards (all PLC racks).

Allen Bradley P/N 1769-OF4CI, no exception.

Channels:	4
Output type:	4-20 mA
Resolution:	16 bit
Differential?	Yes
Isolated?	Yes

C. DIGITAL INPUT/OUTPUT (I/O) MODULES

1. Digital Input Cards (all PLC racks).

Allen Bradley P/N 1769-IQ16, no exception.

Input Channels:	16
Input voltage:	24 VDC
Signal polarity:	Sinking/Sourcing

2. Digital Output Cards (all PLC racks).

Allen Bradley P/N 1769-OB16, no exception.

Output Channels:	16
Output voltage:	24 VDC
Signal polarity:	Sourcing

D. POWER SUPPLY UNITS

1. Each rack shall be powered with a separate power supply as listed below:

   Allen Bradley P/N 1769-PB4, no exception.

Input voltage:	24 VDC
5VDC output ampacity:	4 Amps
12VDC output ampacity:	2 Amps

E. PLC SOFTWARE

Provide one licensed copy of software required for configuration and maintaining the Membrane Equipment PLC operating system.

F. Third party components that comprise a portion of the PLC system shall be approved by the PLC manufacturer for compatibility.

2.4 REQUIRED ACCESSORIES

A. Provide all accessories required for a complete PLC control system to accomplish the requirements of the process and the Specifications.

B. Provide one copy of the PLC programming software. Programming software must be compatible with the OIU operating system (see Section 16920 Membrane Equipment Operator Interface Hardware, Software and Programming).

C. Provide two licensed copies of the PLC manufacturer's or third party I/O Server for installation by others on the Owner's plant control HMI computers.

D. Provide an Ethernet switch with two ports available for use by others. This PLC shall communicate directly over Ethernet/IP to the plant's Allen Bradley Compact Logix Master PLC.

Process status shall be copied to a non-process memory location for access by the Master PLC.

2.5 REQUIRED SPARE COMPONENTS

A. Provide the following extra materials:

1. Provide one spare processor module for each type of processor module furnished.

2. Provide one spare I/O card for every 10 cards, or fraction thereof, of each type of card installed.

3. Provide one spare power supply for each type of power supply furnished.

4. Provide a list of the manufacturer's recommended spares for maintenance purposes. Include in the list any special tools and test equipment necessary or recommended by the manufacturer for the maintenance of the complete system. Provide any recommended spares not supplied above along with the recommended special tools and test equipment.

5. Provide one spare chassis for each type of chassis furnished.

PART 3 EXECUTION

3.1 PLC PROGRAMMING

A. Program the PLC control system to provide the required functionality and control of the Membrane Equipment System and associated components.

B. PLC SOFTWARE

1. License to the Owner each copy of software provided under this section and provide copies of the license agreement to the Owner within 60 days of award of contract.

2. Provide one licensed copy of software required for configuration and maintaining PLC operating system to the Owner for maintenance purposes.

3. Provide a copy of well-documented annotated source code to the Owner.

4. Provide one copy of the run-time configuration code for the PLC (if different than item 1).

C. Provide PLC programming required for master control system monitoring and control data access functions via all of the required network interfaces. The system shall include all capabilities available in the manufacturer-provided OIU. Configure the Ethernet/IP data interface to concentrate information minimizing data by moving or copying incoming and outgoing data into groups of adjacent registers arranged by data type.

3.2 TESTING

Test, verify, and demonstrate access to and functionality of PLC system in accordance with Sections 11000, 11500, and 01800.

***** END OF SECTION *****

SECTION 16920

MEMBRANE EQUIPMENT OPERATOR INTERFACE HARDWARE, SOFTWARE AND PROGRAMMING

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section shall consist of the Membrane Equipment System Supplier providing electrical work for an operator interface unit (OIU) as specified herein and as required for proper operation and/or monitoring/alarming functions related to the Membrane Equipment System.

1.2 RELATED WORK SPECIFIED ELSEWHERE

Section	Item
01300	Submittals
01800	Testing, Commissioning, and Training
11000	Equipment General Provisions
11500	Membrane Equipment
16910	Membrane Equipment Programmable Logic Controller (PLC) Hardware, Software and Programming
16940	Membrane Equipment PLC Control Panel

1.3 SUMMARY

A. SECTION INCLUDES

1. OIU Industrial Computer

2. OIU Touchscreen Panel.

3. OIU Software.

4. OIU Programming.

1.4 DEFINITIONS

A. OIU (OPERATOR INTERFACE UNIT)

Hardware and software that provides an interface to the Membrane Equipment PLC Hardware and Control System.

1.5 SYSTEM DESCRIPTION

A. DESIGN REQUIREMENTS

The system includes providing, configuring and installing one OIU touchscreen flatpanel and industrial computer. The OIU will, in addition to displaying the user interface graphics for monitoring and modifying Membrane Equipment operation, be responsible for handling alarms including alarm management through the SCADA system, and displaying and logging historical data.

B. OIU PROGRAMMING

Design and programming of the OIU application and alarming to provide full plant operator capability to monitor, control, and receive/acknowledge alarms of the Membrane Equipment control PLC. Install Radmin or equal to allow the Supplier to remotely connect to the operation system and troubleshoot and revise programming.

1.6 SUBMITTALS

A. See Section 01300.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Provide products by the following manufacturers:

1. Industrial Computer

    a. Siemens, or equal.

2. Flat Panel Hardware

    a. Hope Industrial Systems, Inc., or equal.

3. HMI Software

    a. Wonderware, no exceptions.

2.2 COMPONENTS

A. OIU – INDUSTRIAL COMPUTER

1. SIMATIC IPC427D, Microbox DIN-Rail Mount PC: 6AG4140-6BH15-0HA0, or equal.

   a. Communicate to PLC over Ethernet/ IP

   b. Operating voltage shall be 24 VDC

   c. CPU - Core i7-3517UE (2C/4T, 1.7(2.8)GHz, 3MB Cache); 2x Gigabit Ethernet

   d. RAM - 8GB DDR3 with ECC support

   e. Extension - one RS232 and one PCI.

   f. Drive – 80 GB Solid-State Drive SATA

   g. Operating System - Windows Embedded Standard 7 latest SP, English, 64Bit

B. OIU – FLAT PANEL

1. HIS – ML23 (Rev. B), or equal.

   a. Operating voltage shall be 24 VDC

   b. Screen shall be 23” with 1920 X 1080 resolution color touch screen.

   c. NEMA 4, mount on the door of the Membrane Equipment main control panel.

C. OIU – SOFTWARE

1. InTouch Runtime 3K Tag with I/O, latest version, licensed to the Owner.

2.3 SOURCE QUALITY CONTROL

A. SHOP TEST

Test and demonstrate the OIU configuration during the PLC control panel shop test, prior to installing at the project site.

PART 3 EXECUTION

3.1 OIU PROGRAMMING

Provide OIU application programming of the tagname database, screens (windows), scripts, and similar items for a complete operator interface system that permits operators to monitor the Membrane Equipment System, adjust setpoints, place equipment in/out of service, view historical and real time trends, be notified of alarms, acknowledge and clear alarms, and similar functions.

All equipment provided by the Supplier shall have the following information displayed on the Operator Interface.

A. OIU SCREEN DESCRIPTIONS

All values shall be displayed and logged in the OIU and shall be communicated to the Main Plant PLC (by others). All parameters intended to be field configurable shall be adjustable via the OIU. The following algorithms and functions shall be provided in the Programmable Logic Controller (PLC) programming.

The PLC shall include provisions to present all the data and status of all equipment and instruments provided by the Supplier.

The PLC shall include provision for the plant SCADA system to acknowledge alarms.

Plant equipment controlled or monitored by the PLC shall have information displayed and stored in PLC registers for:

- Equipment run time (stored in seconds/displayed in tenth of hours).
- Equipment number of starts
- Equipment status (requested, available, running, fail).
- Motor over temperature (where applicable).
- Pump leakage (where applicable).

Variable Frequency Drive (VFD) equipment shall have additional information provided to the PLC by the VFD over Ethernet/IP. This information shall be displayed and shall include:

- VFD status (off, run, fault)
- Motor amperes/volts.
- VFD speed

Provisions shall be made for register to contain values for time delays, setpoints, lead-lag order, etc., all values are to be adjustable via the OIU. The OIU shall include provisions to modify all the operator adjustable setpoints listed herein or required by the PLC code. Critical setpoints shall have password protected pop-up windows (5 digit password = 14484). Each OIU screen shall include indication of whether any alarms are active and whether there are any unacknowledged alarms. One of the alarms displayed by the OIU will be communications stalled alarm.

Motors and equipment representations shall be colored red when off and green when on. The presence of unacknowledged alarms shall be indicated by alternate flashing of a yellow color with the red or green on-off status color. The presence of acknowledged alarms shall be indicated by a solid yellow color. Motors and equipment shall have a label with the motor or equipment tag number. The label shall be a rectangular box with black outline and text and light color fill.

A “navigation” tab shall always be visible at the top of the monitor. The tab contains buttons or pull-down menus, which access other screens. Other screens shall be made visible below the navigation screen when selected. When a screen is displayed the associated navigation button is “grayed out.” The navigation screen shall include a status light for indication of alarm conditions. The light shall flash yellow and red if an unacknowledged alarms exists with a nameplate text “Alarm”. The light shall be yellow if an acknowledged alarm exist. If no alarms exist the light shall be gray.

An “overview” screen shall provide a system overview with operational status indicators, mode selection touch zones, sequence start and stop touch zones, and access to the other system screens. This screen shall show a representation of the entire membrane equipment system and associated equipment, motor operational status, real-time data for instrumentation, alarm status, and valve positions. Individual areas or equipment items will “highlight” when the cursor is over that area and “clicking” that area will display the screen associated with that area or equipment. General status information shall be displayed by superimposing text and animated symbols or cells.

Provide a legend display for status with symbols as follows:

- Off symbol of red color
- On symbol of green color
- Unacknowledged alarm symbol flashing between yellow and red.
- Acknowledged alarm symbol of yellow color

An "Alarm" screen shall display all the alarms. The screen shall contain an alarm history/summary control, within a separate popup window or accessible via pull-down menu. The alarm control shall be labeled with the tagname of the currently displayed alarm group. A button shall be provided that toggles the display between alarm history and alarm summary. The history screen shall display the most recent alarms for a period of 60 days. A button shall be provided to scroll the alarm control (e.g., "Next Page," "Previous Page"). A button shall be disabled if the alarm control indicates that no further scrolling is possible. A button shall be provided to acknowledge all alarms in the currently displayed alarm group. This button shall be the only button that acknowledges alarms. A button shall be provided to print the window containing the currently displayed alarm control.

3.2 FIELD QUALITY CONTROL

Test, verify and demonstrate the complete configuration of the OIU communication to the Membrane Equipment control PLC.

***** END OF SECTION *****

SECTION 16940

MEMBRANE EQUIPMENT PLC CONTROL PANEL

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section shall consist of the Supplier providing electrical work as specified herein and as required for proper operation and/or monitoring/alarming functions related to the Membrane Equipment System.

This control panel shall be referred to as the Membrane Equipment PLC Control Panel [01 CP 02].

1.2 RELATED WORK SPECIFIED ELSEWHERE

Section	Item
01300	Submittals
11000	Equipment General Provisions
11500	Membrane Equipment
16910	Membrane Equipment Programmable Logic Controller (PLC) Hardware, Software and Programming
16920	Membrane Equipment Operator Interface Hardware, Software and Programming

1.3 SUMMARY

Control panels (whether provided under Division 16, or provided, or specified to be provided, with equipment specified under other Divisions).

1.4 REFERENCES

A. REFERENCED STANDARDS

1. National Electrical Manufacturers Association (NEMA)

   a. ICS 1, General Standards for Industrial Control and Systems.

   b. ICS 4, Terminal Blocks for Industrial Use.

   c. ICS 6, Enclosures for Industrial Controls and Systems.

d. Publication No.250, Enclosures for Electrical Equipment (1,000 V maximum).

2. National Fire Protection Association (NFPA)

3. National Electric Code (NEC).

4. Joint Industrial Council (JIC-EMP-1)

1.5 SYSTEM DESCRIPTION

A. CONTROL PANELS

The system includes new control panels for control and/or monitoring of the process equipment. Control panels, whether provided under Division 16 or other Divisions, shall meet the requirements of this Section.

The Membrane Equipment PLC Control Panel will be identified as tag number [01 CP 02] and will be mounted inside the Electrical Room.

1.6 SUBMITTALS

A. See Section 01300 “Submittals.”

1.7 QUALITY ASSURANCE

A. Control panels supplied under this Section shall be provided by a single manufacturer.

B. Provide control panels bearing the label of a recognized testing laboratory, or otherwise deemed acceptable to the State of Washington Department of Labor and Industries.

C. Test panels prior to shipment to project site. The Engineer and/or Owner shall be permitted to observe the shop test, if he/they so desire. Notify the Engineer at least 1 week before testing. Testing shall be performed at the Membrane Equipment manufacturer’s shop.

1. Provide a test plan at time of notification of testing. Coordinate the time of testing of the panels with the Construction Schedule.

2. The entire assembled panel shall be meggered and tested to be free from grounds and shorts.

3. Controllers, circuits and interlocks shall be rung out and tested to assure that they function correctly before the panel is shipped. Each device and control loop shall be tested and demonstrated to function properly in each mode (such as “hand,” “local,” “automatic”). Discrete input signals shall be tested in both the “on” and “off” state. Analog signals (4-20 milliamp, or similar type) shall each be tested at not less than three values (4.08 mA or 0.5 percent, 12 mA or 50 percent, and 19.92 mA or 99.5 percent). Test results shall be documented.

4. Provide signal generators, multimeters, and other test equipment as required to verify proper operation of the assembled panel. Simulate input signals, both discrete and analog, to verify operation of control and monitoring circuits.

5. Correct, replace, or repair panel wiring, and/or components until testing demonstrates proper operation. Do not ship panels to the site until testing has demonstrated satisfactory operation of the panels.

6. Provide updated and complete ‘as shipped’ drawings at the time of final testing. The Engineer shall review the drawings against the panel construction at the time of final testing. Drawings which do not reflect the actual construction of the panel will need to be revised and reviewed again by the Engineer against the actual construction prior to shipment of the panel to the job site. “As shipped” drawings which require revisions shall be submitted to the Engineer for review prior to the actual field review of these drawings against the panel construction. This process of revision and review of the drawings will be repeated as necessary to produce drawings which reflect the actual construction of the panel at the time of shipment. Do not ship panels to the site until the “as-shipped” drawings are updated, complete, and reflect the actual “as-shipped” status of the panel.

D. Revise all drawings upon completion of the work to show “as constructed” status of the panel at time of project acceptance.

1.8 STORAGE AND HANDLING

A. After completion of shop assembly and testing, enclose panels in heavy-duty polyethylene envelopes or secured sheeting to provide complete protection from dust and moisture. Place dehumidifiers inside the polyethylene covering.

B. Skid-mount the equipment for final transport. Show shipping weight on shipping tags, together with instructions for unloading, transporting, storing, and handling on job site.

1.9 EXTRA MATERIALS

The following quantities cover all control panels fabricated by the fabrication shop (quantities are not per panel).

1. DIN-rail Fused Terminals

   Provide five spare DIN-rail fused terminals of each type and rating.

2. DIN-rail Feed-Through Terminals

   Provide five spare DIN-rail feed-through terminals of each type, color, and rating.

3. Power Fuses (line power)

   Provide three spare power fuses of each type and rating.

4. Control Power Fuses

   Provide 10 percent (minimum of two) spare control power fuses of each type and rating.

   Provide one control fuse puller.

5. PLC I/O Fuses

   Provide 10 percent (minimum of two packets of five fuses each) spare control fuses of each type, voltage, and rating. Fuse ampacity should be clearly shown or marked.

6. PLC Buffer Relays

   Provide 10 percent (minimum of four) spare PLC buffer relays of each type, style, and rating.

7. Control and Timing Relays

   Provide 10 percent (minimum of four) spare control and timing relays of each type, style, and rating.

8. Control and Timing Relay Sockets

   Provide two spare control and timing relay sockets of each type, style, and rating.

9. Relay/Solenoid Surge Protective Devices

   Provide two spare Metal Oxide Varistors (MOVs) for AC relays and solenoids and two spare diodes for DC relays and solenoids.

10. Provide a single latching plastic container with a printed label adhered to the lid stating "CONTROL PANEL SPARE PARTS."

PART 2 PRODUCTS, MATERIALS

2.1 CONTROL PANEL ENCLOSURES

A. ENCLOSURE BODIES

Control panel [01 CP 02] enclosure shall be factory UL labeled, fabricated of stretcher leveled steel welded into a rigid, self-supporting structure.

[01 CP 02] shall be NEMA 1 gasketed, with open bottom for mounting directly onto a housekeeping pad.

B. HINGES AND HINGE PINS

1. Provide full length (continuous) piano hinges rated for 1.5 times the weight of the door plus all door-mounted instruments.

2. Hinges shall be welded to all surfaces and shall match the metallurgy of the enclosure.

3. Hinge pins shall be 316L stainless steel on all panels.

C. MOUNTING FEET

Provide 12 inch mounting feet made of the same material as the enclosure body that it supports.

D. NAMEPLATES

Phenolic.

2.2 CONTROL PANEL POWER DEVICES

B. FUSES

1. Control Power Fusing

Control power fuses are FRN for ratings above 10 amperes and FNQ for 10 amperes and below. FRN fuses are mounted in phenolic blocks with a fuse puller mounted adjacent to them. FNQ fuse holders are DIN-rail mounted type, 12A, 300 V minimum, hinged to disconnect and replace fuse, with blown fuse indicating light. Label all fuseholders with fuse identification number and fuse size and type. Provide five spare fuses of each type and size in each panel. Provide box mounted on panel interior marked "SPARE FUSES" to hold the spares.

2. PLC I/O Field Connection Fusing

a. 24 VDC Fusing

i. Fuses for 24 VDC circuits shall be 5 x 20 mm, glass body, fast acting, 250 VAC, sized by the integrator unless specifically called in the Plans or Specifications.

ii. Fuse holders for 24 VDC circuits shall be DIN-rail mounted type, provided in fusible terminal blocks, for 5 x 20 mm fuses, black, hinged to open, 10-57 VAC/VDC, with red LED blown fuse indicators, #30 AWG - #12 AWG, 15A.

b. 120 VAC Fusing

i. Fuses for 120 VAC circuits shall be 1/4" x 1-1/4", glass body, time-delay, 250 VAC, sized by the integrator unless specifically called in the Plans or Specifications.

ii. Fuse holders for 120 VAC circuits shall be DIN-rail mounted type, provided in fusible terminal blocks, for 1/4" x 1-1/4" fuses, black, 100-300 VAC, with neon blown fuse indicators, #30 AWG - #12 AWG, 15A.

C. CIRCUIT BREAKERS

1. Control Power Circuit Breakers

Control power circuit breakers shall be DIN-rail mounted type, miniature, 240 VAC, single pole, 10 kAIC (minimum) @ 240 VAC, “C” curve (inductive) trip characteristics, 1,500 VAC dielectric strength (minimum), #14 to #12 AWG 75^{o}C line and load screw terminals, UL 489, CSA 22.2 No. 5.1; Allen Bradley Bulletin 1492-SPU Series A or equal.

D. DISCONNECT SWITCHES AND ACTUATORS

1. For Power Circuits > 30 Amps

Reference Specification 16410, Enclosed Switches, Fuses, and Circuit Breakers.

2. For Power Circuits <= 30 Amps

Disconnect load switches shall be OFF-ON, 90 degree, 20 A rating, single pole, front door installation; Allen Bradley 194L-HC4L-1751 or equal.

Disconnect load switch actuators shall be OFF-ON, 90 degree, front/door installation, 22.5 mm central hole mount, red/yellow handle with padlock provision, 48 mm x 48 mm; Allen Bradley 194L-E20-1751 or equal

E. SURGE PROTECTIVE DEVICES

1. For Control Power Circuits

Control power SPDs shall protect L-N, L-G and N-G and have a minimum peak surge current of 40kA, shall have terminals that accept a #12 AWG conductor, shall be rated for the voltage shown in the Plans, shall be UL listed, and shall have a terminal configuration with separate Line, Neutral, and Ground connections.

Control power SPDs shall meet Mil-Std-220 for maximum EMI/RFI attenuation.

Control power SPDs shall be DIN-rail mounted, 1-inch wide maximum.

Control power SPDs shall be Innovative Technology HS-DIN-120 series or equal.

F. UPS SYSTEMS

1. 24 VDC UPS Systems

24 VDC UPS Systems shall include the 24 VDC power supplies, the converters, batteries, and redundancy modules as described herein. Each of these devices shall be DIN-rail mounted, industrial rated, packaged, and UL-Listed. Custom built circuits boards and loose electronic devices shall not be allowed. Provide a minimum of 120 minutes of battery backup time.

Provide a dual (paralleled) 24 VDC UPS system including, as a minimum, the following devices: 2x 24 VDC Power Supplies, 2x 24 VDC UPS Controllers, 2x 12 VDC Backup Batteries, 1x 24 VDC DC Redundancy Module.

The minimum DC UPS system shall be capable of providing 10 Amps at 24 VDC continuously. The specifications listed below are for a minimum system. Increase the system ampacity as required.

a. 24 VDC Power Supplies

24 VDC power supplies shall be 120 VAC input, 24 VDC output, 10 A minimum, with +/- 1 percent voltage regulation from no-load to full-load. Process power supplies shall be sized by the integrator and increased in size as required. Provide the power supply sizing calculations with the product submittal. PULS #QS10.241 or equal.

b. 24 VDC UPS Controller

DC UPS controller shall be 24 VDC/24 VDC, 10 A, with indicating LEDs. The unit shall monitor the battery and provide a dry contact output to indicate that the battery should be replaced. PULS #UB10.241 or equal.

If 12 VDC circuits are required within [03 CP 02], replace the PULS #UB10.241 units with PULS # UB10.245 or equal.

c. 12 VDC Backup Batteries

Batteries shall be fully sealed get type. Batteries shall be rated for 12 Ah (minimum) and rated to operate between -40 degrees C to 60 degrees C.

d. DC Redundancy Module

DC Redundancy Modules provide parallel connectivity of two separate 24 VDC systems and are required on all dual 24 VDC supply systems.

Provide DC Redundancy module, 24 VDC/24 VDC input, 24 VDC output, 20 Amp; PULS YR2.DIODE or equal.

If 12 VDC circuits are required within [03 CP 02], then provide separate DC Redundancy modules for the 24 VDC system and the 12 VDC system.

The Operator Interface Unit (OIU) will operate at 24 VDC (reference Specification 16920). If the total 24 VDC load of all devices, including the OIU, require above 8 A, then provide a third and separate 24 VDC UPS system for the Operator Interface Unit. This system shall include, as a minimum, the following devices: 1x 24 VDC Power Supply, 1x 24 VDC UPS Controllers, and 1x 12 VDC Backup Battery.

1.10 CONTROL PANEL CONTROL DEVICES

A. PILOT LIGHTS

1. Pilot lights shall be heavy duty, Class 9001, Type J, NEMA 4 (watertight) and NEMA 13 (oil-tight), push-to-test, multi-segmented LED with red, green, amber, blue, clear, white, or yellow colored caps as shown on the Plans.

a. Allen-Bradley

b. Cutler-Hammer

c. General Electric

d. Siemens

e. Square D

B. PUSH BUTTONS

1. Push buttons shall be heavy duty, Class 9001, Type K, UL types 4 and 13, NEMA 4 (watertight) and NEMA 13 (oil-tight), non-illuminating, with full button guard. Contact block shall be provided with 1 N.O. and 1 N.C. contacts minimum with the ability to stack additional blocks. Provide additional blocks as required.

Pushbutton actuators may be standard, mushroom head, recessed (flush collar), or deep recessed (deep collar) as required.

a. Allen-Bradley

b. Cutler-Hammer

c. General Electric

d. Siemens

e. Square D

C. SELECTOR SWITCHES

1. On-Off Selector Switches

ON-OFF selector switches shall be Class 9001, Type K, UL types 4 and 13, NEMA 4 (watertight) and NEMA 13 (oil-tight), non-illuminating push button contact blocks with 2-position operators and standard knob. Contact block shall be provided with 2 N.O. and 2 N.C. contacts minimum with the ability to stack additional blocks. Provide additional blocks as required.

The 2-position operator shall be manual rotation to left and manual rotation to right. Two contact block stacks shall be provided. In both contact block stacks, one set of contacts is closed in the left position and open in the right position. In both contact block stacks, one set of contacts is closed in the right position and open in the left position.

a. Allen-Bradley

b. Cutler-Hammer

c. General Electric

d. Siemens

e. Square D

2. Hand-Off-Auto (HOA) Selector Switches

HOA selector switches shall be Class 9001, Type K, UL types 4 and 13, NEMA 4 (watertight) and NEMA 13 (oil-tight), non-illuminating push button contact blocks with 3-position operators and standard knob. Contact block shall be provided with 2 N.O. and 2 N.C. contacts minimum with the ability to stack additional blocks. Provide additional blocks as required.

The 3-position operator shall be manual rotation to left and right from center and manual return back to center. Two contact block stacks shall be provided. In both contact block stacks, one set of contacts is closed in the left position and open in the center and right positions. In both contact block stacks, one set of contacts is closed in the right position and open in the center and left positions.

a. Allen-Bradley

b. Cutler-Hammer

c. General Electric

d. Siemens

e. Square D

D. RELAYS

1. Contactor relays

Contactor relays for switching 120 VAC power circuits including, but not limited to, lighting, solenoid valves, and small motors shall be electro-mechanical machine tool, heavy-duty type, NEMA rated, with 120 VAC/24 VDC coils and double-break contacts rated at 20 A at 250 VAC. Equip relays with surge suppressers. IEC rated relays are not permitted.

2. Control relays

Control relays for logic control circuits shall be permitted to be miniature “ice cube” type DPDT or 4PDT with 24V or 110-120V AC/DC coils with a mechanical life of 20 million operations minimum and an electrical life of 1 million operations minimum at 1 amp. The dielectric strength between the coil and contacts shall be 2,000 VAC for 1 minute. Contacts shall be rated at 10A at 250 VAC, 10A at 30 VDC. Relays shall have a maximum pickup and release time of 25 milliseconds and a minimum drop voltage of 30 percent of the rated voltage. Relays shall include non-polarized LED coil indictors. Relays shall be IDEC, P&B/Tyco or equal.

3. Time delay relays

Time delay relays shall be electronic, programmable, multifunction type with a minimum of two (2) Form C time-delay contacts; Crouzet Chronos 2 or equal.

Time delay relays shall be capable of TDAE and TDAD functions as a minimum.

Time delay relays shall be provided with selectable time ranges in seconds, minutes, and hours and adjustable settings within the range.

Time delay relays can be problematic. Provide timers that can operate repeatedly without error when their coils are directly paralleled by another relay or timer coil.

4. PLC 24 VDC Output Buffer Relays

PLC 24 VDC output buffer relays shall be miniature DIN-rail DPDT type with silver-nickel alloy contacts rated at 8 amps @ 250 VAC/30 VDC (resistive load), 4 amps @ 250 VAC/30 VDC (inductive load), and 100,000 operations at full rated load with a dielectric strength between contacts of 1,000 VAC for 1 minute.

The relay coil shall be 24 VDC, with a mechanical life of 50 million operations and a dielectric strength between the coil and contacts of 5,000 VAC for 1 minute. Relays shall have a maximum pickup time of 15 milliseconds and release time of 10 milliseconds and a minimum drop voltage of 10 percent of the rated voltage.

Relays shall include a non-polarized LED coil indicator.

Relays shall include a DIN-rail mounting socket, 0.625" wide maximum with finger-safe screw terminals and replacement locking lever. DPDT relays and sockets shall be stackable at 0.625".

Relays shall be IDEC RJ2S-CL-D24 or exact equal.

5. PLC 120 VAC - to - 24 VDC Input Buffer Relays

PLC 120 VAC input buffer relays shall be miniature DIN-rail DPDT type with silver-nickel alloy contacts rated at 8 amps @ 250 VAC/30 VDC (resistive load), 4 amps @ 250 VAC/30 VDC (inductive load), and 200,000 operations at full rated load with a dielectric strength between contacts of 1,000 VAC for 1 minute.

The relay coil shall be 120 VAC, with a mechanical life of 30 million operations and a dielectric strength between the coil and contacts of 5,000 VAC for 1 minute. Relays shall have a maximum pickup time of 15 milliseconds and release time of 10 milliseconds and a minimum drop voltage of 30 percent of the rated voltage.

Relays shall include a non-polarized LED coil indicator.

Relays shall include a DIN-rail mounting socket, 0.625" wide maximum with finger-safe screw terminals and replacement locking lever. DPDT relays and sockets shall be stackable at 0.625".

Relays shall be IDEC RJ2S-CL-A120 or exact equal.

E. INTRINSICALLY SAFE BARRIERS

1. Intrinsically Safe Barriers, Analog (ISBAs)

a. ISBAs shall be single-channel, 4-20 mA input, 2-wire, 4-20 mA output, 24 VDC powered with an ungrounded field circuit; R. Stahl P/N 9002/13-280-110-001, no exceptions.

b. ISBAs shall provide electrical isolation between the input circuit, the output circuit, and the supply voltage.

c. ISBAs shall transfer 4-20 mA or 0-10 VDC input signals without attenuation (1:1 throughput).

2. Intrinsically Safe Barriers, Digital (ISBDs)

a. ISBDs shall be contact input, 2-channel, 2 x SPST, 2 Amp rated output (configurable N.O. or N.C.), universal supply voltage 20-250 VAC/20 – 125 VDC, UL-913 listed: Turck IM1-22Ex-R, PR Electronics 5202B2 or equivalent.

b. ISBDs shall provide electrical isolation between the input circuit, the output circuit, and the supply voltage.

c. ISBDs shall have programming switches to select if the output will operate in normally closed, normally open, or short circuit/wire break modes (fault detection mode). Disable the wire-break and short-circuit monitoring when using mechanical contacts as the input.

d. ISBDs shall have an LED on the front cover to indicate the switching status of the digital device.

F. ETHERNET SWITCHES

Ethernet switches shall be industrial grade, 10 / 100 MB, DIN-rail mounted type, 24 VDC powered, 8-port; N-Tron 300 series or equal.

Exceptions:

- *If the requirements exceed 8 ports, then provide the higher value.*
- *Non-DIN-rail acceptable if over 16 channels.*

1.11 CONTROL PANEL ANCILLARY DEVICES

Three separate 120 VAC circuits will be supplied to the Membrane Equipment PLC Control Panel by others. Two of the circuits shall be used in the control panel for the redundant 24 VDC control power circuits. The third circuit shall be used for ancillary control panel circuits as described in this section.

A. RECEPTACLES MOUNTED IN CONTROL PANELS

120 VAC power to convenience and device receptacles in control panels shall not be derived from the same PanelBoard circuit as that used for process control devices (PLC, flow meters, DC power supplies, etc.).

1. Convenience Receptacles

Convenience receptacles in control panels are not dedicated and are intended for providing 120 VAC convenience power for non-process equipment.

Convenience receptacles shall be GFCI, 15 Amp, 125 VAC, duplex, white, in a DIN-rail mount, cast aluminum box. Stamped steel boxes shall not be used.

2. Process/Device Receptacles

Process/Device receptacles are dedicated for communication and control devices operating within the control panel on a continuous basis. These include devices with 120 VAC power packs like VPNs, Fiber-To-Voice Converters, Data-To-Voice Converters, and etc.

Process /Device receptacles shall be non-GFCI, 15 Amp, 125 VAC, duplex, white, in a DIN-rail mount, cast aluminum box. Stamped steel boxes shall not be used.

B. PANEL LIGHTING

120 VAC power to the panel light shall not be derived from the same Panelboard circuit as that used for process control devices (PLC, flow meters, DC power supplies, etc.).

Provide an LED lighting package, under cabinet style, hardwired, 120 VAC, with integral door-activated ON/OFF switch.

C. PANEL COOLING FANS

120 VAC power to panel fans shall not be derived from the same PanelBoard circuit as that used for process control devices (PLC, flow meters, DC power supplies, etc.).

Provide a panel fan cooling system consisting of two fans, a thermostat, and associated filtered and screened intake vents. The cooling system shall be sufficiently sized to maintain an internal enclosure temperature below the maximum operating temperature of all internal devices.

Provide a thermostat for cooling, N.O. contact, adjustable setpoint range 32-140 degrees F, 15 Amp-rated contact at 120 VAC.

Cooling fans shall be configured to exhaust air. Vents shall be provided for supply air. Layout fans and vents in such a manner as to:

1. Maximize cooling of critical components,
2. Minimize air flow restriction,
3. Eliminate entry of water or dust particles into the enclosure.

Provide vent covers over fan and vent openings to eliminate rain and moderate washdown for all outdoor panels.

D. TERMINAL BLOCKS

1. For Non-Fused Control, Instrumentation, and Power Circuits < 30 VDC, < 150 VAC, and <= 30Amps

   Provide standard feed-through DIN-rail type IEC terminal blocks, single circuit, screw terminal type, #22 - #10 AWG, rated 600 V AC/DC at 30 A, white or grey; Allen Bradley Bulletin 1492-J4 series or equal.

   Exceptions:

   - *For equipment/chassis grounded circuits*

     Provide DIN-rail type IEC grounding blocks, single circuit, screw terminal type, #22 - #10 AWG, rated 600 V AC/DC at 30 A, green/yellow in color; Allen Bradley Bulletin 1492- WG6 or equal. These ground blocks shall be inherently connected to the din rail.

   - *For instrumentation cable shield terminations (reference Section 2.1.F)*

     Provide standard feed-through DIN-rail type IEC terminal blocks, single circuit, screw terminal type, #22 - #10 AWG, rated 600 V AC/DC at 30 A, blue; Allen Bradley Bulletin 1492-J4-B or equal.

5. Terminals used for digital and analog I/O field connections shall be grouped as shown in Section 2.1.F, FABRICATION, FIELD CONNECTIONS TO PLC I/O.

E. PANEL WIRING PRODUCTS

1. Power Circuit Wiring; Reference Specification 16120.

2. Control Circuit Wiring; Reference Specification 16120.

3. Analog PLC I/O Wiring

Signal cables connected completely inside control panels between analog input and output field terminal groupings and their associated PLC analog cards shall be #22 AWG, stranded, tinned copper, twisted pair, 300 V, 100% overall foil shielded cable with #22 AWG tinned copper drain wire; Belden #8451 or equal.

For analog I/O wiring outside the panel, reference Specification 16120.

1.12 CONTROL PANEL ACCESSORIES

A. PANEL NAMEPLATES AND IDENTIFICATION

1. Identify each item on the control panel with rectangular nameplates.

2. Provide nameplates of rigid phenolic plastic laminate with engraved lettering or engraved metal plate with filled lettering. Use black background with white lettering.

3. Minimum letter height is 1/2 inch for instrument description and 1/4-inch height for instrument tag number.

4. Provide each panel with a 2-inch by 10-inch (minimum) nameplate with 1-inch-high lettering with panel identification.

5. Abbreviations are not permitted unless approved by the Owner or specifically shown on the nameplates, schedules, or plans.

6. Install nameplates plumb and parallel to the lines of doors or structure to which they are attached. Attach to the sheet metal structure by a thin coat of adhesive and sheet metal screws. Make adhesive and screw applications in such a manner as to avoid nameplate buckling or distortion due to use of excessive adhesive or over tightening of screws.

PART 2 — INSTALLATION

2.9 FABRICATION

A. GENERAL

1. Control panels are factory or shop fabricated units completely assembled, wired, and tested before shipment to the job site.

2. Panel construction, in general, meets JIC EMP-1 standards and applicable NEMA and IEEE standards.

Exceptions:

- *Where open penetrations are required, such as for fans and vents, the NEMA rating of the panel may be modified to meet the intent of the design and fit the environment of the application.*

3. The panels shall be constructed in accordance with Article 409 of the NEC and electrical testing laboratory standards and shall be so labeled (the standards of a recognized electrical testing laboratory).

4. Size panels for enclosed equipment and available space for mounting of panel or as shown on the Plans.

5. Panels shall be descaled, cleaned, and primed in preparation for painting. Painting shall consist of one coat of flat white enamel in the interior and two coats of hard finish exterior enamel, gray in color. Paint shall be suitable for field touch-up. Spare paint (1 quart) shall be provided for touch-up purposes.

6. Panel material, penetrations, and etc. shall be verified for proper operation in their intended locations. Issues and concerns shall be brought to the attention of the Engineer prior to fabrication within or on the panel.

B. FREE-STANDING PANELS

1. Welded construction

2. Completely enclosed, self-supporting, and gasketed dust-tight.

3. Seams and corners welded and ground smooth.

4. Furnish doors with keyed alike locking handles and three point catch.

5. Provide each panel with lifting eyebolts. Furnish stainless steel base channels.

6. Slotted bolt holes in base, 1-1/2 long for field adjustment.

C. COMPONENT INSTALLATION

1. Minimize welding to panel fronts and avoid distortion of panel metal.

2. Reinforce around areas of the enclosure weakened by openings or mounting of heavy equipment/components.

3. Accurately and cleanly cut or nibble cutouts, and finish free of sharp edges or burrs. Make cutouts plumb, level, and on-line vertically or horizontally within 1/32 of an inch where components are in rows or columns.

4. Provide minimum 1-5/8-inches spacing between horizontal rows of externally mounted components; 1-1/2 inches minimum between vertical columns of components.

5. Provide minimum 1/4-inch spacing between components mounted on the panel sub-plate, Provide minimum spacing between the component and the wire duct of 1-1/2 inches above, and 1 inch below.

6. Components mounted in the interior shall be fastened to an interior subpanel using machine screws plus adhesive to insure vibration-free attachment.

7. Interior component mounting and wiring shall be grouped as much as possible by function and then by component type. Interiors shall be so arranged that control relays, terminal blocks, fuses, etc., can be replaced or added without disturbing adjacent components.

8. Open batteries provided to support DC UPS systems shall be mounted on 316L stainless steel shelves and provided with non-conducting bracing straps to firmly hold the battery in place. The shelves shall have a raised lip around all sides that are not in contact with a wall. The bottom of the shelf shall be at least 4 inches above the bottom of the enclosure.

Exception:

- *Batteries provided with manufacturer's mounting systems do not require the additional stainless steel shelving.*

D. PANEL WIRING METHODS

1. Provide PLC analog and digital input and output circuit field terminations and wiring methods per Section 2.1.F.

2. Field wiring terminations to control panel terminal strips shall be connected as shown on the Plans. Cable shields or "drain" wires shall be terminated as per manufacturer's recommendations.

3. Provide a chassis-connected equipment ground bus at the bottom of PLC control panels.

4. Provide an isolated ground bus, dedicated solely for analog shield connections, adjacent to the equipment ground bus. Provide a separate and dedicated #10 AWG minimum green-insulated ground wire from the Panelboard ground bus to the isolated ground bus.

5. Provide raceways for panel wiring.

   a. Size raceways per the requirements of NEC.

   b. Provide panel wireways between each row of components, and adjacent to each terminal strip.

   c. Wireways are a minimum of 1 inch wide and 3 inches deep with removable snap-on covers and perforated walls for easy wire entrance. Wireways shall be constructed of non-metallic materials with a voltage insulation in excess of the maximum voltage carried therein Panduit type LG, Panel Channel or equal

6. Run wires neatly in wiring duct tied and bundled with tie wraps or similar materials.

7. Provide wire bending space per NEMA ICS 6.

8. Label wiring within the panel with wire numbers using the same number on both ends of the wire. Identify each wire termination,

including long jumpers, with wire markers. Arrange wire labels to permit reading of identification when installed.

9. Connect wiring internal to the panel to one side, leaving the opposite side for field terminations. Connect no more than two wires to any one control terminal point.

10. Arrange wiring inside the panel to separate instrumentation cables, conductors, and terminals at least 12 inches from 120 VAC power and control circuits.

11. Connect electrical equipment grounds to the chassis grounding bus.

12. Provide necessary power supplies for control equipment.

B. WIRES IN CONTROL PANELS

Wires in control panels are those wires that are not routed through raceways external to control panels.

1. Control Panel Power And Control Wire

a. Insulation

Power and control conductors in control panels shall be MTW or THHN/THWN-2.

Wire minimum size and color:

Circuit Type	Wire Size	Wire Color
120 Vac Circuits		
120 Vac, Line	#12 AWG	Black
120 Vac, Neutral	#12 AWG	White
120 Vac Control Circuits	#14 AWG	Yellow
Ground Circuits		
Chassis Ground	#12 AWG	Green
Isolated (Shield) Ground	#12 AWG	Light Blue
24 Vdc Circuits		
+24 Vdc Power	#14 AWG	Red
24 Vdc Common	#14 AWG	Dark Blue
24 Vdc Control Circuits	#14 AWG	Orange

E. WIRE TERMINATION METHODS

1. Terminate one end of all instrumentation cable shields to blue isolated-ground terminals (reference Section 1.3).

3. Provide fused terminals as shown on the Plans or defined herein. Reference Section 2 for materials

4. Terminals used for 4-20 mA analog input and output circuits shall be grouped as shown herein. This grouping shall be provided for each analog input and output connected to a PLC, whether assigned or unassigned (spare).

5. Provide terminal strips for the termination of panel wiring not directly connected to panel mounted devices.

6. Terminals shall facilitate wire sizes as follows:

   a. 120 VAC applications: Wire size 12 AWG and smaller.

   b. Other: Wire size 14 AWG and smaller.

7. Tag each I/O terminal to indicate tag number of the connected device or wire.

8. Provide 20 percent excess terminals (minimum) for future expansion.

9. Provide a minimum of 1.5 inches between terminal strips and wireways or between terminal strips.

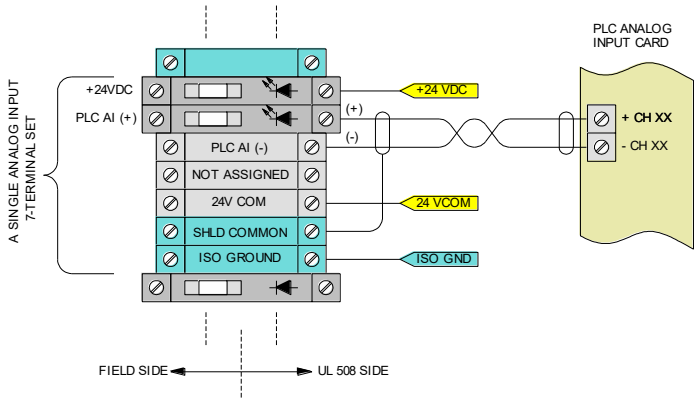
F. FIELD CONNECTIONS TO PLC I/O

1. ANALOG INPUT, Termination and Connectivity

   Each 4-20 mA PLC analog input shall be connected to a 7-terminal grouping as shown below and as detailed on the Analog Loop Diagrams on the Plans whether the input channel is assigned or unassigned (spare) and whether the input is single-ended, differential, or isolated. No chassis-grounded terminals shall be used. Reference table below.

7-TERMINAL ANALOG INPUT GROUPING, TERMINAL ASSIGNMENTS

Internal Panel Connections	Clarification	Terminal Type and Color
+24VDC	+ 24 VDC Power	Fused, Black
PLC AI (+)	PLC Analog Input, +	Fused, Black
PLC AI (-)	PLC Analog Input, -	Feedthrough, Gray
NOT ASSIGNED	2-Device Connection	Feedthrough, Gray
24VCOM	24 V Common	Feedthrough, Gray
SHLD COMMON	Shield Common	Feedthrough, Blue
ISO GROUND	Isolated Ground	Feedthrough, Blue



All connections on the UL 508 side are the same, regardless of the type of field connection.

Bundle all analog input terminal groups in the same sequence as the analog input cards and channels.

Maintain a minimum of 12 inches between analog terminal groups and AC power circuits.

The shields shall be connected at the terminal block-end only. Shields shall not be connected at the PLC cards.

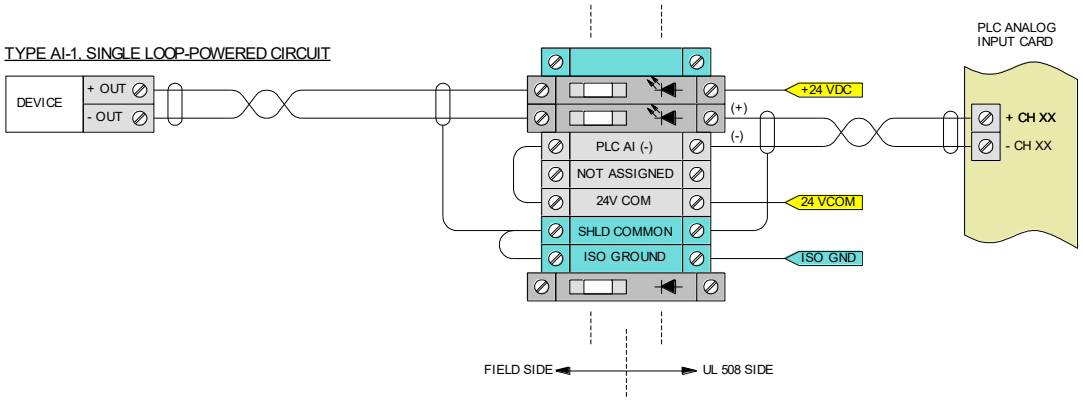
No additional 24 VDC fusing is to be provided.

For cable type between terminal groupings and analog input PLC cards, reference Section 1.3.

2. ANALOG INPUT, 7-Terminal Connection Methods

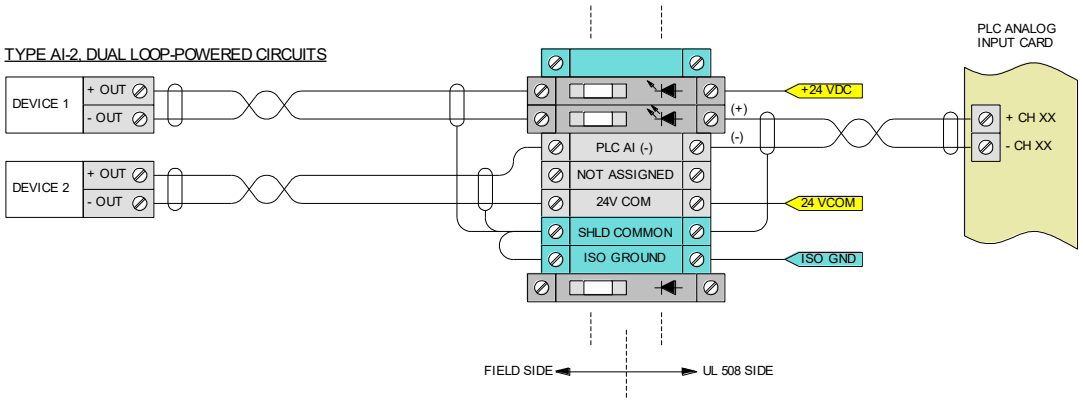
a. Field Connection **TYPE AI-1**, connection to a single loop-powered field device

The Figure below shows the method of connecting a PLC analog input to a single loop-powered field device using a 7-terminal standard analog input terminal group.



b. Field Connection **TYPE AI-2**, connection to two loop-powered field devices

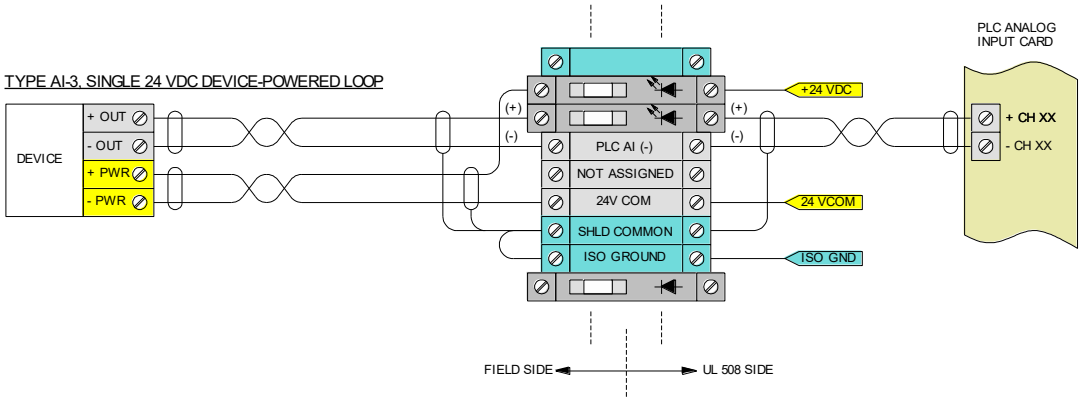
The Figure below shows the method of connecting a PLC analog input to two loop-powered field devices using a 7-terminal standard analog input terminal group.



c. Field Connection **TYPE AI-3**, connection to a single 24 VDC device-powered field device

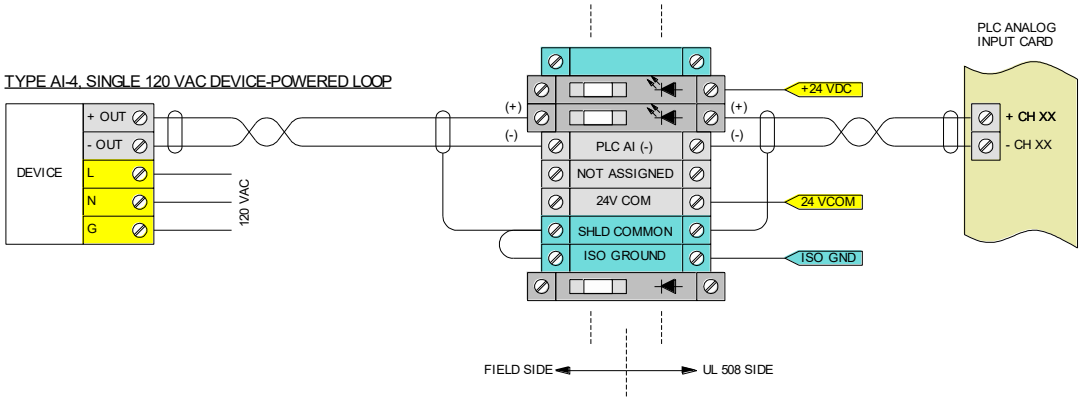
The Figure below shows the method of connecting a PLC analog input to a single 24 VDC device-powered field

device using a 7-terminal standard analog input terminal group. Device power is provided by the control system power.



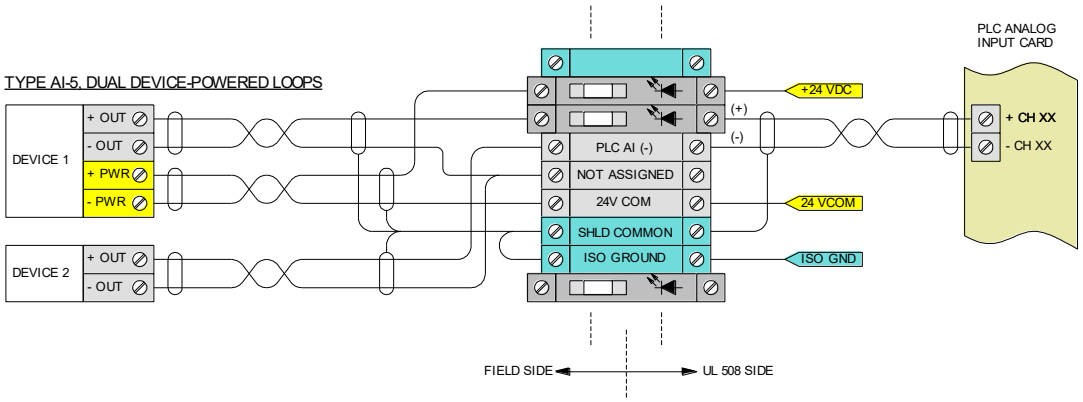
d. Field Connection **TYPE AI-4**, connection to a single 120 VAC device-powered field device

The Figure below shows the method of connecting a PLC analog input to a single 120 VAC device-powered field device using a 7-terminal standard analog input terminal group.



e. Field Connection **TYPE AI-5**, connection to a set of 24 VDC device-powered and loop-powered field devices

The Figure below shows the method of connecting a PLC analog input to two field devices, with at least one requiring 24 VDC device power using a 7-terminal standard analog input terminal group. Device power is provided by the control system power.

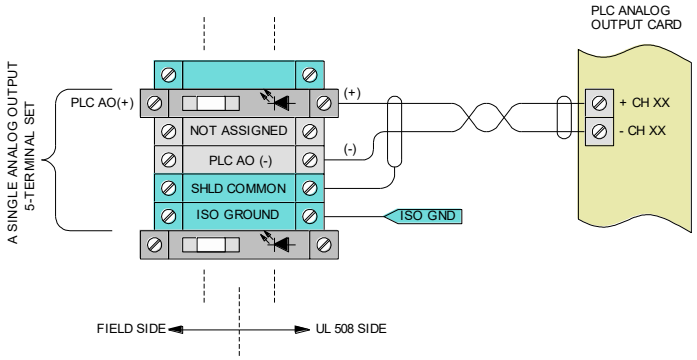


3. Analog Output, Termination and Connectivity

Each 4-20 mA PLC analog output channel shall be connected to a 5-terminal grouping as shown below and as detailed on the Plans whether the input channel is assigned or unassigned and whether the output is isolated or not. No chassis-grounded terminals shall be used. Reference table below.

5-TERMINAL ANALOG INPUT GROUPING, TERMINAL ASSIGNMENTS

Internal Panel Connections	Clarification	Terminal Type and Color
PLC AO(+)	PLC Analog Output, +	Fused, Black
NOT ASSIGNED	2-Device Connection	Feedthrough, Gray
PLC AO(-)	PLC Analog Output, -	Feedthrough, Gray
SHLD COMMON	Shield Common	Feedthrough, Blue
ISO GROUND	Isolated Ground	Feedthrough, Blue



All connections on the UL 508 side are the same, regardless of the type of field connection.

Bundle all analog output terminal groups in the same sequence as the analog output cards and channels.

Maintain a minimum of 12 inches between analog terminal groups and AC power circuits.

The shields shall be connected at the terminal block-end only. Shields shall not be connected at the PLC cards.

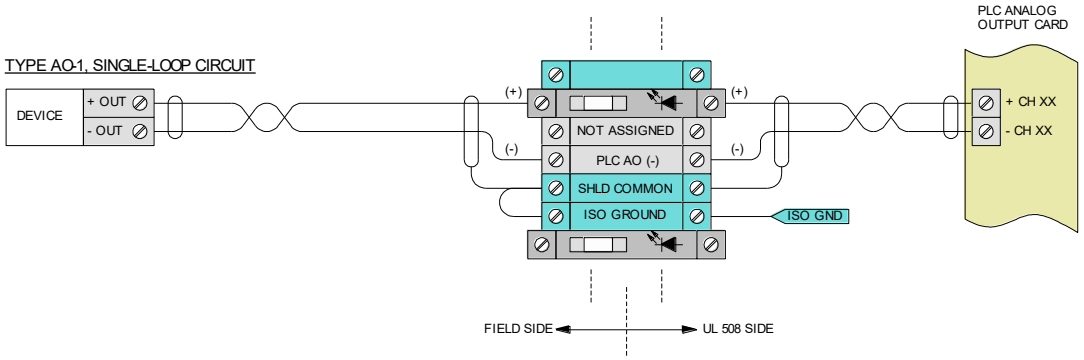
No additional 24 VDC fusing is to be provided.

For cable type between terminal groupings and analog input PLC cards, reference Section 1.3.

4. Analog Output, 5-Terminal Connection Methods

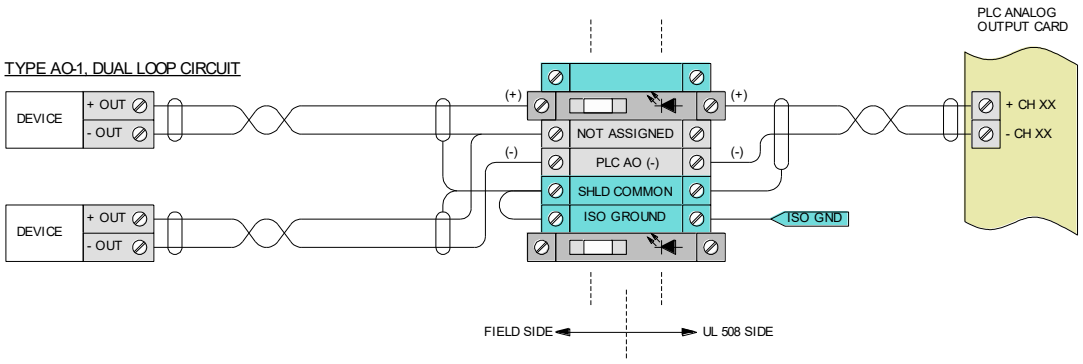
a. Field Connection **TYPE AO-1**, connection to a single field device

The Figure below shows the method of connecting a PLC analog output to a single field device using a 5-terminal standard analog output terminal group.



b. Field Connection **TYPE AO-2**, connection to two field devices

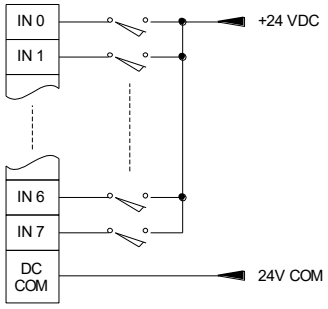
The Figure below shows the method of connecting a PLC analog output to two field devices using a 5-terminal standard analog output terminal group. These devices can be loop-powered or device powered.



5. Digital Input, Termination and Connectivity

a. Digital Input Type

All digital inputs shall be the "sinking" type as shown below. Reference Specification Section 13450, Programmable Logic Controller (PLC) Hardware.



1/2 OF 24 VDC, 16 CHANNEL PLC
DIGITAL SINKING INPUT CIRCUIT

b. Digital Input Fusing to Field Circuits

Provide fusing for each field-connected digital input. A single fuse shall be used for a group of field inputs from a common remote panel providing that the inputs are connected to the same input card. A common fuse shall not be used for separate cards.

Separate fuses shall be provided for field inputs that are not terminated in a common remote panel.

Provide a separate fuse for each set of 4 unassigned (spare) Digital Inputs.

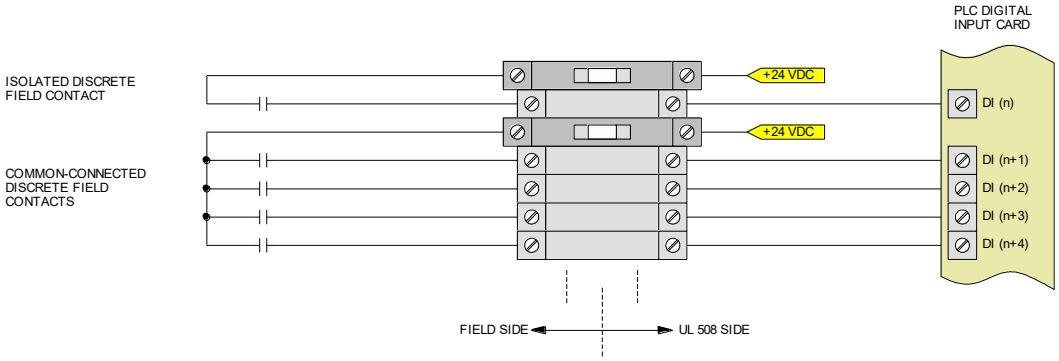
Fuses shall be 0.5 Amp.

Provide a separate gray feedthrough terminal for each digital input channel whether the input channel is assigned or unassigned.

c. Digital Input Connection Methods

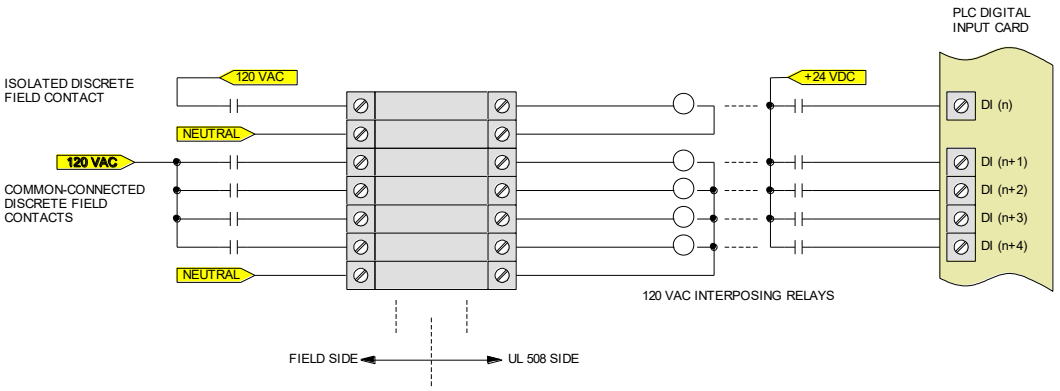
1) Connections to “Dry” Field Contacts

Discrete input field devices with dry Form A or Form B contacts sharing a common cabinet or piece of equipment may be combined into a group sharing a single +24 VDC fused common as shown below.



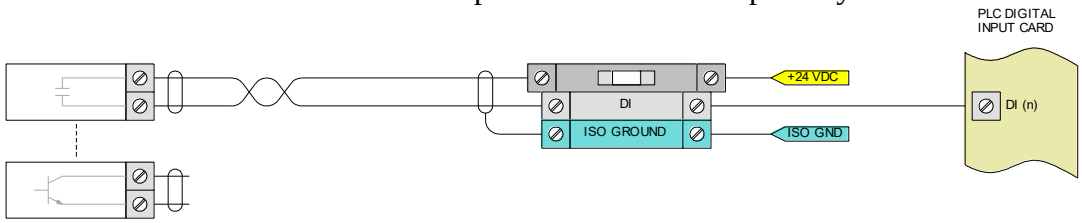
2) Connections to “Hot” (wet) 120 VAC Field Circuits

Digital inputs derived from 120 VAC "hot" circuits shall be buffered through interposing relays inside the PLC control panel prior to connection to the 24 VDC Digital Input PLC cards in a manner shown in the Figure below. Reference "PLC 120 VAC - to - 24 VDC Input Buffer Relays" in Section 2.2 for relay product type.



3) Digital Pulse Inputs

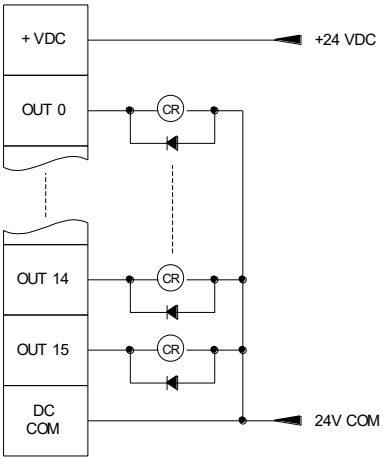
Digital pulse inputs shall be either dry Form A or Form B contacts or active open-collector circuits as shown in the Figure below. The +24 VDC power shall be provided by the 24 VDC control system power and shall be separately fused.



6. DIGITAL OUTPUT, Termination and Connectivity

a. Digital Output Type

All digital outputs shall be the “sourcing” type as shown below. Reference Specification 16910, Programmable Logic Controller (PLC) Hardware.



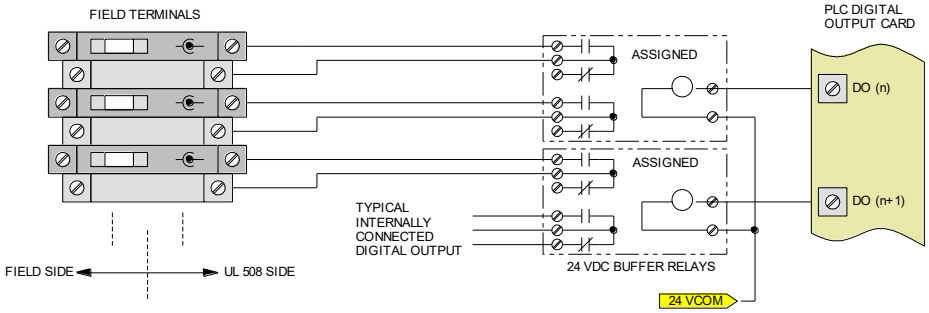
24 VDC, 16 CHANNEL PLC
DIGITAL SOURCING OUTPUT CIRCUIT

b. Digital Output Buffer Relays

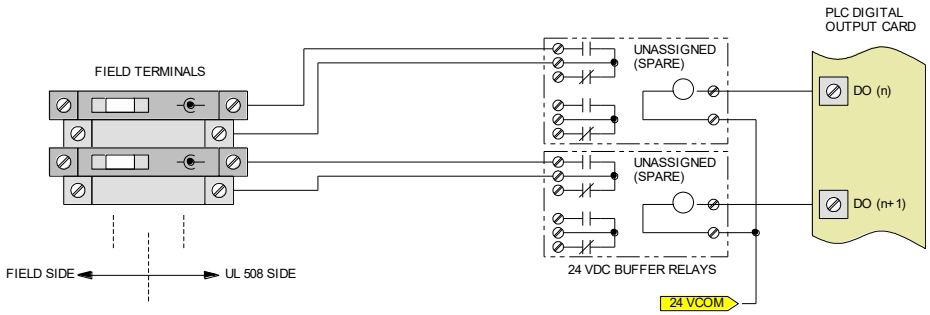
All 24 VDC digital outputs, even if unassigned (spare), shall be buffered through a DPDT (minimum) interposing relay prior to being connected to other internal circuits or field terminals. 4PDT relays shall be provided where shown on wiring diagrams. Reference "PLC 24 VDC Output Buffer Relays" in Part 2 for product type.

Internally connected buffered outputs shall not be fused.

Assigned digital outputs shall be assigned to single or double fused output terminal pairs as shown in the Figure below.



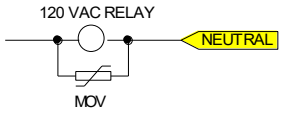
All unassigned digital outputs shall be buffered to a single fused output terminal pair as shown in the Figure below.



G. RELAY COIL SURGE SUPPRESSION

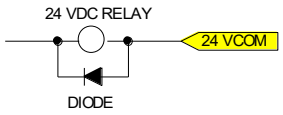
1. 120 VAC Coil Surge Suppression

All 120 VAC coils shall be paralleled by a Metal Oxide Varistor (MOV) type surge suppressor as shown in the Figure below. The suppressor shall be connected directly across the relay socket coil terminals with short wire leads.



2. 24 VDC Coil Surge Suppression

All 24 VDC coils shall be paralleled by a reverse-connected shunt diode as shown in the Figure below. The diode shall be connected directly across the relay socket coil terminals with short wire leads. The diode shall be rated at 1A, 100 PIV minimum.



2.10 SOURCE QUALITY CONTROL

A. Submit a shop test plan indicating how the test will be conducted, and how the system will be verified.

B. Revise all plans upon completion of the work to show the "as shipped" condition of the panel.

C. Allow for the owner and Engineer to witness the shop test. Provide a minimum of 15-days notice prior to the test.

D. Provide a shop test after factory completion and prior to shipment.

1. Test Documentation

    a. Provide a detailed testing procedure and submit to the Engineer at least 1 week prior to the shop test.

    b. Document all required corrections, even those that may be remedied during the shop test.

    c. Issue a copy of the test procedures and necessary corrections to the Engineer.

    d. Make all necessary corrections before shipping any panels, equipment, or devices to the job site.

    e. Issue a final signed document verifying that each correction has been made.

2. PLC Control Test

    a. Conduct a burn-in period (minimum of 2 days) where the system is operated continuously and checked for proper operation.

    b. Utilize simulated I/Os to verify proper operation. Demonstrate the operation of each digital and analog I/O point.

    c. Demonstrate compete connectivity and data transfer over the process control network. Verify the operation of all motor starters and remote devices monitored and controlled over the network.

    d. Provide a computer and the software required for testing such that the owner may view the simulation of operator entries of field parameters such as set points and alarm values during the test.

3. Relay and Process Controller Test

    a. Demonstrate the complete operation of the relay logic, backup logic, process controllers, and etc.

4. Other Tests

   a. Provide normal operating voltage to all equipment. Demonstrate the operation of all equipment while under power.

   b. The entire assembled panel shall be tested to be free from grounds and shorts.

   c. Controllers, circuits and interlocks shall be rung out and tested to assure that they function correctly before the panel is shipped.

***** END OF SECTION *****

APPENDIX B

MEMBRANE EQUIPMENT SYSTEM SUPPLIER DESIGN SUBMITTAL DOCUMENTS

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Diffuser Cleaning Valve EQ-04
CIP Station EQ-05

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TMP Sensor INS-02
Permeate Pump Pressure Gauges INS-03
Air Scour Flow Sensor INS-04
Membrane Tank Float Switches INS-05
RAS Pump Station Level Transmitters INS-06
Turbidity Sensor INS-07

VALVES

Manual Valves VLV-01

GENERAL INFORMATION

GN-01

SCOPE LIST

No	Equipment Location	Tag	Category	Function	Name	Type	Chosen Size/Capacity	Unit	Material	Manufacturer	Model/ Specification	Motor HP	Voltage	FLA	QTY
	MBR Equipment	**x**													
1	MBR	02 MBR 01 02 MBR 02 02 MBR 03 02 MBR 04	SMU	Membrane Filtration	MBR SMU	Flat Plate			304SS	KUBOTA	FS150				4
2	MBR	n/a	SMU	SMU Maintenance	MBR SMU Lifting Tool	Lifting Tool			CS, SS	KUBOTA	TG150				1
3	MBR	n/a	SMU	SMU Maintenance	MBR SMU Lifting Chain	Lifting Tool			304SS	KUBOTA	CS30M				4
4	MBR	02 MOV 03 02 MOV 04	Auto Valve	Diffuser Cleaning	MBR Diffuser Cleaning Valve	ON/OFF Plug	4	inch	CI/DI	Auma/Pratt	SQ10.2/AC01.2/S651 w/2' extention stem	1/12	120 VAC	2.9	2
5	MBR	BFV280, BFV283, BFV286, BFV289	Other Valve	Isolation Valve	SMU Air Isolation Valve(inlet)	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S31				4
6	MBR	BFV282, BFV285, BFV288, BFV291	Other Valve	Isolation Valve	SMU Air Isolation Valve(outlet)	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S31				4
7	MBR	See Section VLV-01-C for Valve ID Tags	Other Valve	Isolation Valve	SMU PRMT Isolation Valve	Manual Butterfly	2	inch	DI, EPDM, Nylon Coat	Bray	S31				4
8	MBR	BFV 292, BFV 293	Other Valve	Isolation Valve	SMU PRMT Header Isolation Valve	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S31				2
9	MBR	BV282, BV283	Other Valve	Manual Valves	CIP injection	Manual Ball	1	inch	PVC, EPDM	ASAHI	Type21 True Union, extension stem				2
10	MBR	BV281, BV284	Other Valve	Manual Valves	CIP pressure relief	Manual Ball	1	inch	PVC, EPDM	ASAHI	Type21 True Union				2
11	MBR	02 LS 03 02 LS 04 02 LS 05 02 LS 06	Gauge, Switch	Level Measurement	MBR Level Switch	Float			PP, PU	Conery	2902-B8S1 w/ counter weight and brackets		Loop power		4
12	MBR	n/a	Fabrication	Fabrication	MBR SMU Guide & Stabilizer + Seismic Bracing				304SS	TBD					4
13	MBR	n/a	Fabrication	Fabrication	MBR SMU Fasteners				304SS	TBD					40
14	MBR	n/a	Fabrication	Fabrication	MBR In-Basin Pipe&Supports (Permeate Drop Pipe)				PVC	TBD					4
15	MBR	n/a	Fabrication	Fabrication	MBR In-Basin Pipe&Supports (Air Drop Pipe)				304SS	TBD					8
	Permeate (PRMT) Control Equipment	**x**													
16	PRMT	01 PMP 01 01 PMP 02 01 PMP 03	Permeate Pump	Permeate Extraction	PRMT Pump	Rotary Lobe	45	gpm		Boerger	AN 70 w/ piggyback mount	5	460 VAC	6.6	3
17	PRMT	PI169 PI170 PI171	Gauge	Pressure Gauge	PRMT Pump Pressuge Gauge(Inlet)		-15 - +15	psig	SS	Ashcroft or equivalent	1279 w/ grycelin filled				3
18	PRMT	PI172 PI173 PI174	Gauge	Pressure Gauge	PRMT Pump Pressuge Gauge (Inlet)		-15 - +15	psig	SS	Ashcroft or equivalent	1279 w/ grycelin filled				3
19	PRMT	01 PTR 01 01 PTR 02	Pressure Sensor	TMP Measurement	PRMT Pump Pressure Transmitter	Diaphragm	-15 - +15	psi	SS	Endress & Hauser	Cerabar PMCB51		Loop power		2
20	PRMT	01 MFM 01 01 MFM 02	Flow Sensor	Flow Measurement	PRMT Flow Meter	Electromagnetic	3	inch	PU	Endress & Hauser	Promag W 400		24VDC		2
21	MBR	BFV160 - 167	Other Valve	Isolation Valve	MBR PRMT Pump isolation valve	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S31				8
22	MBR	See Section VLV-01-C for Valve ID Tags	Other Valve	Check valve	MBR PRMT Pump discharge check valve	Manual ball	3	inch	PVC, EPDM	ASAHI	True Union Ball Check				3
23	PRMT	01 TM 01	Other Instrument	Turbidity Measurement	PRMT Turbidity Meter	Laser	0-5	NTU		HACH	TU5300sc				1
24	PRMT	01 TM 01	Other Instrument	Turbidity Measurement	PRMT Turbidity Transmitter					HACH	SC4500		24VDC		1
25	PRMT	n/a	Other Instrument	Turbidity Measurement	Turbidity Meter Maintenance Kit					HACH					1
	Return Activated Sludge (RAS) Control	**x**													
26	RAS	Relocated from MBR 02 SLS02 02 SLS03	Other Instrument	Level Measurement	MBR Level Sensor	Hydrostatic	15	ft	SS	Endress & Hauser	Waterpilot FMX21 w/ brackets		Loop power		2

No	Equipment Location	Tag	Category	Function	Name	Type	Chosen Size/Capacity	Unit	Material	Manufacturer	Model/ Specification	Motor HP	Voltage	FLA	QTY
	MBR Blower	**x**													
27	MBR BLW	01 MSB 01 01 MSB 02 01 MSB 03	Blower	Blower	MBR Blower	Positive Displacement	114	scfm	CI	Aerzen	GM 4S DN 80	5	460 VAC	6.6	3
28	MBR BLW	n/a	Option	Noise Suppression	MBR Blower Sound Enclosure	With Blower									3
29	MBR BLW	n/a	Option	Blower Temperature	MBR Blower Temperature Gauge	With Blower									3
30	MBR BLW	n/a	Option	Blower Pressure	MBR Blower Pressure Gauge	With Blower									3
31	MBR BLW	n/a	Option	Blower Temperature	MBR Blower Temperature Switch	With Blower									3
32	MBR BLW	01 AFM 01 01 AFM 02	Flow Sensor	Air Flow Measurement	MBR Blower Flow Meter	Thermal Mass	3	inch	PU	Endress & Hauser	t-mass I 300, w/ flow conditioner plate		24VDC		2
33	MBR BLW	BFV101-104	Other Valve	Manual Valves	Air Scour Blower Isolation Valves	Manual Butterfly	3	inch	DI, FKM, SS Disk	Bray	S31				4
	Clean-In-Place Equipment	**x**													
34	CIP Station	n/a	Chemical Injection	Chemical Injection	SMU CIP System PVC pipes		1	inch	PVC	KUBOTA	Loose ship parts shown on xxx				1
35	CIP Station	n/a	Flow Sensor	Flow Measurement	CIP solution Flow Meter	Electromagnetic	1	inch	PU				24 VDC		1
36	CIP Station	n/a	Flow Sensor	Flow Measurement	CIP shelf chenical Flow Meter	Electromagnetic	3/8	inch	PU	Keyence	FD-Q10C		24VDC		1
37	CIP Station	*1	Auto Valve	Flow Control	CIP Flow Control Valve	ON/OFF Ball	1	inch	DI	ASAHI	S19-120VAC--1"-C20/S20		120VAC	0.18	1
38	CIP Station	*1	Other Valve	Manual Valves	Isolation Valves on CIP Station	Manual Ball	1, 0.5	inch	PVC	ASAHI	Type21 True Union				1
39	CIP Station	*1	Other Valve	Manual Valves	Pressure reducing valve	Pressure Reducing	1.5	inch	CI	Zurn	ZW209				1
	System Control Equipment	**x**													
40	CONTROL	n/a	Control Panel	Control Panel	Control Panel	OIT, PLC					NEMA 4/12, 72" x 72" x 18" floor mount enclosure (estimated size) , Allen Bradley 1756-L81E PLC (BABA-Version), FactoryTalk View SE		120VAC	TBD	1
41	D. SERVICE	n/a	D. Service	Direct Service	Direct Service						Design support, start-up, field service, remote service				1

***1; Note CIP System Valve Tag Numbers not included in this section. See Section EQ-05-B-CIP Station.**

GN-02

P&ID

Not Included – Reference Plan Set P&ID Drawings

GN-03

CONTROL NARRATIVES

KUBOTA MBR System Control Narrative

Taylor Bay Beach Club, WA WWTF

OPID85-1621-001 r002 – Control Narrative MBR

Revised for Review - 08/19/2025

KUBOTA Water and Environmental USA Corporation

- This manual describes the MBR process and system for the operators to understand the MBR process and system, and how to operate and maintain the system properly.
- Please refer to the Equipment O&M manual (separate documents) for O&M information of each piece of equipment.

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1. Introduction

1.1. Purpose of this Manual

The Membrane Bioreactor (MBR) process is a treatment process utilized for the treatment of wastewater in the Taylor Bay Beach Club, WA WWTP. The MBR process consists of an EQ Basin, Anoxic Basin, Pre-Aeration Basin, MBR Tanks(s) with Permeate Pump System, Return Activated Sludge (RAS), Waste Activated Sludge (WAS) and Process and MBR Air Scour equipment.

Most equipment is operated automatically following a control program stored in a Programmable Logic Controller (PLC). This manual describes how the system operates and how the equipment is controlled by the PLC program. Operation and maintenance (O&M) information related to each piece of equipment or instrumentation is shown in the O&M manual, which is provided separately from this document.

1.2. Definition and Acronym

Table 1: Acronym Definitions

Acronym	Description
AAF	Annual Average Flow
AC	Alternating Current
AD	Aerobic Digester
ADWF	Annual Dry Weather Flow
AI	Analog Input
AN	Anaerobic
AO	Analog Output
AXP	Post-Anoxic
AWWF	Annual Wet Weather Flow
CBD	Coarse Bubble Diffuser
CGMS	Compressed Gas Mixing System
CIP	Clean-In-Place
DC	Direct Current
De-OX	Deoxygenation
DFC	Drum Fine Screen
DI	Digital Input
DIG	Digestor
DO	Digital Output
DO	Dissolved Oxygen
EQ	Equalization
FBD	Fine Bubble Diffuser
FC	Feed Channel
FCV	Flow Control Valve
FF	Feed Forward

Acronym	Description
GFD	Gallons Per Square Feet Per Day
GPM	Gallon Per Minute
HMI	Human Machine Interface
HOR	HAND-OFF-REMOTE positions of a selector switch to control motors
IO	Input and Output
LCP	Local Control Panel
MBT	Membrane Thickener
MBR	Membrane Bioreactor
MGD	Million Gallon Per Day
ML	Mixed Liquor
MLSS	Mixed Liquor Suspended Solids
MMDWF	Maximum Month Dry Weather Flow
MMWWF	Maximum Month Wet Weather Flow
MWWWF	Maximum Week Wet Weather Flow
OCR	OPEN-CLOSE-REMOTE positions of a selector switch to control actuated valves
OIT	Operator Interface Terminal
PA	Pre-aeration
PAX	Pre-Anoxic Basin
PD	Positive Displacement
PDAF	Peak Daily Average Flow
PID	Proportional–Integral–Derivative
PIF	Peak Instantaneous Flow
PLC	Programmable Logic Controller
PSI	Pounds Per Square Inch
RAS	Return Activated Sludge
RASB	Return Activated Sludge Basin
RIO	Remote I/O
SCADA	Supervisory Control and Data Acquisition
SCFM	Standard Cubic Feet Per Minute: Standard means 20 deg C and 0 atm.
SHT	Sludge Holding Tank
SMU	Submerged Membrane Units
SP	Setpoint
SWD	Side Water Depth
TMP	Trans-Membrane Pressure
TSS	Total Suspended Solids
UV	Ultraviolet
VFD	Variable Frequency Drive
WL	Water Level
WAS	Waste Activated Sludge

2. Overview of the Treatment Process

2.1. Overall Treatment Process

The Overall MBR process consists of one (1) fine screen / compactor system, one(1) EQ pump/tank system, one(1) Anoxic Basin, one(1) Aeration Basin, two(2) membrane tanks and one(1) RAS pump station. RAS pump station receive mixed liquor overflow from the MBR tanks via overflow weirs and the troughs. The RAS pump return the mixed liquor to the Anoxic Basin and combines with the influent flow. The mixed liquor goes to the Aeration Basin and splits to two (2) MBR Tanks, which each have one (1) independent permeate pump, as well as one common standby pump. Additionally, there are three (3) MBR Scour Air Blowers, one dedicated to one MBR Tank to provide aeration to the membranes contained within the MBR Tanks. The common backup can be assigned either MBR Tank#1 of #2.

Please see project PIDs for detailed diagrams of the process.

2.2. MBR Process

The MBR process consists of a biological treatment process and filtration process for final solid-liquid separation. Compared to a conventional treatment process, the MBR process can generate much cleaner treated water because the membrane filtration process physically blocks suspended solids. In the KUBOTA MBR process, KUBOTA Submerged Membrane Units (SMU) are used for the filtration process. The KUBOTA SMU consists of multiple membrane modules having a pore size of average 0.2 microns and a maximum of 0.4 microns. The MBR process is carried out in a series of process basins. Influent wastewater is introduced into those process basins and converted to purified treated water.

In the Taylor Bay Beach Club, WA WTF, wastewater enters the MBR system through the new fine screen system and is split into two parallel tank systems that both contain anoxic and feed forward pretreatment zones. The feed forward system will provide flow-paced and screened wastewater to each new membrane tank. Each membrane tank is plumbed into a common RAS / WAS pump system that returns the mixed liquor to the anoxic tank where it proceeds towards the membrane tanks again. Within each membrane tank, the air scour blowers provide membrane cleaning while also assisting with agitation and mixing of the basin. Each membrane tank can operate independently, and has one permeate pump dedicated to filtration duties. Clean in place may be operated in a semi-manual operation with some components being automated, and others requiring manual intervention.

3. Control System

3.1. Overview of the Control System

There are several devices that can run/stop each piece of equipment. The description is provided below in Table 3.

Table 3: Control Device

Device	Description	Note
Field HOA Switch	MCC HOR (Hand / Off / Auto) is the switch which is installed on the front door of the MCC. If MCC HOR is in "A (Auto)" position, then the equipment will be controlled by PLC.	
Field OCR Switch	Field OCR (Open / Close / Remote) is the switch which is installed on or adjacent to valves. If Field OCR is in "R (Remote)" position, then the equipment will be controlled by PLC.	
OIT HOA / OCR Switch	OIT HOA / OCA (Hand / Off / Auto or Open / Close / Auto) is the software switch (button) shown on OIT to control each piece of equipment. The OIT HOA / OCA becomes effective only when MCC HOR or Field OCR is in "R (Remote)" position. If OIT HOA / OCA is in "A (Auto)" position, then the equipment/actuator will be controlled by the PLC program automatically.	OIT HOA / OCA is provided for all motors and actuators.

3.2. Control Method through OIT

3.2.1. Local Operation and Remote Operation

If both the Field HOA / OCR and MBR PLC HOA / OCA are in "R and A" position, then the equipment/actuator will be fully controlled by the MBR PLC. This is called "Remote Operation". If the device MCC HOR switch is in the "H" position, the equipment will be controlled locally in the field. The device field HOA switch must be in the "A" position for the equipment to be controlled manually through the OIT.

The following sections describe the control of equipment under Remote Operation (through PLC).

3.2.2. Manual Operation and Auto Operation

Each device can be manually operated (Manual Operation) or automatically operated (Auto Operation) through the OIT.

Each device can be run/stopped (or opened/closed if it is an actuated valve) by pressing the corresponding button on the OIT. This is called "Manual Operation". If the equipment is controlled via a VFD, the percentage of the VFD speed can be also entered through the OIT. If the equipment is an actuated valve with modulation, the percentage of the opening can be also manually set. Details of the interlock conditions are shown in the following sections describing each system. When the equipment is under Manual Operation via OIT, the equipment is free from any software interlocks (i.e. low level alarm, alarm nap, high temperature alarm and etc.).

If the equipment is under Auto Operation, then that equipment will be automatically run/stopped (or opened/closed if it is an actuated valve) following the program stored in the PLC. Details are shown in the following sections.

3.2.3. Control Modes

Control Modes allow equipment to be operated according to a predetermined sequence. The operator can select alternate Control Modes that are available on the OIT. Software interlocks will prevent modes that are not allowed to be enabled / disabled.

Once a Control Mode is selected, the PLC will run the equipment according to pre-programmed sequences in the PLC. Depending on the system requirements, the PLC will automatically enable / disable equipment, device speed, valve positions etc.

The MBR process may be operated in the following modes:

OFFLINE – The MBR will be **OFFLINE** when selected by the operator. During **OFFLINE** mode, no equipment will operate, and all valves will be in the closed position. De-selecting **FILTRATION** will return the MBR to **OFFLINE. RODUCTION** – The MBR will produce permeate when **PRODUCTION** mode is selected by the operator.

NAP – The MBR will change modes to **NAP** when the **FILTRATION** button is selected by the operator. From the NAP mode, the PLC will change the mode to **RELAX** if the process is ready to be operated (i.e. appropriate level

or interlock conditions), or **NAP ALARM** if there is a critical alarm present. During **NAP** mode, screening, aeration and feed forward operations are enabled.

RELAX – The MBR will be advanced to **RELAX** from **NAP**, or **NAP ALARM** when the conditions noted above are satisfied. Additionally, **RELAX** will be used periodically when the MBR is in **FILTRATION** mode to allow debris to be separated from the membrane surface. During **RELAX** mode, screening, aeration and feed forward operations are enabled, however filtration activities are disabled.

FILTRATION – The MBR will be advanced to **FILTRATION** from **RELAX** when the conditions above are satisfied. Typically, the MBR will cycle through the **RELAX-FILTRATION** cycle repeatedly while level and permissive conditions permit it to do so. During **FILTRATION** mode, all the process equipment is enabled, and filtration activities are enabled.

DIFFUSER BLOWDOWN – The MBR will be advanced to **DIFFUSER BLOWDOWN** periodically (scheduled by the operator, typically daily). **DIFFUSER BLOWDOWN** is used to clear debris from the diffusers by allowing liquid to enter the diffuser housing and aid in softening the obstructions. Once completed, the mode will be changed to **NAP**.

3.2.4. Duty and Standby Selection

When there is a factory installed alternate or backup piece of equipment, it is possible to select which device will be Duty (lead), and which will be Standby (lag). In these cases, Duty/Standby selector switches can be found in the OIT. Details are shown in the following sections describing each system.

3.2.5. Alternation

If equipment/systems are configured so that alternation can be allowed, the operator can select the desired alternation method on the OIT.

3.2.6. PID Loop Control

Some equipment will be controlled via PID feedback control to maintain a certain process parameter, such as flow rate. The operator can provide the desired setpoint to each PID loop on the OIT. The operator can also fine tune the PID control parameters if necessary. Details are shown in the following sections describing each system.

4. Control Strategy of MBR Equipment

4.1. Overview

The MBR process consists of several systems, and each component system is controlled independently. The components are shown below. The system provided by Kubota and directory controlled by Kubota is marked as "provided and controlled by Kubota". Whereas the system provided by others and directory controlled by others is marked as "provided and controlled by others". Kubota MBR PLC communicates the plant PLC via Ethernet communication so that Membrane systems provided and controlled by others will be operated properly.

- Membrane Systems – Mode Control and Tank Monitoring (provided and controlled by Kubota)
- Membrane Systems – Permeate (provided and controlled by Kubota)
- Membrane Systems – Air Scour (provided and controlled by Kubota)
- Membrane Systems – Clean in Place (provided and controlled by Kubota)
- Membrane Systems – RAS (provided and controlled by others)
- Membrane Systems – WAS (provided and controlled by others)
- UV systems (provided and controlled by others)

4.2. Membrane Systems – Mode Control and Tank Monitoring

The level transmitter in the RAS pump station will be used to control permeate flow rate of Membrane Systems – Permeate. Also, MBR PLC monitors incoming flowrate and the level in the RAS pump station to adjust the number of MBR tanks that Filter or Nap.

MBR PLC monitors the status of the UV system and use it as permissive signal to hold the permeate flow. ~~During the on-hold time due to the UV system, the EQ pumps shall not run so that the level in the RAS pump station will be stabilized.~~

4.3. Membrane Systems – Permeate

There are two membrane bioreactor basins with SMUs, and three permeate pumps. There is one dedicated permeate header per membrane tank, and the standby pump may be enabled as the alternate for either train with manual switch. Each permeate header is an independent subsystem comprised of a pump, one suction pressure transmitter to observe Trans-membrane Pressure, flow indicating transmitters. Additionally, there is one turbidity sensor downstream of the permeate pumps

The permeate pumps are sized to handle roughly 1/2 of the peak design flow of the overall plant. As the level in the upstream tanks rises, the membrane trains will be enabled, and the flow rates will be set based on 3 operator selectable level thresholds. Once in **FILTRATION** mode each permeate header is controlled independently to meet permeate production requirements.

- The Permeate Pump shall run when:

    - The respective MBR Tank is in **FILTRATION** Mode
- The Permeate Pump shall stop when:
    - Any of the above "run condition" is not met
    - Any Fault Alarm
    - Any MBR Low Level Alarm (Switch or Transmitter)
    - Any MBR High Pressure Alarm
    - Any High Flow Alarm
- The Permeate Pump speed shall be set by:
    - Flow Setpoint (L, M, H) – PID loop
    - Manual Setpoint

4.4. Membrane Systems – Air Scour

The MBR Tanks blowers supply oxygen to the membrane tank mixed liquor. The scour air produces turbulence which scours the membrane surface, transferring rejected solids from the membrane surface. Each blower is piped to an independent discharge header, which is configured so that each MBR Tanks has a dedicated blower, however there is a crossover connection available which can be used in the event that a blower has failed. Discharge flow transmitters monitor the discharge conditions. When the train is not in **FILTRATION** mode, intermittent Air Scour can be selected via the OIT, including period and duration settings.

- The Membrane Air Scour Blower shall run when:
    - The respective MBR Tank is in **PRODUCTION** Mode
- The Membrane Air Scour Blower shall stop when:
    - Any of the above "run condition" is not met
    - Blower VFD Failure
    - Intermittent Air Scour is enabled
    - Membrane Basin Level Alarm
    - Blower Flow Alarm
    - Blower Pressure Alarm
- The Membrane Air Scour Blower speed shall be set by:
    - Operator Flow Setpoint in Auto
    - Manual Setpoint

4.5. Membrane Systems – RAS

The RAS pumps are provided and controlled by others. However, RAS pumps are important to achieve the target nitrogen removal and to avoid overthickening the MBR tanks. Therefor MBR PLC will communicate with the plant PLC for the items below.

- The WWTP PLC will control the RAS flow rate based on the time averaged influent flow rate and the selected multiplier value.

- ~~MBR PLC wants to give the target RAS flow rate to the plant PLC. The plant PLC needs to control the RAS pumps accordingly.~~
- ~~When MBR PLC detect the target RAS flow rate is not achieved with a certain delay timer, MBR PLC generate RAS flow deviation alarm and send it to the plant PLC. MBR PLC may stop filtration in order to avoid overthickening the MBR tanks if needed.~~
- ~~MBR PLC wants to give permissible signal to the RAS pump system~~
- ~~MBR PLC wants to know the status of hardware HOR switches for the RAS pumps at MCC and software HOA for the RAS pumps at the plant SCADA.~~

4.6. Membrane Systems – Clean in Place

When Clean in Place (CIP) operations is performed, the CIP water on/off valve opens to provide clean water to the CIP station with Mazzei injector. The plant NPW pumps maintain the clean water supply line pressurized so that clean water is fed as soon as the valve opens. The clean water generates suction pressure at Mazzei and the shelf chemical is sucked to the Mazzei to mix the water and the shelf chemical. The positions of the manual valves at the chemical suction stream is set at commissioning for Sodium Hypochlorite and Citric acid respectively. The CIP water on/off valve closes when MBR PLC confirmed that the target injection amount is achieved.

See O&M for more information on the CIP process(To be provided).

5. Alarms

5.1. Overview of Alarms

5.1.1. Purpose of the Alarm

An Alarm is generated automatically by the PLC to warn the operator that the system is not in a normal condition. Once the operator notices the alarm, the alarm condition should be investigated and resolved promptly to maintain good operation.

5.1.2. Alarm Indication

When PLC detects an alarm condition, the alarm will be shown on the bottom area of the OIT screen.

The alarms which are newly generated and have not been acknowledged yet are shown in red. The alarms which have been already acknowledged by the operator are shown in black. To acknowledge the alarm, an "Acknowledge" button nearby the alarm window should be selected. After selecting the acknowledge button, the color of the alarm messages is changed to black. Please note that selecting the acknowledge button itself does not resolve any alarm. The alarm will be only cleared when the condition which causes that alarm is resolved.

If an important alarm is generated, it will be also called via Win 911 on PCS which may be provided by others.

5.1.3. Alarm Function

Some alarms are only for information and may not be able to stop any equipment. Other alarms may stop related equipment or systems, which will protect them from damage. It should be noted that such an alarm which stops the related equipment/system can stop the treatment process.

5.1.4. Alarm Reset

Some alarms are automatically reset (removed) if the alarm condition is resolved. For example, a high-level switch alarm will automatically disappear when the water level returns to the normal range. Others are not automatically reset (removed) until the operator takes action to reset the alarm. For example, control failure alarm of any equipment needs to be cleared by clicking yellow "failure" status indicator shown nearby the equipment icon on the OIT screen. Some equipment failure requires pushing the hardware reset button on the Local Control Panel to reset the alarm.

5.2. Alarm List

Preliminary list will be provided before commissioning and the as-built list will be provided after the commissioning.

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http://www.kubota-membrane.com/

GN-04

TITLE 22

State of California—Health and Human Services Agency
Department of Health Services

California Department of Health Services
DIANA M. BONTÁ, R.N., Dr. P.H.
Director

GRAY DAVIS
Governor

March18, 2003

Mr. Hiroyuki Takatori
Kubota Corporation
Tokyo Head Office
1-3, Nihombashi-Muromachi 3-chome
Chuo-Ku, Tokyo 103-8310
Japan

Subject: Use of the Kubota Membrane Bioreactor (MBR) to comply with California Water Recycling Criteria

Dear Mr. Takatori:

By transmittal memo dated February 26, 2003, Montgomery Watson Harza, Consulting Engineers, requested Departmental approval of the Kubota Membrane Bioreactor (MBR) filtration treatment unit as an acceptable filtration technology for compliance with the State of California Water Recycling Criteria (Title 22). Accompanying this request was a report prepared by Montgomery Watson Harza entitled "Assessing the Ability of the Kubota Membrane Bioreactor to Meet Existing Water Reuse Criteria, dated February 2003. The report was prepared under a grant from the U.S. Bureau of Reclamation and outlines findings from a study conducted in the City of San Diego, California. The Department has reviewed this report and offers the following comments.

The Kubota MBR filtration system evaluated utilizes the Type 510 chlorinated polyethylene flat sheet membrane with a nominal pore

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1180 Eugenia Place, Suite 200, Carpinteria, California 93013
(805) 566-9767; (805) 745-8196 fax
Internet Address: www.dhs.ca.gov/ps/ddwem/

size of 0.4 micron. The membranes are submerged and operated under vacuum pressure with a maximum test flux of 20 gallons per square foot per day (gfd).

The California Water Recycling Criteria recognize membrane filtration as an acceptable filtration technology provided prescribed performance requirements (i.e. turbidity) are reliably met. The turbidity performance criteria require that the filtered wastewater not exceed any of the following:

1. 0.2 NTU more than 5 percent of the time within a 24-hour period; and

2. 0.5 NTU at any time.

The demonstration studies conducted using the Kubota MBR have sufficiently demonstrated the ability to produce an oxidized wastewater and the membranes ability to comply with the above stated turbidity performance requirements. In addition, virus seeding experiments demonstrated the processes ability to achieve a 1-log virus reduction at the 50^{th} percentile. Therefore, the Department of Health Services accepts the use of this membrane, identified as the Type 510 chlorinated polyethylene flat sheet membrane with a nominal pore size of 0.4 micron, as a filtration technology for use in compliance with the Water Recycling Criteria. Based on the performance data, the membrane filtration units will be limited to a maximum loading rate of 20 gfd and a maximum operating vacuum pressure of -3.0 psi.

The acceptance of your technology is specific to the Kubota Type 510 chlorinated polyethylene flat sheet membrane with a nominal pore size of 0.4 micron. Any proposed changes made in the physical attributes or character of this membrane shall be reviewed in advance by the Department to determine whether the modifications will require additional testing.

The Department will continue to review all proposed projects on a case-by-case basis to determine full compliance with all applicable treatment and reliability features required by the Water Recycling Criteria. This will include the collective

review of all treatment unit processes, operational controls (e.g. loading rates, TMP, frequency of integrity tests), 'O&M' procedures, etc.

If you have any questions concerning this letter, please contact the undersigned at (805) 566-9767.

Sincerely,

Original Signed

Jeffrey L. Stone, Chief
Recycled Water Unit
Division of Drinking Water

cc: Enviroquip - Jim Porteous
Montgomery Watson - Samer Adham
City of San Diego - Steve Lagos
Recycled Water Committee

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State of California—Health and Human Services Agency
Department of Health Services

California Department of Health Services
SANDRA SHEWRY
Director

ARNOLD SCHWARZENEGGER
Governor

April 29, 2004

Mr. Hiroyuki Takatori
Kubota Corporation
Tokyo Head Office
1-3, Nihombashi-Muromachi 3-chome
Chuo-Ku Tokyo 103-8310

SUBJECT: CONDITIONAL ACCEPTANCE OF INCREASED FLUX FOR THE KUBOTA TYPE 510 MEMBRANE

Dear Mr. Takatori:

The Department of Health Services has reviewed the report *addendum* entitled "Assessing the Ability of the Kubota Membrane Bioreactor to Meet Existing Water Reuse Criteria" dated April 2004, prepared by Montgomery-Watson-Harza concerning increased flux rate for the Kubota Type 510 membrane filter. This filter was previously granted acceptance by the Department in a letter dated March 18, 2003 (copy attached).

The March 18, 2003 acceptance letter for the Type 510 chlorinated polyethylene flat sheet membrane limited the flux rate at 20 gfd and a TMP of -3.0 psi based on performance studies previously conducted. Based on recent pilot studies outlined in the April 2004 report addendum, the membrane performs satisfactorily at an increased flux rate up to 42 gfd and a TMP of -5.0 psi. The Department therefore accepts the use of this membrane as a technology to meet the filtration requirements of the California Water Recycling Criteria at an increased flux of 42 gfd and a TMP of -5.0 psi in an MBR type of module.

All other conditions of acceptance outlined in the March 18, 2003 letter remain unchanged. Any proposed changes made in the physical attributes or character of this membrane shall be reviewed in advance by the Department to determine whether the modifications will require additional testing.

Southern California Drinking Water Field Operations Branch
1180 Eugenia Place, Suite 200, Carpinteria, CA 93013-2000
(805) 566-1326; (805) 745-8196 fax
Internet Address: http://www.dhs.ca.gov/ps/ddwem/default.htm

The Department will continue to review all proposed projects on a case-by-case basis to determine full compliance with all applicable treatment and reliability features required by the Water Recycling Criteria. This will include the collective review of all treatment unit processes, operational controls (e.g. loading rates, TMP, frequency of integrity tests), 'O&M' procedures, etc.

If you have any questions concerning this letter, please contact the undersigned at (805) 566-9767.

Sincerely,

Jeffrey L. Stone, Chief
Recycled Water Unit
Division of Drinking Water
and Environmental Management

cc: Montgomery Watson Harza- Samer Adham
Recycled Water Committee

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State of California—Health and Human Services Agency
Department of Health Services

dhs

California
Department of
Health Services
DIANA M. BONTÁ R.N. Dr. P.H.
Director

GRAY DAVIS
Governor

March18, 2003

Mr. Hiroyuki Takatori
Kubota Corporation
Tokyo Head Office
1-3, Nihombashi-Muromachi 3-chome
Chuo-Ku, Tokyo 103-8310
Japan

Subject: Use of the Kubota Membrane Bioreactor (MBR) to comply with California Water Recycling Criteria

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size of 0.4 micron. The membranes are submerged and operated under vacuum pressure with a maximum test flux of 20 gallons per square foot per day (gfd).

The California Water Recycling Criteria recognize membrane filtration as an acceptable filtration technology provided prescribed performance requirements (i.e. turbidity) are reliably met. The turbidity performance criteria require that the filtered wastewater not exceed any of the following:

1. 0.2 NTU more than 5 percent of the time within a 24-hour period; and

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The acceptance of your technology is specific to the Kubota Type 510 chlorinated polyethylene flat sheet membrane with a nominal pore size of 0.4 micron. Any proposed changes made in the physical attributes or character of this membrane shall be reviewed in advance by the Department to determine whether the modifications will require additional testing.

The Department will continue to review all proposed projects on a case-by-case basis to determine full compliance with all applicable treatment and reliability features required by the Water Recycling Criteria. This will include the collective

review of all treatment unit processes, operational controls (e.g. loading rates, TMP, frequency of integrity tests), 'O&M' procedures, etc.

If you have any questions concerning this letter, please contact the undersigned at (805) 566-9767.

Sincerely,

Original Signed

Jeffrey L. Stone, Chief
Recycled Water Unit
Division of Drinking Water

cc: Enviroquip - Jim Porteous
Montgomery Watson - Samer Adham
City of San Diego - Steve Lagos
Recycled Water Committee

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Kubota

Iwakura, Kazuo <kazuo.iwakura@kubota.com>

Fwd: Kubota 510 membrane cartridge

1 message

Gordon Williams <gordonw@trusselltech.com> Thu, Nov 6, 2014 at 3:40 PM
To: Kazuo Iwakura <kazuo.iwakura@kubota.com>
Cc: Shane Trussell <shanet@trusselltech.com>

Issey-

Based on our discussions, I transmitted Koichi Nakagawa's August 12, 2014 Letter with the subject "Title-22 acceptance of the updated version of the KUBOTA Type 510 membrane cartridge," to the California Division of Drinking Water (DDW), and had multiple conversations with Randy about the changes to the Type 510 Membrane cartridge. The Title-22 conditional acceptance testing for membranes was intended to verify the performance of the membrane material, and changes to the module architecture and welding process do not affect the conditional acceptance. Please see the e-mail below from Randy Barnard, who is the technical lead for the Recycled Water program at DDW. In Randy's e-mail, he is confirming our understanding, which is that the change in weld procedure does not impact the Title-22 conditional acceptance for the Type 510 membrane, and your previous conditional acceptance remains the same as there is no change to the membrane material.

Please let me know if you have any questions.

Regards,
Gordon

Gordon Williams, Ph.D., P.E.
gordonw@trusselltech.com
Trussell Technologies Inc.
1939 Harrison Street, Suite 600
Oakland, CA 94612
T: 858.458.1030 ext 113

Begin forwarded message:

From: "Barnard, Randy@Waterboards" <Randy.Barnard@waterboards.ca.gov>
To: "Gordon Williams (gordonw@trusselltech.com)" <gordonw@trusselltech.com>
Cc: "Barnard, Randy@Waterboards" <Randy.Barnard@waterboards.ca.gov>
Subject: Kubota 510 membrane cartridge
Date: November 5, 2014 at 1:50:14 PM PST

Gordon,

The proposed change to the Kubota Type 510 membrane cartridge from an ultrasonic weld to a heat weld will not affect the previous Title 22 conditional acceptance letter issued by the Division of Drinking Water (formally California Department of Public Health).

Please let me know if you have any questions.
Randy

Randy Barnard, P.E.
Senior Sanitary Engineer
Recycled Water Treatment Specialist

Recycled Water Unit
Division of Drinking Water
State Water Resources Control Board
1350 Front St., Rm. 2050
San Diego, CA 92101

Phone: (619) 525-4022
Email: Randy.Barnard@waterboards.ca.gov
http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/RecycledWater.shtml

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For Earth, For Life
Kubota

Dr. Gordon Williams
Supervising Engineer,
Trussell Technologies, Inc.
1939 Harrison Street, Suite 600
Oakland, CA 94612, USA

August 12, 2014

Subject: Title-22 acceptance of the updated version of the KUBOTA Type 510 membrane cartridge

Dear Dr. Gordon Williams,

KUBOTA is getting ready to release an updated version of Type 510 membrane cartridge. The main difference between the new version and existing one is the type of welding method used to bind the membrane to the rigid support structure. With the original Type 510 cartridge, an ultrasonic method was used to weld the membrane to the support, but a heat weld (*i.e.*, thermal weld) method is used for the new version of the Type 510 cartridge.

There is NO change to the membrane material itself for the newer Type 510 cartridge. The membrane sheet used for the new version will be same as what is used for existing version. Therefore, the membrane properties including the pore size distribution unchanged from the product that was originally demonstrated for the California Title-22 Testing. The table below shows the summary of major specifications of both new and existing versions.

KUBOTA Type 510 membrane cartridge specifications

Membrane Cartridge		Existing version of Type 510	New version of Type 510
Effective Membrane Area		0.8 m^2	0.8 m^2
Welding method		Ultrasonic wave weld	**Heat (thermal) weld**
Membrane Sheet			
	Shape	Flat Sheet	Flat Sheet
	Material	Chlorinated Polyethylene	Chlorinated Polyethylene
	Nominal Pore Size	0.4 μm	0.4 μm
Supporting Plate			
	Shape	Flat Plate	Flat Plate
	Material	Acrylonitrile Butadiene Styrene	Acrylonitrile Butadiene Styrene

Under this new version of the Type 510 cartridge, there are two (2) sub models. The difference between these two (2) sub models of the Type 510 cartridges is the mass of the cartridge. The difference in cartridge mass is a result of the different patterns of grooves on the surface of the internal supporting plate and has no impact on the membrane material performance. Both sub models will be manufactured using same membrane sheet and same heat welding method.

We anticipate releasing this new version of Type 510 membrane cartridge to the market starting in early September 2014. Before releasing this new product, we would like to receive written confirmation from California Division of Drinking Water (formerly the California Department of Public Health) that this updated version of the Type 510 cartridge (including both sub models) will fit within our existing Title-22 acceptance of the Type 510 cartridge. We understand the Type 510 is currently included in the October 2013 "Historic Conditional Acceptance for Membrane Filters" in the California Department of Public Health report titled *Alternative Treatment Technology Report for Recycled Water*, and that startup verification is still needed to demonstrate compliance with the *Title-22 California Water Recycling Criteria* for all recycled water filter installations in California.

We highly appreciate your cooperation in communication with the California Division of Drinking Water on this matter.

Sincerely yours,

中河浩一

Koichi NAKAGAWA,
General Manager
Engineering Dept., Water Engineering & Solution Business Unit
KUBOTA Corporation

GN-05

SPECIFICATION 11500 EXCEPTIONS

SECTION 11500

MEMBRANE EQUIPMENT

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section shall consist of the Supplier providing membrane equipment as described herein. The membrane equipment will be installed by others (the General Contractor) in covered concrete membrane basins and on a concrete pad, in an equipment building provided by others. The complete scope of supply for the Supplier is provided in Section 01110.

1.2 RELATED WORK SPECIFIED ELSEWHERE

Section	Item
01110	Summary of Work
01300	Submittals
01800	Testing, Commissioning, and Training
11000	Equipment General Provisions
Division 11	Equipment
Division 13	Special Construction
Division 15	Mechanical
Division 16	Electrical

1.3 PERFORMANCE REQUIREMENTS

A. DESIGN PRODUCTION CAPACITY:

1. Required design production capacities excluding facility drain recycle flow for the WWTF:

   a. 24,200 gpd at annual average flow rate (AAF).

   b. 37,700 gpd at maximum monthly flow rate (MMF).

   c. 61,900 gpd at maximum day flow rate (MDF).

   d. 111,700 gpd at peak hour flow rate (PHF).

   e. Flow at rates in excess of 111,700 gpd (peak hour equalized flow) will be equalized prior to the membrane system.

2. The influent wastewater flow pattern to the WWTF follows typical domestic diurnal flow patterns, with limited infiltration and inflow. The wastewater will enter the facilities via force mains on an intermittent basis from new and existing sewage pump stations. Influent flow will be constantly measured by a magnetic flow meter and all influent flow will be screened in an upstream headworks via 2-mm fine screens.

3. Screened influent wastewater flows will be equalized in a separate Equalization Basin provided by Others located upstream of the Membrane Equipment System. The maximum permeate flow required will not be required to exceed the peak equalized flow rate on a daily basis, except due to normal flow control variations. The Supplier is advised to consider the flow pattern and to recognize that diurnal varying flows will be equalized.

4. Provide sufficient membrane equipment for the WWTF to treat the maximum day flow rate for 24 hours and the peak hour equalized flow rate for a maximum of 3 hours **with all membrane basins in service**. **Provide sufficient membrane equipment for the WWTF to continuously treat the maximum month flow rate with one membrane basin out of service for 31 consecutive days.** If the submerged membrane units (SMU's) have integral air diffusers, clean-in place, and permeate systems, and are capable of being operated, isolated, and removed from a membrane basin individually, while continuing to operate all other SMUs in that basin, then the system shall be provided with **sufficient membrane equipment for the WWTF to continuously treat the maximum month flow rate with one SMU out of service for 31 consecutive days. The flux rates listed in the table below shall not be exceeded for all of the conditions listed above.** Provide sufficient permeate pumps and air scour blowers to treat the maximum day flow rate for 24 hours with one pump or blower out of service.

   The design net flux rates shall be based on Membrane System Supplier membrane type as follows:

Parameter	Membrane System A Maximum Flux at 10° C (Microfiltration)	Membrane System B Maximum Flux at 10° C (Ultrafiltation)
Net Flux Rate at Maximum Month Flow	12.0 gfd	8 gfd
Net Flux Rate Peak Day Flow	24 gfd	16 gfd

5. Provide membrane equipment to equip two membrane basins, including membrane cassettes, cassette frames, permeate pumps, air scour blowers, controls, piping, valves, etc. The total quantity of SMUs and associated membrane equipment provided shall be the Supplier's options, within the requirements of the Specifications of the Contract.

6. Design production capacities shall be met while also meeting all other requirements specified herein including cleaning frequency and membrane permeate quality.

B. MEMBRANE PERMEATE QUALITY:

1. Membrane permeate shall be capable of meeting the following requirements upon continuous sampling:

a. Turbidity

Must not exceed a monthly average of 0.2 NTU and shall never exceed 0.5 NTU.

C. MEMBRANE CLEANING:

1. Membrane modules shall be cleaned in place using chemical solutions, to meet production capacity and other performance requirements specified within this document.

2. Maintenance Cleans shall not be performed more frequently than every 90 days.

SK1
Recovery Cleans are not required for Kubota membranes

3. Recovery Cleans shall not be performed more frequently than every 90 days.

4. Supplier shall supply data to demonstrate that the minimum specified Maintenance Clean and Recovery Clean intervals can be achieved. Alternative cleaning frequencies will be considered provided Supplier can demonstrate the advantages of such alternative.

5. The following chemicals will be provided by the Owner for the chemical cleaning operation:

a. Sodium hypochlorite as 12.5 percent liquid solution by weight concentration.

b. Citric acid or oxalic acid as 50 percent liquid solution by weight concentration.

1.4 SUBMITTALS

Manufacturer certification of Build America, Buy America Act (BABAA) compliance for membranes and all ancillary components which meet these requirements.

1.5 EXPERIENCE REQUIREMENTS

The Supplier must have a minimum of four successful full-scale Publicly Owned Treatment Works with the proposed membrane units installations, with a maximum month design capacity greater than 100,000 gpd, not pilot or demonstration plants, each operating for at least 3 years, for which the Supplier has provided similar scope as this Contract, to include membranes, permeate pumps, air scour blowers, automatic valves, chemical feed systems, instrumentation, control panels, and control panel programming. The Supplier shall submit a reference list for full scale operating wastewater treatment plants, which shall include the names and telephone numbers of contacts.

1.6 GUARANTEE AND WARRANTY

A. Supplier shall, in the information submitted with the Proposal, provide documentation of warranty with a minimum 2-year duration. The warranty shall not be prorated. All warrantee and support shall be provided directly by the Supplier and not the local representative.

Supplier shall warrant membrane modules under the following terms:

1. Supplier shall repair or replace, at no cost to the Owner, one or more membrane modules if membrane modules fail before 2 years (24 months) from the date of successful completion of the Initial Performance Test. Failure is defined as any of the following:

   a. Inability to meet production capacity requirements under conditions specified in Service Conditions.

   b. Inability to meet the Performance Requirements after a cleaning as specified.

   c. Inability to meet membrane permeate quality requirements specified in Performance Requirements.

2. Operation outside of the target MLSS concentration range up to 20,000 mg/L shall not reduce or void the warranty.

3. Supplier shall warranty the performance of the membrane system to meet the requirements of the permeate quality, as listed in 11500-1.3, when the MLSS concentration of the system is between 2,500 mg/L and 18,000 mg/L.

4. Any instance where PLC communication is lost, or where one or more parameters is non-conforming per Contract Documents, for a period of 6 hours or less in each calendar month, shall not reduce or void the membrane performance warranty.

5. Any instance where PLC communication is lost for a period of more than 6 hours in each calendar month shall not reduce or void the membrane performance warranty provided the Owner can supply missing information and demonstrate conformance to Contract Documents.

6. If Supplier is unable to modify the system through addition of membranes or other elements, and cannot satisfy requirements of Initial Performance Test, or system fails to meet specified performance criteria within 24 months following the date of successful completion of the Initial Performance Test, then Supplier shall be responsible for complete removal of nonconforming system and subsequent installation of membrane products that are capable of meeting specified performance conditions.

B. Supplier shall also, in the information submitted with the Proposal, provide documentation of an extended warranty prorated as follows:

Year after the date of successful completion of the Initial Performance Test	**Percent of Equipment and Installation Cost**
3	85%
4	70%
5	55%
6	40%
7	25%
8	10%

All warrantee and support shall be provided directly by the Supplier and not the local representative. Supplier shall provide an extended warranty on the membrane modules under the following terms:

1. Supplier shall pro-rata repair or replace, one or more membrane modules if membrane modules fail before 8 years from the date of successful completion of the Initial Performance Test. Failure is defined as any of the following:

    a. Inability to meet production capacity requirements under conditions specified in Service Conditions.

    b. Inability to meet the Performance Requirements after a cleaning as specified.

    c. Inability to meet membrane permeate quality requirements specified in Performance Requirements.

C. Supplier shall guarantee that for components manufactured by the Supplier, replacement parts shall continue to be available to the Owner for a minimum of 20 years from date of successful completion of Initial Performance Test. Supplier shall guarantee that, if Supplier or Supplier's product line is sold, Supplier shall make provisions such that all guarantees, warranties, and bonds will remain in effect and that replacement parts and operational support continue to be available to the Owner for the time period specified above.

D. Guaranteed Membrane Module Replacement Cost: The Supplier shall guarantee that membranes may be purchased by the Owner at the price bid in the Proposal or lower, any time during the 20 years following successful completion of the Initial Performance Test.

1.7 DEFINITIONS

A. PRODUCTION CAPACITY

Equals the net production rate of treated effluent (permeate), in gallons per day (gpd), over a 24-hour period of continuous operation.

B. DESIGN FLOW

Design flow is equivalent to "production capacity." Refer to "production capacity" for definition.

C. NET FLUX RATE

Equals the total amount of permeate, in gallons per day, produced by the membrane system over a 24-hour period that is available for downstream discharge divided by the total membrane outside surface area in square feet. Units of "Flux Rate" are gallons per square foot per day (gfd).

D. INSTANTANEOUS FLUX RATE

Equals the permeate flow rate, in gallons per day, produced during the service cycle divided by the total membrane outside surface areas. Service cycle is defined as the period of continuous permeate production between the membrane relaxation, backwash, or backpulse. Units of "Flux Rate" are gallons per square foot per day (gfd).

E. PEAK FLUX

The maximum membrane flux rate that the system is permitted to operate at during a period when a portion of the membrane system is offline for maintenance or recovery cleaning operations. Units of Peak Flux are gallons per square foot per day (gfd).

F. TRANSMEMBRANE PRESSURE (TMP)

The pressure differential across the membrane. TMP should be adjusted for losses from membrane discharge to pressure gauge. Units of TMP are pounds per square inch (psi).

G. MICROFILTRATION

Membrane filtration pore size greater than 0.1 microns

H. ULTRAFILTRAION

Membrane filtration average pore size greater than 0.01 microns and less than or equal to 0.1 microns.

I. PERMEABILITY

Equals the instantaneous flux rate divided by the transmembrane pressure. The units of permeability are gfd/psi.

J. TEMPERATURE CORRECTED PERMEABILITY

Equals permeability multiplied by Supplier's Temperature Correction Factor (TCF) expressed in the following form:

$P_{20} = P_t \times TCF^{(20-t)}$

Where:
P_{20} = permeability at 20 degrees C (Celsius)
P_t = permeability at measured temperature t
t = temperature (degrees C)

K. BACKWASH OR BACKPULSE CLEAN

Any routine instance a membrane basin is taken offline for application of air, water, and/or chemical solution for the purpose of maintaining permeate production rate of membrane.

L. RELAXATION

Any routine instance a membrane basin is taken offline by temporarily stopping the permeate pump to maintain net flux rate of membrane system.

M. MAINTENANCE CLEAN

Any routine instance a membrane basin is taken offline for application of a chemical solution that is not considered part of the normal backwash cycle. Its purpose is to maintain design production capacity by reducing TMP and increasing permeability by oxidizing or solubilizing biological and non-biological matter within the membrane surface and in the membrane pores.

N. RECOVERY CLEAN

Any non-routine procedure, manual, automated or semi-automated, that uses one or more cleaning chemicals to reverse the effects of membrane fouling by reducing TMP and increasing permeability. This may involve removing a membrane tank from service and draining the tank, if required. The tank is then filled with cleaning solution. The membranes are soaked for a period of time then the chemical solution is drained from the tank. Its purpose is to remove all solids that have accumulated in membrane modules (including on membrane surface and within membrane pores) so that the design permeate production capacity and the temperature

corrected permeability directly following the cleaning are consistently restored to values required to meet Performance Requirements.

O. NSF refers to National Sanitation Foundation.

P. Days are defined as calendar days.

Q. MEMBRANE MODULE

Basic unit of membrane production system. The Module may be a single assemblage of fibers in a common potting (element) or a cartridge of flat plates bonded to a common support frame.

R. MEMBRANE CASSETTE

A submerged membrane unit, a group of membrane modules or multiple elements sharing common air and permeate connections. A cassette is the smallest assembled unit of a delivered system that is designed to be removed and replaced as a complete unit.

S. MEMBRANE BASIN

A membrane bank, or a grouping of membrane cassettes, located in a concrete tank, which share a common permeate header, pump, and air supply header, and that are removed from operation as an entity for backpulsing, relaxing, maintenance cleaning, or recovery cleaning.

SK2
Company name has been changed in March 2025.
The official company name is KUBOTA Water and Environment U.S.A. Corporation

PART 2 PRODUCTS

2.1 SUPPLIER

Membrane products Supplier shall be Kubota Membrane USA Corporation, Toray, or Mann + Hummel No other manufacturers shall be allowed.

2.2 MANUFACTURER

Membrane products supplied shall meet the Experience Requirements in Section 1.4 and the technical specifications. No manufacturers other than named in the technical specifications shall be accepted.

2.3 GENERAL

A. Membrane equipment shall be provided complete, with all necessary components, accessories, and appurtenances required to make a complete and operable system. Interconnecting piping between Membrane Basins

and interconnecting piping between ancillary systems, including air compressors, and air blowers will be provided by the General Contractor.

B. Membrane modules and equipment shall be prefabricated, pre-assembled, and tested before shipment to the site.

C. Supplier shall provide the equipment as described in these Specifications:

SK3
Kubota would like to take exception here. Can we replace it with "influent wastewater"? Kubota has used coated steel valves in MBR tanks in the past. Wastewater can be deemed as mixed liquor. If so, RAS pumps will have to be stainless steel...

1. Items shall be new and unused, and shall be Supplier's most current product line at the time of product submittal.

2. Furnished as a complete and operable system including all required valves and in-basin piping.

D. All metal in contact with wastewater or chemicals shall be stainless steel. Any carbon steel components provided shall be painted as follows and shall only be for uses that do not come into contact with wastewater or chemicals.

SK4
Kubota would like to take exception here. Can we add "manufacture recommendation for surface preparation and Shop Primer System is also acceptable"

1. Surface Preparation

   Near-white blast cleaning, SSPC-SP-10.

2. Shop Primer System

Product:	Tnemec Omnithane Series 1 or equal
MDFT:	2.5 to 3.5 mils

E. Membrane equipment shall have been recognized by the California Department of Public Health as being acceptable for compliance with the treatment requirements of the State of California Recycled Water Criteria (Title 22).

F. Membrane equipment to be installed in Hazardous Locations, as described in Division 16, shall be of the type that is suitable and labeled for the environment. All equipment installed below the top of wall in the MBR basins and aeration basins (below the FRP covers) shall be suitable for Class I, Divisions 2 NFPA 820 classification, including all in-basin instrumentation and isolation valves.

2.4 SERVICE CONDITIONS

A. INFLUENT LOADING CONDITIONS

1. Design influent loading rates for the Taylor Bay Wastewater Treatment Facility are:

   a. 25 lbs/day at annual average BOD_5 loading rate.

   b. 38 lbs/day at annual average TSS loading rate.

   c. 7 lbs/day at annual average TKN loading rate.

   d. 72 lbs/day at maximum month BOD_5 loading rate.

   e. 74 lbs/day at maximum month TSS loading rate.

   f. 11 lbs/day at maximum month TKN loading rate.

B. Membrane Equipment System requirements specified herein shall be met when mixed liquor characteristics comply with the criteria listed below. Process design will be by the Owner's Engineer.

1. Wastewater Temperature

   Minimum of 10 degrees C; Maximum of 22 degrees C.

2. Average Membrane Basin Mixed Liquor Suspended Solids (MLSS) Concentration

   Between 8,000 mg/L and 15,000 mg/L. 10,000 mg/L at design conditions.

3. Biological Aerobic Solids Retention Time (SRT)

   Normally between 19 days and 25 days. Owner will design for 23 days at 10 degrees C and a diurnal peaking factor of 1.5, and may be adjusted downward during warmer temperatures while maintaining nitrification.

4. Wastewater to membrane bioreactor will be screened using a 2-mm fine screen provided by General Contractor as part of the overall facility design.

5. The recycle rate shall not exceed 400 percent of the 24-hour averaged influent flow rate (Maximum Day Flow rate).

6. Influent wastewater flows to the WWTF will be equalized in an Equalization Basin provided by Others located upstream of the Membrane Equipment System. The maximum permeate flow required will not exceed the peak equalized flow rate, except due to normal flow control variations. The Supplier is advised to consider the flow pattern and to recognize that diurnal varying flows will be equalized.

2.5 MEMBRANE TANKS

The membrane basins will be partially below grade concrete tanks with odor control covers, which will be designed and constructed by others.

2.6 MEMBRANE EQUIPMENT

A. MEMBRANES

1. Use polymeric flat plate membranes having a nominal pore size of 0.4 micron or less, intended for submerged operation in mixed liquor.

2. Flow shall pass from the outside to the inside of the sheet.

3. Membranes shall be constructed of chemically resistant materials suitable for exposure to the Supplier's proposed cleaning chemical solutions. At a minimum, the membrane materials shall be capable of being washed in high chlorine solutions (1,000 mg/L), low pH (range 2 to 3) wash solutions and high pH (range 9 to 10) wash solutions for 10 hours.

4. Membranes shall be physically strong enough to withstand the operating conditions associated with operation in an aerated tank of mixed liquor at concentrations up to 15,000 mg/L.

5. Membranes shall be able to withstand backwash/backpulse flow (from within lumen or the interior side of plate to outside), if proposed by Supplier, without any damage.

B. MEMBRANE CASSETTE

1. The membrane flat sheets or modules shall be assembled into a unit called a cassette.

SK5
Remove " UV resistant". The plastic parts of membrane cassettes are ABS and PVC and they are not completely UV resistant. Kubota recommends to avoid direct sunlight when storing membranes.

2. Each cassette shall be supported within a frame manufactured of Type 304 stainless steel.

3. All non-steel components of the membrane cassettes or modules shall be UV resistant and have a chemical resistance at least equal to that of the membranes.

4. The base of each cassette shall contain diffusers to allow compressed air to escape and travel upwards past and between the membrane fibers or plates creating an agitation effect.

5. Provide manual isolation valves for the permeate and agitation air for each connection to each membrane cassette to provide means of isolating individual cassettes from the remainder of the system, enabling the system to produce permeate with one or more cassettes out of service.

6. Each frame shall be fitted with two lifting eyes (one at each end) or equivalent lifting system to allow the entire membrane cassette/rack to be lifted into and out of the basin/mixed liquor and transported away from the membrane basin.

7. All fasteners, including nuts, bolts, screws, cables, washers, and other appurtenances associated with the membrane cassette and housing shall be manufactured from Type 304 stainless steel.

C. PERMEATE SYSTEM

1. Permeate Suction Piping

a. Each membrane basin shall have a suction header for permeate collection. The header will have a connection for a pressure gauge at each end.

b. All cassettes in a membrane basin shall be connected to the common suction header. The pipe connections between the membrane cassettes and the manifold header pipe work shall be UV-resistant flexible pipe capable of operating at the positive and negative pressures expected for this system.

2. Permeate (Membrane Effluent) Pumps

a. Provide a pumped permeate collection system including pumps, controls, isolation valves, check valves, flow meters, and pressure gauges as required by Supplier to meet performance requirements.

b. Pumps shall be rotary lobe in accordance with Section 11305.

c. Pump capacity shall meet the requirements in this Section. There shall be one suction header from each MBR basin to a single common permeate pump suction manifold at the pump location, with Supplier provided isolation valves and check valves, to the dedicated and redundant permeate pumps. There will be one common discharge header from the permeate pumps to the in-vessel UV system and to the downstream Non-Potable Water Tank (NPW Tank). The permeate will flow by gravity from the NPW tank overflow to the outfall. The Supplier shall provide manual isolation valves, check valves, automatic modulating valves, and magnetic flow meters, shipped loose, for installation on permeate pump discharge lines as required to control the flow from each pump. The water surface elevation in the MBR basins will be 6 to 8 feet below the permeate pump suction inlet center-line elevation. The permeate pump discharge line will discharge to a water surface elevation of 10 to 12 feet above the pump centerline elevation. The length of pump suction line will be 150 to 200 feet and the length of pump discharge piping will be 100 to 150 feet. The connection point from the membrane cassette permeate isolation valve to the Contractor provided permeate suction piping shall be above the normal water surface elevation of the membrane tanks, and the remainder of the permeate suction piping to the permeate pumps will be designed to be installed at a slightly positive slope, such that no high point will be present in the suction line from the membrane cassette to the permeate pump. A high point in the permeate discharge, downstream of the common connection point from each of the permeate pump discharge headers, will be designed to include a Contractor provided air release valve.

3. Permeate Pump Priming System, if required:

   a. Provide automatic permeate priming system, including pumps, check valves, and automatic valves, if required, to allow the permeate pumps to start and stop automatically, without the need for manual priming at any time.

   b. An air extraction system shall be included, if required, to remove air bubbles generated during the permeate extraction process, unless the Supplier does not require an air extraction system.

   c. The system shall consist of air release valves on the permeate pump suction lines, connected to liquid reservoirs and vacuum pumps, to protect the permeate pumps, or as required for the Supplier's permeate system.

   d. Liquid Reservoirs, if required:

      1. Supplier shall size the liquid reservoirs to provide adequate residence time to ensure satisfactory air removal from the permeate.

      2. Column shall be Type 316 stainless steel.

      3. Provide a minimum of two reservoirs for the membrane system.

      4. The air outlet of the air separation column shall be connected to a vacuum generating system.

      5. Each reservoir shall be equipped with a level sensor. Apart from normal operating control loops, the level sensor shall include a Level-Alarm-Low level. Should the liquid level in the vessel drop to this level, an alarm will be generated, and the system will proceed to shut down.

   e. Vacuum Pumps, if required:

      1. Pumps shall be positive displacement type.

      2. Quantity: A minimum of two duty, and one installed spare.

3. Rated Capacity: As required by the Supplier.

D. AIR COMPRESSOR SYSTEM

1. If compressed air is required to operate any equipment, pneumatic valves or instrumentation provided by the Supplier, the Supplier shall design and provide a complete compressed air system.

2. Provide a minimum of two air compressors (one duty, one installed spare), if required for the Supplier's equipment.

   a. Reciprocating or rotary screw air compressor, single-stage or two-stage, with dedicated dryer, inlet air filter/silencer, flexible connections, air check valves, automatic drip trap and other components for a complete system.

   b. Cylinders shall be cast iron construction with cooling fins.

   c. Valve assemblies shall be individually removable without disturbing head and inlet or discharge piping.

   d. Adjustable tapered roller bearings mounted on each end of crankshaft to take both radial and thrust loading.

   e. Use V-belt drive, full-discharge size flexible discharge connection, air check valve, and an adequate number of vibration isolators.

   f. Provide oil filter, combination air intake filter/silencer, and discharge cushion chamber.

3. Dryers: Provide a minimum of two (one duty, one installed spare) electric heat regenerative desiccant air dryers or refrigerant air dryers.

4. Provide coupling guards and other features to fully comply with OSHA requirements.

5. Provide vertical air receiver, if required, constructed to ASME Section VIII, Division 1, rated for 150 psig, minimum.

6. Provide ASME-rated pressure relief valve, pressure gauge with gauge cock, automatic condensate drain valve, and miscellaneous fittings as required.

2.7 CLEANING SYSTEMS

A. GENERAL

1. All chemicals required for cleaning shall be indicated by Supplier. Sodium hypochlorite and citric acid (or oxalic acid) will be provided by the Owner in the concentrations listed in Part 1.3 of this Section.

2. Chemical metering pumps, chemical storage tanks, and all valves, level control instrumentation and accessories for a complete system shall be provided by the Supplier.

B. AGITATION AIR SYSTEM

1. Provide agitation air scour blower system as required by Supplier to meet Performance Requirements, including blowers, valves, air diffusers, instruments and accessories for a complete system. Blowers shall be positive displacement type in accordance with Section 11370. Air piping and valves shall be in accordance with Division 15 of the specifications.

2. Air scour blower capacity shall meet the requirements of Section 11370. There shall be one common discharge header from the air scour blowers to the MBR basins. The Supplier shall provide manual isolation valves, check valves, pressure transmitters (as required for warranty), and air flow meters (as required for warranty), shipped loose, for installation on air scour discharge lines as required to control each blower. The common discharge header from the scour air blowers will be connected to the aeration blower, which will be supplied by others. The Supplier shall provide PLC and Operator Interface Unit (OIU) programming to allow the uninstalled spare air scour blower to be controlled by the WWTF PLC to also act as a backup to the aeration blowers.

3. Provide automatic valves and piping in each of the MBR tanks to allow automatic reversal of flow through any membrane coarse bubble air scour diffuser systems to allow mixed liquor to flow through the diffusers and discharge to the MBR tank, if required. The valve operator shall be provided with a 4-foot minimum extension to allow it to be installed above the tank cover.

4. Provide solenoid valves for installation on the permeate piping and air scour piping as required for relax or backpulse operation as required.

C. MAINTENANCE CLEAN SYSTEM

1. Provide actuated valves, check valves, chemical injection connections, mixing systems, flow meters, backpulse pumps, Mazzei injectors, pressure reducing valves, chemical cleaning solution line high pressure overflow/relief line (to protect membranes from over-pressurization), chemical metering or backwash pumps, controls, and other components to provide manual maintenance clean and recovery clean flow systems as required for the Supplier's system.

2. Backwash and/or backpulse pumps, if provided, shall be horizontal end suction centrifugal pumps in accordance with Section 11310. The backwash and/or backpulse pumps shall deliver the required maintenance clean backwash flow and recovery clean flow at maximum system headloss and maximum transmembrane pressure. Alternatively, rotary lobe pumps may be used for backwash service.

3. Dilution water will consist of non-potable water at 80 to 100 psi.

4. The Supplier shall supply all the valves and control elements required to perform Maintenance Clean or Recovery Clean cycles, including switching from normal operation to cleaning operation, and from cleaning operation to normal operation. Backpulse clean cycles must be automatically initiated and controlled. The recovery clean cycle may be manually initiated, but must be automatically controlled. Maintenance clean cycles will be manually initiated and controlled.

D. CHEMICAL FEED SYSTEMS

SK6
Remove. Permanent installed storage tank is not required. Drum tank as shipped will be placed at storage area.

One MBR tank requires 4.8gal and 7.6 gal of 12.5%NaClO and 50% Citric acid respectively for CIP. Typically, CIP frequency is 2-4 times per year.

1. For each chemical proposed by the Supplier to be used in the cleaning systems, the Supplier shall supply a complete and workable chemical storage and feed system.

2. Bulk Chemical Storage Tanks

The Supplier shall provide polyethylene tanks for the storage of cleaning chemicals that are rated for the storage of the respective chemical. The chemicals will be supplied by the Owner at the concentrations noted in Part 1.3 of this Section. The tanks shall be equipped with continuous level measurement instrumentation and alarms for low chemical level.

3. Chemical Make-down Systems

The Supplier shall provide equipment to make-down or dilute the bulk chemicals provided by the Owner for use in membrane cleaning. Potable or non-potable water connections to the make-down systems will be provided by others.

4. Chemical Feed Pumps

SK7
Kubota would like to exception here. Kubota can provide shelf spare for Mazzei.

The Supplier shall provide two chemical feed pumps or Mazzei injectors (one duty, one installed spare) and appurtenances for each chemical service to deliver cleaning chemical and dilution water to the membranes. In all cases chemical feed pumps or injectors and appurtenances shall be approved by the manufacturer for the proposed chemical service. Pumps, if provided, shall be peristaltic or diaphragm pumps. The Supplier shall provide all valves and instrumentation required for a complete and workable chemical feed system.

2.8 PIPING AND VALVES

A. Provide piping and valves per requirements of Division 15.

B. All piping, hoses, and pipe appurtenances, including air, permeate, or other required headers for the Membrane Equipment located within the Membrane Basin, shall be provided by the Supplier. Piping shall be in accordance with Section 15050. The Supplier shall design and provide the permeate and air piping systems to extend above the normal water surface elevation in the membrane basins, each to a separate, Supplier provided, isolation valve located above the common wall between the membrane basins and the deoxygenation basin. Flexible connections to the membrane units shall be provided as required to allow the membrane units to be removed from the basins without removing rigid piping.

C. Flanged wall pipes through the Membrane Basin walls will be provided and installed by the General Contractor. In-basin piping supplied by the Supplier shall be drilled to meet ANSI 125-pound flanged bolt circles at the terminal connection point at the basin wall.

D. Provide all check valves, control valves, and isolation valves required for a completely functional system including chemical feed systems and compressed air systems (shipped loose). Each permeate pump shall be provided with a suction isolation valve, discharge isolation valve, and discharge check valve. Supplier shall provide valves suitable for intended

service and relevant chemical exposure. All control valves shall be automatically actuated. Valves shall be in accordance with Section 15100.

E. Provide automatic modulating valves on discharge of each permeate pump to control the permeate flow as required.

F. Provide automatic valves on each air scour discharge header and each permeate pump suction header to allow automatic switchover to the standby redundant pump or blower upon failure of any of the duty pumps or blowers. Alternatively provide manual operated valves for this purpose and provide HMI programming which allows operators to easily select which MBR basin is associated with the standby pump or blower, based on the operator adjusted position of the manual valves provided. All valves related to operation of backpulse shall be automatically activated.

SK8
Current P&ID is such that manual valve operation is required for switching duty and the installed stand-by for both Air Scour Blowers and Permeate pumps

G. Provide actuated valve operators in accordance with Section 15110, and as described herein, and where required by the Supplier for operation of automated systems.

1. Electric Actuators

Electric actuators can be used for typical OPEN/CLOSE application and modulating applications.

2.9 ELECTRICAL

A. Electrical components provided by the Supplier shall be provided in accordance with the requirements of Division 16, Electrical.

B. Three-phase, 480V AC power will be available for the Membrane Equipment System major equipment items and ancillary equipment and shall be used for any motor loads 1/2 hp and larger.

C. Three separate 120 VAC, 20 A single phase circuits will be provided to power the control panel. All power distribution for instruments, field devices, and control panel components shall be provided in the control panel using circuit breakers and fuses per Specification 16940.

D. Motor control centers, adjustable frequency drives, panel boards, transformers, and other equipment necessary to provide power distribution and motor control for all equipment will be provided by the General Contractor.

E. Pre-piped and skid-mounted components power and control wiring shall be prewired to separate terminal junction boxes located on the skid.

2.10 CONTROLS SYSTEM

Provide controls, PLC and Operator Interface hardware and software, Membrane Control System software package, and data links with the Owner's Plant Control System in accordance with Division 16. All equipment provided by the Supplier shall be controlled from a PLC located in a single control panel provided by the Supplier. The status of all equipment and instrumentation and the ability to change control parameters shall be provided by the Supplier shall be displayed on an operator interface mounted on the outside door of the control panel.

2.11 INSTRUMENTATION

A. GENERAL REQUIREMENTS

Provide instrumentation described herein in accordance with Division 13 and 16. Additional instrumentation may be provided as required by the Supplier's proposed system, and shall meet the technical requirements in accordance with Divisions 13 and 16.

B. TURBIDITY TRANSMITTERS

1. Function

Continuously measures, indicates, and transmits signals proportional to turbidity of membrane permeate from each basin.

2. Provide at least one turbidity transmitter for the common permeate pump discharge header. Turbidity transmitters shall comply with Specification Section 13414.

C. MAGNETIC FLOW METERS

1. Function

Continuously measures, indicates, and transmits signals proportional to flow of liquid services.

2. Provide one Magnetic Flow Meter and transmitter for each membrane basin permeate flow for installation on each of the pump discharge lines (one flow meter per pump), for each backwash connection to each cassette, and for chemical cleaning system dilution water or other liquid service as required by the Supplier's system, sized for respective flow rates, in accordance with Specification Section 13426.

D. THERMAL MASS AIR FLOW METERS

1. Function

Continuously measures, indicates, and transmits signals proportional to air flow from the agitation blower system.

2. Provide at least one flow meter and transmitter for the agitation air header to each membrane basin. Thermal mass air flow meters shall comply with Specification Section 13428.

E. PRESSURE GAUGES

Provide pressure gauges for the suction and discharge of each pump, compressor, and blower, at each end of each permeate header, upstream and downstream of each injector and pressure reducing valve, and elsewhere as specified or required by the manufacturer for process control. Pressure gauges shall comply with Specification Section 13417.

F. PRESSURE DIFFERENTIAL TRANSMITTERS

1. Function

Continuously measure, indicate, and transmit pressure in various pipes; provide a signal to the control system when low or high pressure setpoints are reached.

2. Provide pressure transmitters on compressed air header pipes, if compressed air is required for the Supplier's system, and elsewhere as required for control of the Supplier's system. Pressure transmitters shall comply with Specification Section 13419.

G. PRESSURE SWITCHES

1. Function

To provide a discrete signal to the control system when low or high pressure setpoints are reached.

2. Provide pressure switches at all process locations required for warranty or proper operation and/or alarming functions related to the Supplier's system. Pressure switches shall comply with Specification Section 13418.

H. LEVEL INDICATING TRANSMITTERS

1. Function

Continuously measure, indicate, and transmit liquid level in the Membrane Basins.

2. Provide a minimum of one pressure level indication transmitter in each membrane basin (if required for by warranty or control of the Supplier's system). Pressure level indicating transmitters shall comply with Specification Section 13424.

I. FLOAT SWITCHES

Provide a minimum of two float switches to monitor discrete liquid levels in the Membrane basins. Float switches shall comply with Specification Section 13422.

2.12 FACTORY TESTS

SK9
Not applicable, Kubota's standard factory QA control applies. The QA control performs permeability test with tap water and mechanical destructive tests by a production lot.

A. Prior to delivery, the Supplier shall test the membrane equipment actually furnished.

B. Test for proper alignment and operation, proper connection, pumping capacity, and satisfactory performance.

C. Notify the Engineer of testing dates as he may wish to witness pump tests.

D. Provide written certification of tests and test results to the Engineer.

E. Upon receipt of the Engineer's approval, the equipment shall be released for shipment to the job site.

2.13 SPARE PARTS

The Supplier shall provide the manufacturer's recommended spare parts and special tools as specified herein and as specified in each individual specification section. All parts and tools shall be suitably identified, provided with appropriate wrappings or coatings for effective protection from moisture and corrosion, and stored in durable boxes (not cardboard). At a minimum these shall include all special tools and appliances necessary to service, repair, and adjust the Membrane Equipment System, and the following spare parts items:

A. One spare set of expendable material such as gaskets, seals, and packing.

B. One set of new and unused special tools required for installation, operation, and maintenance.

C. One repair kit for sealing off damaged membrane fibers or sheets within the membrane cassettes.

D. All jigs, fixtures, clamps, lifting beams, hooks, and other instruments required for facilitating the removal, disassembly, reassembly, and installation of each item of equipment within the system.

E. Reagents/chemicals, calibration sets, and spare parts as specified for individual equipment items or instruments.

Guarantee availability of the recommended spare parts as listed above for a period no less than 20 years.

Provide a complete list of replaceable parts, including prices.

PART 3 EXECUTION

3.1 INSTALLATION

Supplier shall furnish installation instructions and recommendations to the Owner. Manufacturer's written installation instructions shall be included with the delivered equipment, one set of instructions with each piece of equipment. Each piece of equipment delivered to the site shall have an identification tag with the equipment identification number, or the packing slip shall identify the equipment identification number referencing the equipment serial number.

General Contractor will install the Membrane Equipment in accordance with Supplier's instructions and recommendations.

3.2 TESTING AND COMMISSIONING

A. PROCEDURES

Per Section 01800 and as specified herein.

B. CALIBRATION

Once written certification of proper installation has been issued, the Supplier shall field calibrate all instruments where possible, including pressure differential transmitters, process analyzers, and flow meters. Instruments which cannot be field calibrated shall be checked for accuracy by the Supplier in the field.

C. COMPONENT AND SYSTEM TESTS

1. Following the Supplier's calibration of instruments, the Supplier shall perform Component and System Tests on the Membrane Equipment System. It shall be the responsibility of the Supplier and General Contractor to communicate with each other to arrange the times for testing and startup activities; however, the General Contractor must confirm that these times are acceptable to the Owner and the Engineer.

2. To perform the Component and System Tests, the Supplier shall operate all valves, controls, and other devices to ensure they are functional and ready for performance testing.

3. Purpose of the Component and System Tests shall be to demonstrate the proper operation of the following system components and features:

    a. Automatic control, during Contractor's operation testing of the entire WWTF, of all membrane equipment with clean water as Specified in 01800.

    b. Automatic START/STOP and flow control of membranes using Plant Control System.

    c. Manual flow control using membrane basin OIU and PLC.

    d. Automatic relaxation or backpulsing/backflushing at various time intervals.

    e. Automatic shutoff and alarm for various failure modes for each membrane basin and for entire Membrane Equipment System.

    f. START, STOP, and cycling of air agitation system, including control valves.

    g. Determination of clean water permeability of each membrane basin and temperature correction of the clean water permeability for each basin.

    h. Monitoring and recovery of operating data.

    i. Monitoring and control from remote workstation.

j. Automatic switchover from normal power to standby power, and standby power to normal power.

k. All control functions, both at local system and remote workstation.

l. Operation of systems for Maintenance Cleans and Recovery Cleans.

m. Communication of all data to the main plant control panel.

n. Operation of all monitoring instruments.

D. INITIAL PERFORMANCE TEST

Following completion of the Component and System Tests, the Supplier, General Contractor, and Owner shall conduct the Initial Performance Test on the complete Membrane Equipment System. The requirements and procedures for the Initial Performance test are specified in Section 01800.

E. COMMISSIONING PERIOD

After completion of the Initial Performance Test, the commissioning period on the Membrane Equipment System may begin. Owner shall operate the plant during the Commissioning Period; however, Supplier and General Contractor shall provide on-site assistance as requested by the Owner. The requirements and procedures for the commissioning period are specified in Section 01800.

3.3 MEMBRANE EQUIPMENT MANUFACTURER'S SERVICES

A. PRECONSTRUCTION SERVICES

Provide preconstruction services for the Membrane Equipment Systems as described in Section 01110-1.1A.

B. CONSTRUCTION ON-SITE SERVICES

The Supplier shall provide the following on-site services at times designated by the Owner and General Contractor, for the minimum person-days listed below, travel time excluded. If the minimum person-days and trips listed below are insufficient in the opinion of the Supplier, the Supplier shall indicate the required number of person-days and trips in the Proposal. The cost of these services shall be included in the bid price.

Provide qualified individuals who have previously provided on-site services for the installation, testing, and startup of supplier's identical system of similar size. All field service shall be provided directly by the Supplier and not the local representative. Service time spent remedying equipment deficiencies/problems shall not count toward the listed service days and trips.

1. Two person-days (two trips) during unloading of Membrane Equipment System including attendance at a 1-day predelivery site meeting with the Owner.

2. Two person-days (two trips) for providing installation assistance for the Membrane Equipment.

3. Three person-days (three trips) for training of the Owner's operators including attendance at a 1-day pre-startup site meeting with the General Contractor and the Owner.

4. Twenty person-days (two trips) for assistance during startup and testing activities, including the Component and System Tests and the Initial Performance Test.

C. POST-CONSTRUCTION ON-SITE SERVICES

1. Four person-days (two trips) for commissioning and performance optimization services during the 12-month period following successful completion of the Initial Performance Test, such as instrument calibration, programming, fine tuning of equipment settings, and a 2-day review of operations at the end of the first year of operation.

2. Two person-day (two trips) for additional service calls during the 2-year warranty period.

3. Four person-days (four trips) for additional service calls during the 2-year warranty period.

4. 10 Person-days (ten trips) for the supplier programmer/integrator to be on site for trouble shooting.

D. REMOTE SUPPORT SERVICES

1. Provide toll-free telephone and internet-based support for a minimum period of 36 months following successful completion of the Initial Performance Test.

2. Provide a list of three or more names of individuals qualified to support operation and provide cellular phone numbers for these individuals, if available.

3. At least one of the listed individuals shall be available at all times including nights, weekends, and holidays in the event of an emergency.

***** END OF SECTION *****

EQUIPMENT DATA

EQ-01

SUBMERISBLE MEMBRANE UNIT
WITH FLUX INFORMATION

For Earth, For Life
Kubota

Submittal Transmittal

Submersible Membrane Unit with Flux information

Project Name	TAYLOR BAY BEACH CLUB WWTF UPGRADE
Project Site	8220 178TH AVENUE, LONGBRANCH, WA 98351
Engineer	Gray & Osborne, Inc 1130 RAINIER AVENUE SOUTH, SUITE 300
Submit to	Gray & Osborne, Inc
Prepared by	Shingo Kubo | Lead Project Manager KUBOTA Water and Environment U.S.A. Corporation 19910 N Creek Pkwy, Suite 100 Bothell, WA 98011
KMU Project #	KMU-OPID85
Issued Date	August 24, 2025
Package #	EQ-01-B-Submersible Membrane Unit with Flux information
Item	Tag # 02 MBR 01 02 MBR 02 02 MBR 03 02 MBR 04

Clarifications;

1. Section1 contains Kubota scope list. The subjected item for this submittal is marked in red.

2. Section2 contains the manufacture submittal and datasheet for review.

3. Design Flux information is below

Flow Category	Flow [gpd]	Design net flux [gfd]	Design instantaneous flux [gfd]	Min. flux [gfd]
AAF	24,200	4.68	5.20	4.00
MMF	37,700	7.30	8.11	4.00
MDF	61,900	11.98	13.31	4.00
PHF	111,700	21.63	24.03	4.00

Temperature range 10 - 22 deg>C

Response to 60% review comment;

1) General – Make Corrections Noted

a. Note that BABA certifications from manufacturers should be included in the final

Kubota Response: Kubota SMU Equipment does not comply with BABA requirement as shown in ATTACHMENT B.

ATTACHMENT B

SCOPE OF SUPPLY COMPONENTS THAT DO NOT COMPLY WITH BABA REQUIREMENTS

Part Identification (Name)	Equipment Description and Type	Manufacturer	Number of Units	Total Lump Sum Equipment Cost for Line Item
Kubota SMU Equipment	FS150 SMU Units + Associated Lifting Tool	Kubota	4 SMUs 1 Lifting Tool + Chains	$80,400.00
SMU Basin Associated Endress + Hauser Instrumentation	1. Air Pressure Transmitters 2. Blower Flow Meters 3. Permeate Flow Meter 4. Pump Pressure Transmitter 5. Level Transmitter	Endress + Hauser	Type 1 - QTY 3 Type 2 - QTY 2 Type 3 - QTY 1 Type 4 - QTY 2 Type 5 - QTY 2	$33,896.00
SMU Basin Hach Instrumentation	1. Air Pressure Transmitters 2. Blower Flow Meters 3. Permeate Flow Meters	Hach	Type 1 - QTY 1 Type 2 - QTY 1 Type 3 - QTY 1	$12,633.00
Kubota Standard CIP System	Kubota CIP system based around Mazzei injector, rotometer and flow control valve	Various	1 System of Supply	$18,500.00
PVC Isolation Valves + Check Valves	3 inch PVC Ball Valves 3 inch PVC Check Valves	Asahi	11 Ball Valves 3 Check Vavles	$11,072.00

b. Note that manufacturer services should be included in the final submittal.

Kubota Response: Manufacturer service is included per the specifications. For the items that Kubota is certified to provide service, Kubota will provide it.

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Kubota

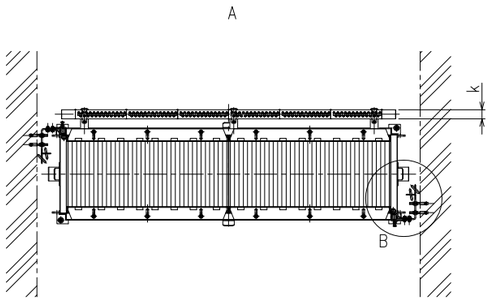
SECTION 1

KUBOTA Water and Environment U.S.A. Corporation
19910 N Creek Pkwy, Suite 100 Bothell, WA 98011| Phone: 425 898 2858 | Fax: 425-898-2853

No	Equipment Location	Tag	Category	Function	Name	Type	Chosen Size/Capacity	Unit	Material	Manufacturer	Model/ Specification	Motor HP	Voltage	FLA	QTY
	MBR Equipment	**x**													
1	MBR	02 MBR 01 02 MBR 02 02 MBR 03 02 MBR 04	SMU	Membrane Filtration	MBR SMU	Flat Plate			304SS	KUBOTA	FS150				4
2	MBR	n/a	SMU	SMU Maintenance	MBR SMU Lifting Tool	Lifting Tool			CS, SS	KUBOTA	TG150				1
3	MBR	n/a	SMU	SMU Maintenance	MBR SMU Lifting Chain	Lifting Tool			304SS	KUBOTA	CS30M				4
4	MBR	02 MOV 03 02 MOV 04	Auto Valve	Diffuser Cleaning	MBR Diffuser Cleaning Valve	ON/OFF Plug	3	inch	CI/CI	Auma/Pratt	SQ12.2-AC01.2/S601 w/extention stem	1/12	120 VAC	2.9	2
5	MBR	n/a	Other Valve	Isolation Valve	SMU Air Isolation Valve(inlet)	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S30				4
6	MBR	n/a	Other Valve	Isolation Valve	SMU Air Isolation Valve(outlet)	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S30				4
7	MBR	BV281 BV282 BV283 BV284	Other Valve	Isolation Valve	SMU PRMT Isolation Valve	Manual Butterfly	2	inch	DI, EPDM, Nylon Coat	Bray	S30				4
8	MBR	n/a	Other Valve	Manual Valves	Isolation Valves for CIP injection	Manual Ball	1	inch	PVC	ASAHI	Type21 True Union				4
9	MBR	02 LS 03 02 LS 04 02 LS 05 02 LS 06	Gauge, Switch	Level Measurement	MBR Level Switch	Float			PP, PU	Conery	2902-B8S1 w/ counter weight and brackets		Loop power		4
10	MBR	n/a	Fabrication	Fabrication	MBR SMU Guide & Stabilizer + Seismic Bracing				304SS	TBD					4
11	MBR	n/a	Fabrication	Fabrication	MBR SMU Fasteners				304SS	TBD					40
12	MBR	n/a	Fabrication	Fabrication	MBR In-Basin Pipe&Supports (Permeate Drop Pipe)				PVC	TBD					4
13	MBR	n/a	Fabrication	Fabrication	MBR In-Basin Pipe&Supports (Air Drop Pipe)				304SS	TBD					8
	Permeate (PRMT) Control Equipment	**x**													
14	PRMT	01 PMP 01 01 PMP 02 01 PMP 03	Permeate Pump	Permeate Extraction	PRMT Pump	Rotary Lobe	45	gpm		Boerger	AN 70 w/ piggyback mount	5	460 VAC	6.6	3
15	PRMT	PI169 PI170 PI171	Gauge, Switch	Pressure Gauge	PRMT Pump Pressuge Gauge(Inlet)		-15 - +15	psig	SS	Ashcroft or equivalent	1279 w/ grycelin filled				3
16	PRMT	PI172 PI173 PI174	Gauge, Switch	Pressure Gauge	PRMT Pump Pressuge Gauge (Inlet)		-15 - +15	psig	SS	Ashcroft or equivalent	1279 w/ grycelin filled				3
17	PRMT	01 PTR 01 01 PTR 02	Pressure Sensor	TMP Measurement	PRMT Pump Pressure Transmitter	Diaphragm	-15 - +15	psi	SS	Endress & Hauser	Cerabar PMCB51		Loop power		2
18	PRMT	01 MFM 01 01 MFM 02	Flow Sensor	Flow Measurement	PRMT Flow Meter	Electromagnetic	3	inch	PU	Endress & Hauser	Promag W 400		24VDC		2
19	MBR	n/a	Other Valve	Isolation Valve	MBR PRMT Pump isolation valve	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S30				8
20	MBR	CV261 CV261 CV261	Other Valve	Check valve	MBR PRMT Pump discharge check valve	Manual ball	3	inch	PVC, EPDM	ASAHI	True Union Ball Check				3
21	PRMT	01 TM 01	Other Instrument	Turbidity Measurement	PRMT Turbidity Meter	Laser	0-5	NTU		HACH	TU5300sc				1
22	PRMT	01 TM 01	Other Instrument	Turbidity Measurement	PRMT Turbidity Transmitter					HACH	SC4500		24VDC		1
23	PRMT	n/a	Other Instrument	Turbidity Measurement	Turbidity Meter Maintenance Kit					HACH					1
	Return Activated Sludge (RAS) Control	**x**													
24	MBR	Relocated from MBR 02 SLS02 02 SLS03	Other Instrument	Level Measurement	MBR Level Sensor	Hydrostatic	15	ft	SS	Endress & Hauser	Waterpilot FMX21 w/ brackets		Loop power		2
	MBR Blower	**x**													
25	MBR BLW	01 MSB 01 01 MSB 02 01 MSB 03	Blower	Blower	MBR Blower	Positive Displacement	114	scfm	CI	Aerzen	GM 4S DN 80	5	460 VAC	6.6	3

No	Equipment Location	Tag	Category	Function	Name	Type	Chosen Size/Capacity	Unit	Material	Manufacturer	Model/ Specification	Motor HP	Voltage	FLA	QTY
26	MBR BLW	n/a	Option	Noise Suppression	MBR Blower Sound Enclosure	With Blower									3
27	MBR BLW	n/a	Option	Blower Temperature	MBR Blower Temperature Gauge	With Blower									3
28	MBR BLW	n/a	Option	Blower Pressure	MBR Blower Pressure Gauge	With Blower									3
29	MBR BLW	n/a	Option	Blower Temperature	MBR Blower Temperature Switch	With Blower									3
30	MBR BLW	01 AFM 01 01 AFM 02	Flow Sensor	Air Flow Measurement	MBR Blower Flow Meter	Thermal Mass	3	inch	PU	Endress & Hauser	t-mass I 300, w/ flow conditioner plate		24VDC		2
31	MBR BLW	n/a	Other Valve	Manual Valves	Air Scour Blower Isolation Valves	Manual Butterfly	3	inch	DI, FKM, SS Disk	Bray	S30				4
	Clean-In-Place Equipment	**x**													
32	SMU CIP	n/a	Chemical Injection	Chemical Injection	SMU CIP System PVC pipes		1	inch	PVC	KUBOTA	Loose ship parts shown on xxx				1
33	SMU CIP	n/a	Flow Sensor	Flow Measurement	CIP solution Flow Meter	Electromagnetic	1	inch	PU				24 VDC		1
34	SMU CIP	n/a	Flow Sensor	Flow Measurement	CIP shelf chenical Flow Meter	Electromagnetic	3/8	inch	PU	Keyence	FD-Q10C		24VDC		1
35	SMU CIP	n/a	Auto Valve	Flow Control	CIP Flow Control Valve	ON/OFF Ball	1	inch	DI	ASAHI	S19-120VAC--1"-C20/S20		120VAC	0.18	1
36	SMU CIP	n/a	Other Valve	Manual Valves	Isolation Valves on CIP Station	Manual Ball	1, 0.5	inch	PVC	ASAHI	Type21 True Union				1
37	SMU CIP	n/a	Other Valve	Manual Valves	Pressure reducing valve	Pressure Reducing	1.5	inch	CI	Zurn	ZW209				1
	System Control Equipment	**x**													
38	CONTROL	n/a	Control Panel	Control Panel	Control Panel	OIT, PLC					NEMA 4/12, 72" x 72" x 18" floor mount enclosure (estimated size) , Allen Bradley 1756-L81E PLC (BABA-Version), FactoryTalk View SE		120VAC	TBD	1
39	D. SERVICE	n/a	D. Service	Direct Service	Direct Service						Design support, start-up, field service, remote service				1

SECTION 2

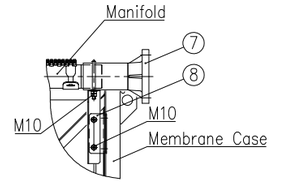


Model	a	Anchor bolt Pcs	Anchor bolt b	c	d	e	f	g	h	i	k	Mass (kg) Membrane Case dry	Membrane Case wet *1	Lifting Tool
FS50-7	1100	4	790	431	2020	500	220	148	ø60	1547	ø60	200	400	15
FS75-7	1450	4	1140	456	2020	500	220	148	ø60	1547	ø60	280	580	20
FS100-7	1800	4	1490	529	2020	500	220	148	ø60	1545	ø60	370	770	40
FS125-7	2150	4	1840	554	2020	500	246	159	ø89	1545	ø60	460	960	50
FS150-7	2500	4	2190	554	2020	500	246	159	ø89	1545	ø60	550	1150	60
FS200-7	3200	6	2890	677	2020	500	246	159	ø89	1552	ø76	740	1540	110
ES75-7	1450	4	1140	456	2520	1000	360	288	ø60	2047	ø60	280	580	20
ES100-7	1800	4	1490	529	2520	1000	360	288	ø60	2045	ø60	370	770	40
ES125-7	2150	4	1840	554	2520	1000	346	259	ø89	2045	ø60	460	960	50
ES150-7	2500	4	2190	554	2520	1000	346	259	ø89	2045	ø60	550	1150	60
ES200-7	3200	6	2890	677	2520	1000	346	259	ø89	2052	ø76	740	1540	110

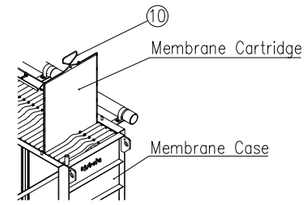
*1 "Wet" mass includes "dry" mass and expected mass of sludge when all the gaps between membrane cartridges are clogged with sludge.

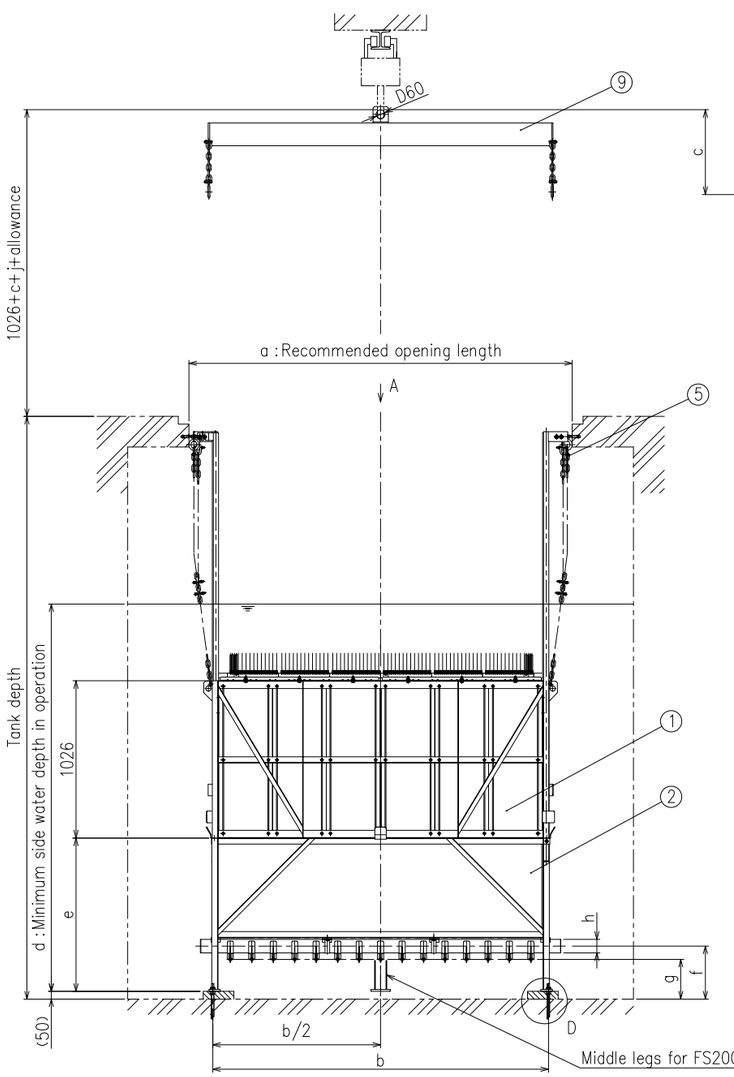
Notes
1. ES150-7 is shown as an example in this drawing. This drawing is applicable for other models. Each model may be different in outline and dimensions.
2. This drawing conforms to JIS standards.
3. Fix the Diffuser Case on the tank bottom with anchor set.
4. Adjust the length of Guide Set and Lifting Chain Set by cutting off on site.
5. Use the specified Lifting Tool in lifting a Membrane Case.
6. If multi-step lifting is required, use the Hanger Rings.
7. Load on a Membrane Case can be reduced with Pipe Set and Pipe Support for Manifold.
8. Use a Hand Hook in taking out the Membrane Cartridges.

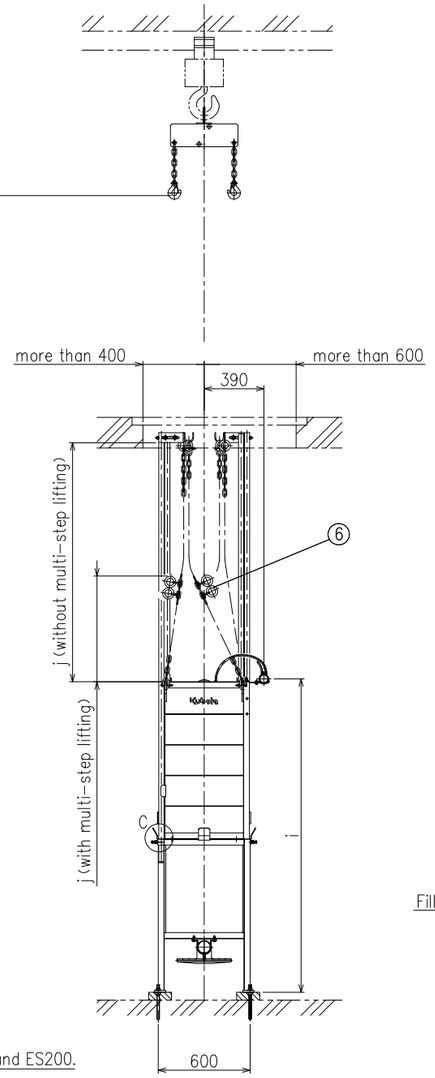
In case a Pipe Set and Pipe Support for Manifold are used.

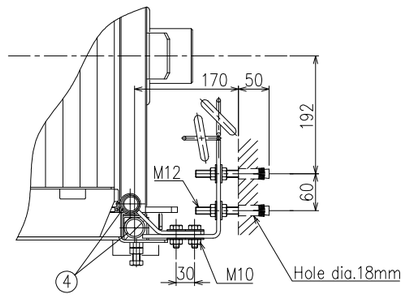


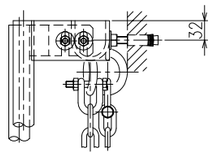
How to use Hand Hook

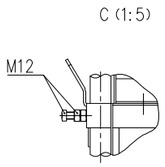


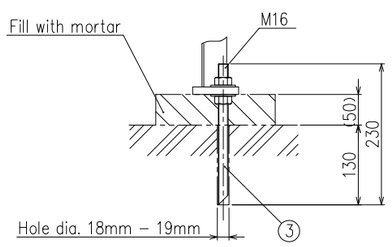












Item 7, 4 and 3 - details are included in membrane tank detail submittal document

PARTS NO.	NAME OF PARTS	MATERIALS	NO.REQD. ※	REMARKS
10	Hand Hook	SUS304	1	Optional
9	Lifting Tool	STKR400 etc.	1	Optional
8	Pipe Support for Manifold	SUS	1	Optional
7	Pipe Set	PVC	1	Optional
6	Hanger Ring Set	SUS	1	Optional
5	Lifting Chain Set	SUS	1	Optional
4	Guide Set	SUS etc.	1	Optional
3	Anchor Set	SUS	1	Optional
2	Diffuser Case	SUS/PVC/ABS	1	Membrane Unit
1	Membrane Case	SUS/PVC/ABS etc.	1	

TYPE: FS50-7,FS75-7,FS100-7,FS125-7,ES150-7,FS200-7 ES75-7,ES100-7,ES125-7,ES150-7,ES200-7
CUSTOMER:
TITLE: Installation drawing of Membrane Unit (with Guide Set)

Membrane Engineering	APPROVED BY	CHECKED BY	DESIGNED BY	DRAWN BY
	K.Y	Y.M	Y.M	S.K

THIRD ANGLE | DATE 2021. 2.22 | SCALE 1 : 20
DWG NO. SP-21-2021 △0
ORDER NO.
FILE NO. R3

KUBOTA Corporation

Specifications of KUBOTA Submerged Membrane Unit™

● Specifications of Product

Model			FS150-7
Dimensions (Height x Width x Length)			H1,526mm × W2,201mm × L600mm
Mass	Membrane Case	Dry Mass	550 kg
		Wet Mass*1	1,150 kg
	Diffuser Case		60 kg
	Lifting Tool*2		60 kg
	Total max. of Lifted Membrane Case*1		550 kg
Number of Membrane Cartridges			150 cartridges
Effective Membrane Surface Area			120 m^2
Pore Size of Membrane Sheet			0.2 μm
Initial Flow Rate with Clean Water*3			111 L/min（20℃, 5 kPa）
Diffuser Air Supply Rate		Required	1.50 Nm^3/min
		Maximum*4	2.25 Nm^3/min
Pressure Loss in Diffuser			1 kPa or less
Filtration Pressure*5			20 kPa or less
Chemical Injection Pressure		Constant	10 kPa or less
		Instantaneous	20 kPa or less
Diameter of Pipe Connection		Air	JIS VP75 or equivalent *6
		Permeate	JIS VP50 or equivalent *6
Periodical Replacement Parts			Retaining Rubber (every three years)
			Tube (every three years)
			Membrane Cartridge (depending on usage conditions)
Optional Parts (These parts shall be ordered separately)			Anchor Set
			Fixing Bolt Set or Guide Set
			Lifting Chain Set
			Lifting Tool
			Hand Hook
			Hanger Ring Set
Precautions in Storage			Avoid direct sunlight and wetness
			Keep fire away

*1 Assuming that all the gaps between the Membrane Cartridges are clogged up.
*2 Optional part
*3 This does not indicate the treatment capacity with real mixed liquor.
*4 Supplying more air flow than this maximum value may cause damage on the Membrane Unit.
*5 Difference (P1-P2) between the pressures while the filtration is OFF (P1) and ON (P2).
*6 Outer diameter of each pipe code; 89mm for VP75, 60mm for VP50.

● Design Considerations

Usage Conditions	Intended Use*7		Solid-Liquid Separation of Activated Sludge
	Filtration Method		Gravity Filtration or Suction Filtration
	Water Temperature		5~40 ℃
	pH		5~10
	Required min. Water Level (from the base of Diffuser Case)		2,020 mm
	Sludge Properties*8 (recommended)	MLSS	5,000~20,000 mg/L
		Viscosity*9	200 mPa·s or less
		Paper Filtration Test	10 mL/5min or more
		DO	1 mg/L or more
		Temperature	15~35 ℃
		pH	6~8
Method of Fixation	Diffuser Case		Anchor Bolts (M16×230L, depth 130mm)
	Membrane Case		Fixing Bolt Set or Guide Set
Equipment relevant to membrane operation (to be provided by Customer)			
	Membrane Blower		
	Diffuser Cleaning Valve		
	Devices to discharge Permeate*10 (example)	Gravity Filtration	Motorized Valve (or Solenoid Valve), Pressure Gauge, Constant Flow Valve (or Flow Regulator and Flow Meter)
		Suction Filtration	Permeate Pump, Pressure Gauge (Negative Gauge or Combination Gauge), Constant Flow Valve (or Flow Regulator and Flow Meter)
	Chemical Injection Port or Equipment		
	Recommended Piping Diameter	Blower	JIS VP65 or equivalent *12
		Diffuser Cleaning	JIS VP65 or equivalent *12
		Permeate*11	JIS VP50 or equivalent *12
Precautions in Operation			Avoid aeration while filtration stops as much as possible.
			Stop filtration while aeration stops or Diffuser is cleaned.

*7 Pretreatment may be required for the following types of wastewater:
・Wastewater with oil, trash, or debris
・Wastewater with high contents of iron, manganese, calcium, or silicon

*8 Use these values as rough targets for treatment control.

*9 This is the value measured by an viscometer model TVC-10 (Rotor No.1, Speed 20 rpm) by Toki Sangyo Co., LTD. If measured by an viscometer model VT-03 by Rion Co., LTD., it is 100 mPa·s or less instead.

*10 Configuration of devices to discharge permeate is not limited to these examples. Refer to "Instruction Manual".

*11 Design the system so as to prevent permeate backflow and air trap while filtration stops.

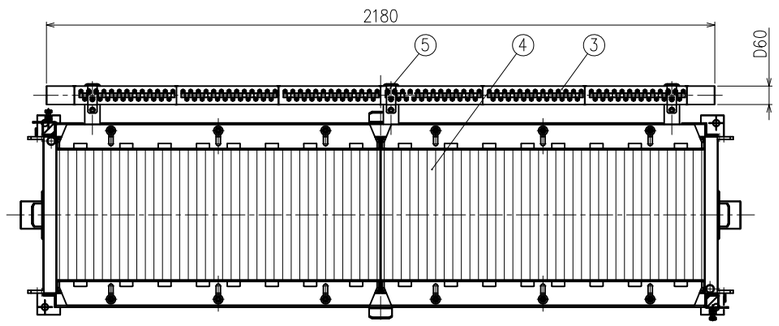
*12 Outer diameter of each pipe code; 76mm for VP65, 60mm for VP50.

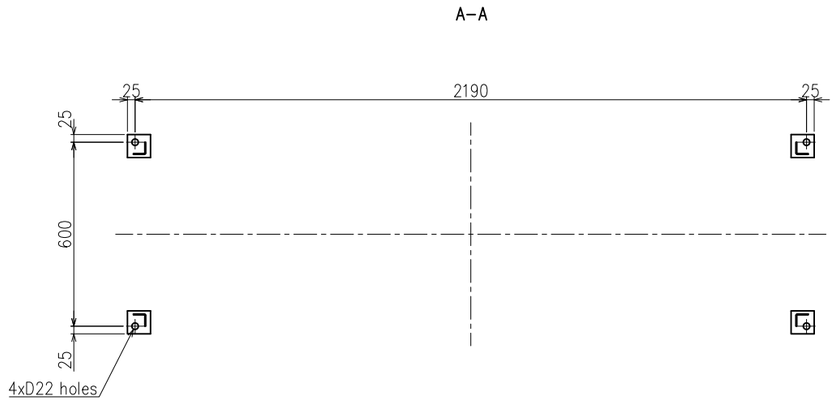
● Maintenance Considerations

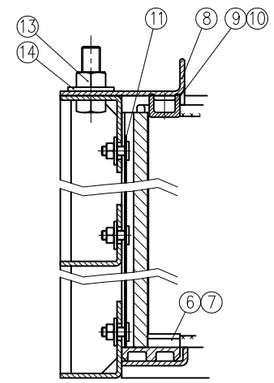
In Situ Chemical Cleaning	Chemical type	Sodium Hypochlorite	0.6% or less when MLSS is more than 10,000 mg/L
			0.3% or less when MLSS is 10,000 mg/L or less
		Oxalic Acid*13	1.0 % or less
	Dosage Volume		450 L
	Timing		When filtration pressure rises by 5~10 kPa from the initial or every six months or more often
Diffuser Cleaning			Once a day, for five minutes

*13 If calcium carbonate precipitates in the tank, dose hydrochloric acid or citric acid (1.0% or less).

[Before using this product, read "Instruction Manual for KUBOTA Submerged Membrane Unit™".]







Notes

1.This drawing conforms to JIS standards.

Materials
SUS304
SUS316

Model		Mass (kg)
Membrane Case	MS150–7	550
Diffuser Case	DFS150	60

PARTS NO.	NAME OF PARTS	MATERIALS	NO.REQD.	REMARKS
21	Nut	SUS	2	M12
20	Bolt	SUS	2	M12x35L
19	Diffuser Band	SUS	4	
18	Branch Pipe	ABS	15	
17	Diffuser Header Pipe	PVC/ABS	1	
16	Cover Plate	SUS	2	
15	Diffuser Case Frame	SUS	1	
Diffuser Case			1	DFS150
14	Washer	SUS	12	M12
13	Nut	SUS	12	M12
12	Tube	PU	150	D8xD10.5x500L
11	Fixing Bar	SUS	24	
10	Retaining Rubber (25)	EPDM	4	
9	Retaining Rubber (50)	EPDM	4	
8	Retaining Plate (75)	SUS	4	
7	Rubber holder (25)	EPDM	4	
6	Rubber holder (50)	EPDM	4	
5	Manifold Band	SUS	3	
4	Membrane Cartridge	ABS etc.	150	H7–510
3	Manifold	ABS/PVC	1	
2	Panel	PVC	12	
1	Membrane Case Frame	SUS	1	
Membrane Case			1	MS150–7

TYPE	CUSTOMER	TITLE
FS150–7		Assembly Drawing of Membrane Unit

Membrane Engineering	APPROVED BY	CHECKED BY	DESIGNED BY	DRAWN BY
	Y.O	K.I	K.I	S.K

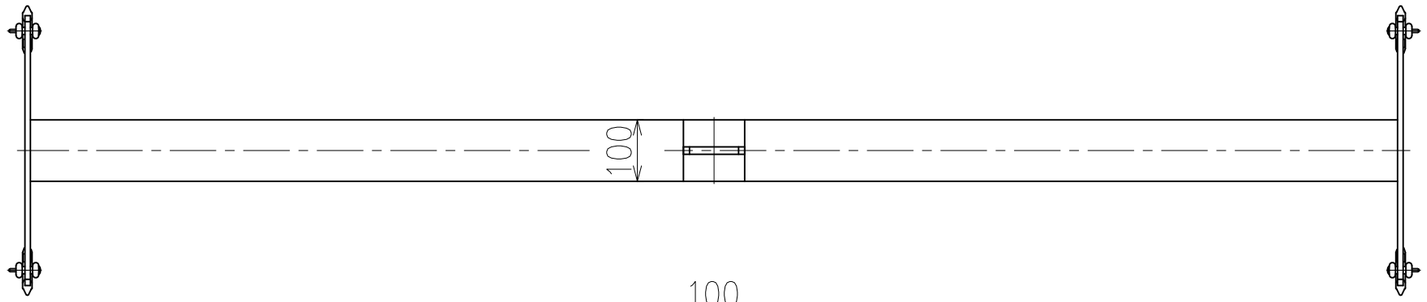
THIRD ANGLE | DATE 2018. 8. 1 | SCALE 1:10

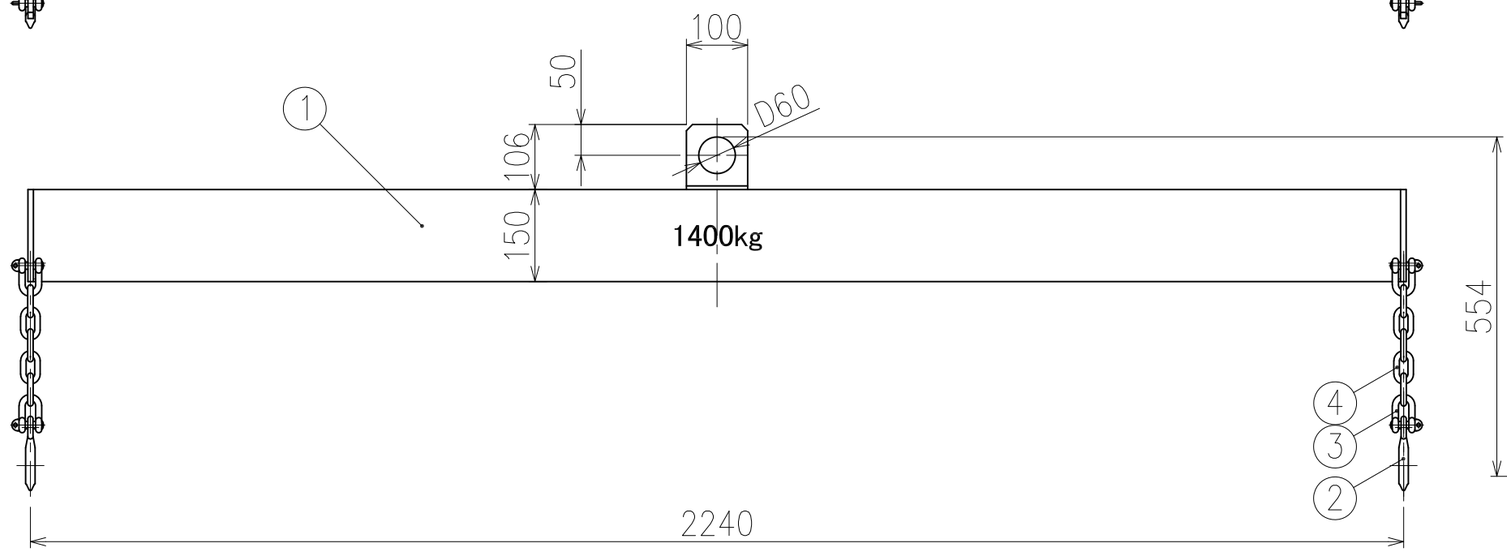
DWG NO. SP–18–2049 | 0

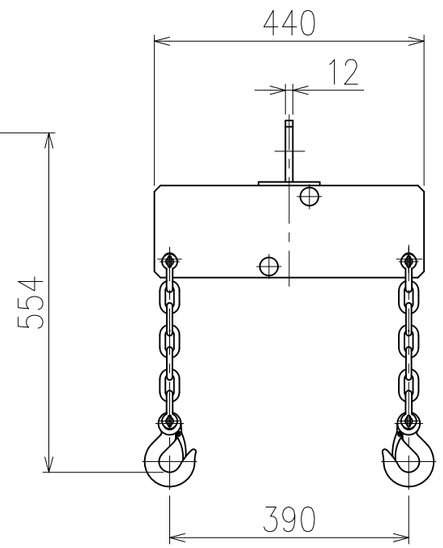
KUBOTA Corporation

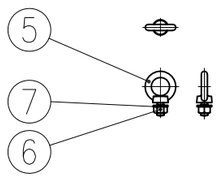
ORDER NO. | FILE NO. R3

9 8 7 6 5 4 3 2 1 A1









PARTS NO.	NAME OF PARTS	MATERIALS	NO.REQD.	(kg) MASS	REMARKS
	7 Washer	SS400	1	0.01	M12 to lift a Diffuser Case
	6 Nut	SS400	1	0.02	M12 to lift a Diffuser Case
	5 Eyebolt	SS400	1	0.12	M12 to lift a Diffuser Case
			4	0.15	
	4 Chain	SS400	4	0.30	
	3 Shackle	S25C	8	0.14	
	2 Eyehook	S45C	4	0.34	
	1 Frame	STKR400 etc.	1	49	
			1	53	
TG150			1	60	

TYPE: TG150

CUSTOMER:

TITLE: Lifting Tool

Membrane Engineering	APPROVED BY	CHECKED BY	DESIGNED BY	DRAWN BY
	K.Y	Y.M	T.S	S.K

THIRD ANGLE | DATE 2022.11. 7 | SCALE 1:10

DWG NO. SP−17−2115 △2

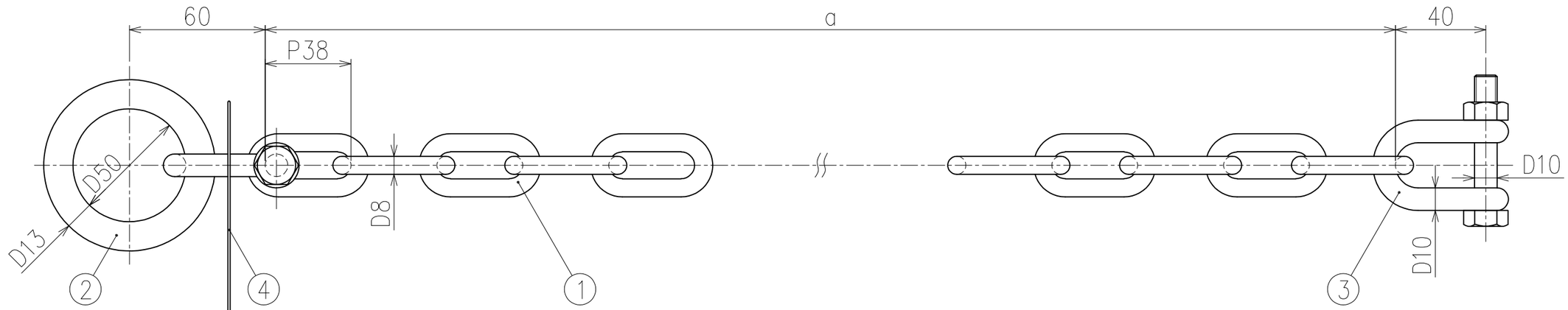
KUBOTA Corporation

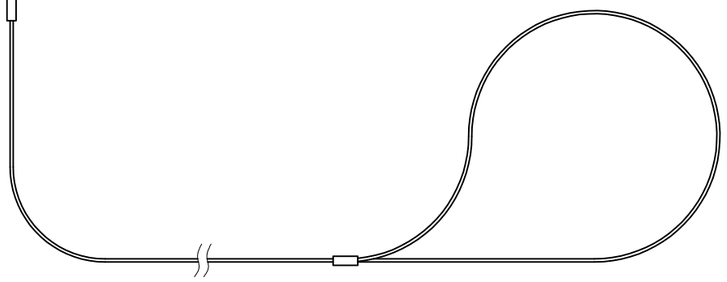
ORDER NO.

FILE NO. 510

Notes

1. This drawing conforms to JIS standards.





PARTS NO.	NAME OF PARTS	MATERIALS	NO.REQD.	(kg) MASS	REMARKS
4	Wire	SUS304	1	–	for anti-drop
3	Shackle	SUS	2	0.13	with a split pin
2	Ring	SUS	1	0.21	
1	Chain	SUS	1	4.6	
			4	5.1	
CS40M			1	20.4	
4	Wire	SUS304	1	–	for anti-drop
3	Shackle	SUS	2	0.13	with a split pin
2	Ring	SUS	1	0.21	
1	Chain	SUS	1	3.5	
			4	4.0	
CS30M			1	16.0	

Notes

1. This drawing conforms to JIS standards.

	Materials
	SUS304
	SUS316

for ①②③

	Model	a
	CS30M	3002
	CS40M	3990

TYPE: CS30M CS40M

CUSTOMER

TITLE: Lifting Chain Set

Membrane Engineering	APPROVED BY	CHECKED BY	DESIGNED BY	DRAWN BY
	Y.O	Y.T	Y.T	S.K

THIRD ANGLE | DATE 13 Dec, 2017 | SCALE 1 : 2

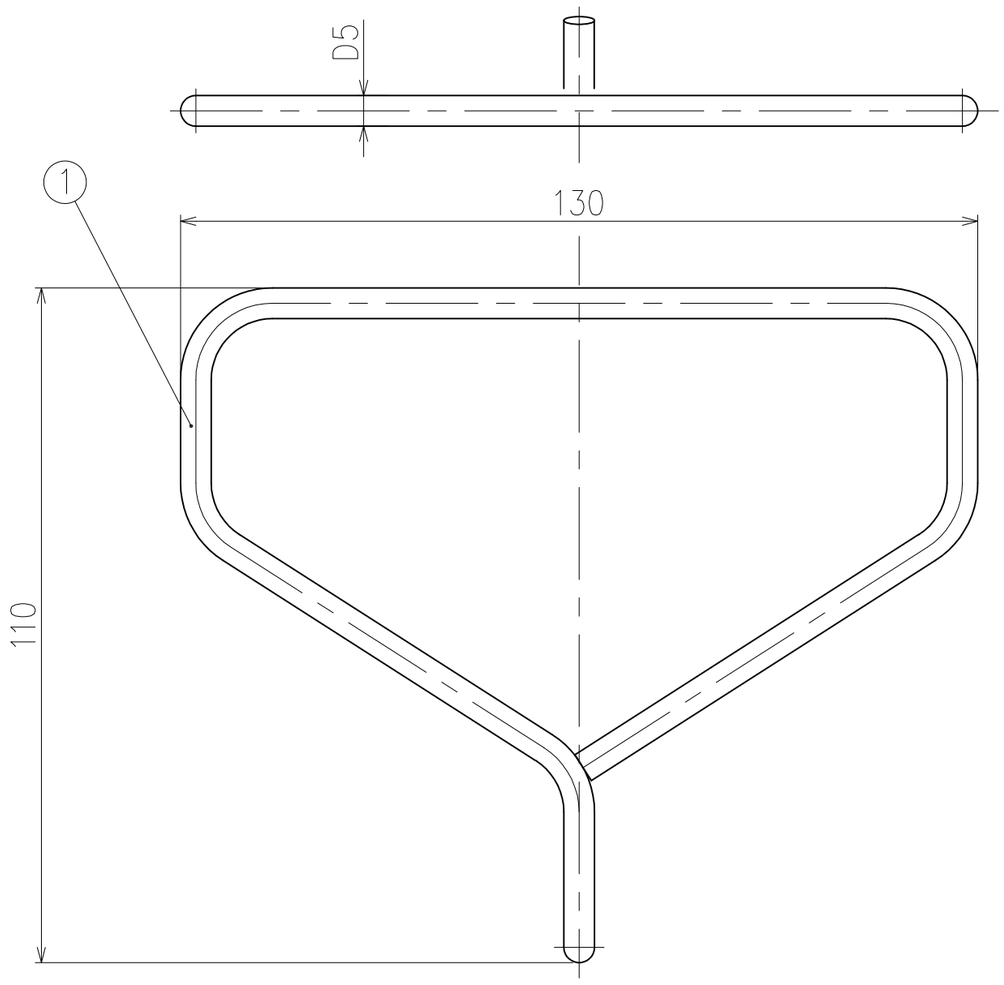
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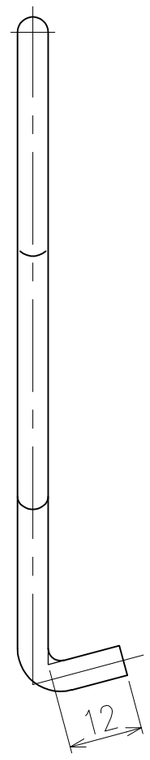
KUBOTA Corporation

ORDER NO.

FILE NO. 510

6 5 4 3 2 1 A3





1	Hand Hook	SUS304	1	0.06	
TH000			1	0.06	
PARTS NO.	NAME OF PARTS	MATERIALS	NO.REQD.	(kg) MASS	REMARKS

TYPE	CUSTOMER
TH000	
TITLE	
Hand Hook	

Membrane Engineering	APPROVED BY	CHECKED BY	DESIGNED BY	DRAWN BY	THIRD ANGLE	DATE	SCALE
	Y.O	K.I	K.I	S.K		2019.11.11	1:1

DWG NO. SP-17-2117 △1

KUBOTA Corporation

ORDER NO.

FILE NO. 510

Notes

1. This drawing conforms to JIS standards.

A3

EQ-02

MEMBRANE SCOUR BLOWER

For Earth, For Life
Kubota

Submittal Transmittal

Membrane Scour Blower

Project Name	TAYLOR BAY BEACH CLUB WWTF UPGRADE
Project Site	8220 178TH AVENUE, LONGBRANCH, WA 98351
Engineer	Gray & Osborne, Inc 1130 RAINIER AVENUE SOUTH, SUITE 300
Submit to	Gray & Osborne, Inc
Prepared by	Shingo Kubo | Lead Project Manager KUBOTA Water and Environment U.S.A. Corporation 19910 N Creek Pkwy, Suite 100 Bothell, WA 98011
KMU Project #	KMU-OPID85
Issued Date	August 24, 2025
Package #	OPID85- EQ-02-B-Membrane Scour Blower
Item	Tag # 01 MSB 01 01 MSB 02 01 MSB 03

Clarifications;

1. Section1 contains Kubota scope list. The subjected item for this submittal is marked in red.

2. Section2 contains the manufacture submittal and datasheet for review.

3. BABA certificate is included at the last page of section 2. Please note that the certificate is subjected to be updated after the manufacturer receives the order.

4. Yes, separate grounding of the unit is required. Notes Grounding straps internal to the sound enclosure to ground the base frame to the sound enclosure are included. Additionally, a Grounding lug is provided for customer attachment at the rear of the package for additional grounding of the blower unit.

5. Manufacturer service is included per the specifications.

Deviations to the specification;

1. 11370; 1.4 Aerzen does not recommend the use of unloading valves while the unit is VFD driven therefore none will be provided.
2. 11370; 2.1 Aerzen will supply their standard Dry fil 4 1/2" P1 and P2 gauges with appropriate snubbers.
3. 11370; 2.16 Aerzen will not supply blower stage bearings, gaskets, and seals as these are available to ship within 24 hours from our Coatesville facility. Internal Bearings, gaskets, and seals are to be installed by a trained service technician and are not field serviceable.
4. 11370; 2.17 Aerzen will supply their packages with standard paint and powder coating in RAL 5001 which is in line with the industries best practices.
5. 11370; 2.17 Aerzen packages will ship with finish coating installed on the package therefore there will be no field painting necessary.
6. 11000; 1.5 As no date of substantial completion was supplied Aerzen will supply their standard warranty period of 24 months from start-up or 30 months from delivery whichever comes first. If additional warranty is required this may be available during receipt of the award.

SUBMITTAL
TAYLOR BAY BEACH CLUB WWTF UPGRADE
KMU-OPID85

For Earth, For Life
Kubota

Response to 60% review comment;

1) General – Make Corrections Noted

a. Note that BABA certifications from manufacturers should be included in the final

Kubota Response: BABA certificate is included at the last page of section 2. Please note that the certificate is subjected to be updated after the manufacturer receives the order.

b. Note that manufacturer services should be included in the final submittal.

Kubota Response: Manufacturer service is included per the specifications.

8) EQ-02-A-Membrane Scour Blower – No Exceptions Taken

a. Please indicate if separate grounding of the unit is required

Kubota Response: Yes, separate grounding of the unit is required. Grounding straps internal to the sound enclosure to ground the base frame to the sound enclosure are included in Aerzen's scope package. Additionally, a Grounding lug is provided for customer attachment at the rear of the package for additional grounding of the blower unit. See the notes added on drawing GB-006947-P2021000.

KUBOTA Water and Environment U.S.A. Corporation
19910 N Creek Pkwy, Suite 100 Bothell, WA 98011| Phone: 425 898 2858 | Fax: 425-898-2853

For Earth, For Life
Kubota

SECTION 1

KUBOTA Water and Environment U.S.A. Corporation
19910 N Creek Pkwy, Suite 100 Bothell, WA 98011| Phone: 425 898 2858 | Fax: 425-898-2853

No	Equipment Location	Tag	Category	Function	Name	Type	Chosen Size/Capacity	Unit	Material	Manufacturer	Model/ Specification	Motor HP	Voltage	FLA	QTY
	MBR Equipment	**x**													
1	MBR	02 MBR 01 02 MBR 02 02 MBR 03 02 MBR 04	SMU	Membrane Filtration	MBR SMU	Flat Plate			304SS	KUBOTA	FS150				4
2	MBR	n/a	SMU	SMU Maintenance	MBR SMU Lifting Tool	Lifting Tool			CS, SS	KUBOTA	TG150				1
3	MBR	n/a	SMU	SMU Maintenance	MBR SMU Lifting Chain	Lifting Tool			304SS	KUBOTA	CS30M				4
4	MBR	02 MOV 03 02 MOV 04	Auto Valve	Diffuser Cleaning	MBR Diffuser Cleaning Valve	ON/OFF Plug	3	inch	CI/CI	Auma/Pratt	SQ12.2-AC01.2/S601 w/extention stem	1/12	120 VAC	2.9	2
5	MBR	n/a	Other Valve	Isolation Valve	SMU Air Isolation Valve(inlet)	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S30				4
6	MBR	n/a	Other Valve	Isolation Valve	SMU Air Isolation Valve(outlet)	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S30				4
7	MBR	BV281 BV282 BV283 BV284	Other Valve	Isolation Valve	SMU PRMT Isolation Valve	Manual Butterfly	2	inch	DI, EPDM, Nylon Coat	Bray	S30				4
8	MBR	n/a	Other Valve	Manual Valves	Isolation Valves for CIP injection	Manual Ball	1	inch	PVC	ASAHI	Type21 True Union				4
9	MBR	02 LS 03 02 LS 04 02 LS 05 02 LS 06	Gauge, Switch	Level Measurement	MBR Level Switch	Float			PP, PU	Conery	2902-B8S1 w/ counter weight and brackets		Loop power		4
10	MBR	n/a	Fabrication	Fabrication	MBR SMU Guide & Stabilizer + Seismic Bracing				304SS	TBD					4
11	MBR	n/a	Fabrication	Fabrication	MBR SMU Fasteners				304SS	TBD					40
12	MBR	n/a	Fabrication	Fabrication	MBR In-Basin Pipe&Supports (Permeate Drop Pipe)				PVC	TBD					4
13	MBR	n/a	Fabrication	Fabrication	MBR In-Basin Pipe&Supports (Air Drop Pipe)				304SS	TBD					8
	Permeate (PRMT) Control Equipment	**x**													
14	PRMT	01 PMP 01 01 PMP 02 01 PMP 03	Permeate Pump	Permeate Extraction	PRMT Pump	Rotary Lobe	45	gpm		Boerger	AN 70 w/ piggyback mount	5	460 VAC	6.6	3
15	PRMT	PI169 PI170 PI171	Gauge, Switch	Pressure Gauge	PRMT Pump Pressuge Gauge(Inlet)		-15 - +15	psig	SS	Ashcroft or equivalent	1279 w/ grycelin filled				3
16	PRMT	PI172 PI173 PI174	Gauge, Switch	Pressure Gauge	PRMT Pump Pressuge Gauge (Inlet)		-15 - +15	psig	SS	Ashcroft or equivalent	1279 w/ grycelin filled				3
17	PRMT	01 PTR 01 01 PTR 02	Pressure Sensor	TMP Measurement	PRMT Pump Pressure Transmitter	Diaphragm	-15 - +15	psi	SS	Endress & Hauser	Cerabar PMCB51		Loop power		2
18	PRMT	01 MFM 01 01 MFM 02	Flow Sensor	Flow Measurement	PRMT Flow Meter	Electromagnetic	3	inch	PU	Endress & Hauser	Promag W 400		24VDC		2
19	MBR	n/a	Other Valve	Isolation Valve	MBR PRMT Pump isolation valve	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S30				8
20	MBR	CV261 CV261 CV261	Other Valve	Check valve	MBR PRMT Pump discharge check valve	Manual ball	3	inch	PVC, EPDM	ASAHI	True Union Ball Check				3
21	PRMT	01 TM 01	Other Instrument	Turbidity Measurement	PRMT Turbidity Meter	Laser	0-5	NTU		HACH	TU5300sc				1
22	PRMT	01 TM 01	Other Instrument	Turbidity Measurement	PRMT Turbidity Transmitter					HACH	SC4500		24VDC		1
23	PRMT	n/a	Other Instrument	Turbidity Measurement	Turbidity Meter Maintenance Kit					HACH					1
	Return Activated Sludge (RAS) Control	**x**													
24	MBR	Relocated from MBR 02 SLS02 02 SLS03	Other Instrument	Level Measurement	MBR Level Sensor	Hydrostatic	15	ft	SS	Endress & Hauser	Waterpilot FMX21 w/ brackets		Loop power		2
	MBR Blower	**x**													
25	MBR BLW	01 MSB 01 01 MSB 02 01 MSB 03	Blower	Blower	MBR Blower	Positive Displacement	114	scfm	CI	Aerzen	GM 4S DN 80	5	460 VAC	6.6	3

No	Equipment Location	Tag	Category	Function	Name	Type	Chosen Size/Capacity	Unit	Material	Manufacturer	Model/ Specification	Motor HP	Voltage	FLA	QTY
26	MBR BLW	n/a	Option	Noise Suppression	MBR Blower Sound Enclosure	With Blower									3
27	MBR BLW	n/a	Option	Blower Temperature	MBR Blower Temperature Gauge	With Blower									3
28	MBR BLW	n/a	Option	Blower Pressure	MBR Blower Pressure Gauge	With Blower									3
29	MBR BLW	n/a	Option	Blower Temperature	MBR Blower Temperature Switch	With Blower									3
30	MBR BLW	01 AFM 01 01 AFM 02	Flow Sensor	Air Flow Measurement	MBR Blower Flow Meter	Thermal Mass	3	inch	PU	Endress & Hauser	t-mass I 300, w/ flow conditioner plate		24VDC		2
31	MBR BLW	n/a	Other Valve	Manual Valves	Air Scour Blower Isolation Valves	Manual Butterfly	3	inch	DI, FKM, SS Disk	Bray	S30				4
	Clean-In-Place Equipment	**x**													
32	SMU CIP	n/a	Chemical Injection	Chemical Injection	SMU CIP System PVC pipes		1	inch	PVC	KUBOTA	Loose ship parts shown on xxx				1
33	SMU CIP	n/a	Flow Sensor	Flow Measurement	CIP solution Flow Meter	Electromagnetic	1	inch	PU				24 VDC		1
34	SMU CIP	n/a	Flow Sensor	Flow Measurement	CIP shelf chenical Flow Meter	Electromagnetic	3/8	inch	PU	Keyence	FD-Q10C		24VDC		1
35	SMU CIP	n/a	Auto Valve	Flow Control	CIP Flow Control Valve	ON/OFF Ball	1	inch	DI	ASAHI	S19-120VAC--1"-C20/S20		120VAC	0.18	1
36	SMU CIP	n/a	Other Valve	Manual Valves	Isolation Valves on CIP Station	Manual Ball	1, 0.5	inch	PVC	ASAHI	Type21 True Union				1
37	SMU CIP	n/a	Other Valve	Manual Valves	Pressure reducing valve	Pressure Reducing	1.5	inch	CI	Zurn	ZW209				1
	System Control Equipment	**x**													
38	CONTROL	n/a	Control Panel	Control Panel	Control Panel	OIT, PLC					NEMA 4/12, 72" x 72" x 18" floor mount enclosure (estimated size) , Allen Bradley 1756-L81E PLC (BABA-Version), FactoryTalk View SE		120VAC	TBD	1
39	D. SERVICE	n/a	D. Service	Direct Service	Direct Service						Design support, start-up, field service, remote service				1

SECTION 2

AERZEN USA CORPORATION
108 Independence Way
Coatesville, PA 19320
Tel. (610) 380-0244 ♦ Fax. (610) 380-0278

AERZEN Reference Number: ENV-379690.3

11-Jun-25

Re: Taylor Bay, WA

To: Shingo Kubo	AERZEN Proposal Prepared By:
Firm - Kubota Water and Enviroment U.S.A.	Name - James Marx
email - shingo.kubo@kubota.com	email - james.marx@aerzen.com
phone - (425) 534-1006	phone - (484) 798-7619
	AERZEN Regional Manager:
	Name - Tom McCurdy
	e-mail - tom.mccurdy@aerzen.com
	phone - (610) 656-1683

Thank you for the opportunity to bid this project for (3) Positive Displacement Blower Packages.

The Aerzen Blower Package Performance and Scope of Supply meet the intent of the specification section 11370. All specification sections not directly referenced here were not reviewed and compliance cannot be guaranteed. Aerzen meets or exceeds the requirements for flow range, power, and noise levels.

Instrumentation as specified below, is part of this scope of supply.

Air Scour PD Blowers **Model: GM 4 S DN 80**

Performance Data:		**Design**	**Min**	
Intake volume, handled at intake condition	cfm	129	22	
Volume handled at normal condition (dry) per ASME	scfm	114	19	
Mass flow	lb/h	536	90	
Density at inlet conditions	lb/cf	0.069	0.069	
Relative humidity	Φ	100%	100%	
Inlet pressure (abs.)	psia	14.71	14.71	
Discharge pressure (abs.)	psia	19.4	19.4	
Pressure difference	psig	4.7	4.7	
Intake temperature	°F	100	100	
Discharge temperature	°F	165	234	
Main rotor speed	rpm	3360	1162	
Power consumption at coupling	bHP	4	1	
Motor Rating	HP	5		
Motor Speed	rpm		1162	
Tolerance on flow & power	± 5 %			
Sound pressure level w/o enclosure	dB(A)	88		*Measured in free field at 3ft. distance from the outline of the unit
Sound pressure level w/ enclosure	dB(A)	65		*does not include system piping noise (tol. ± 2 dB(A)).

Weights & Dimensions:

Discharge connection	ANSI Flange	3"
Blower torso weight	lbs.	675
Blower motor weight	lbs.	0
Blower pkg weight	lbs.	675
Envelope dim.*	L x W x H in.	45 x 42 x 51
Cooling Fan	shaft driven	

* non binding dimensions includes, inlet filter silencer, relief valve, check valve, and flex connector

AERZEN USA CORPORATION
108 Independence Way
Coatesville, PA 19320
Tel. (610) 380-0244 ♦ Fax. (610) 380-0278

GM 4 S DN 80

Aerzen Generation 5 Delta Blower Package consists of the following components, assembled in our factory.

Aerzen Rotary Lobe Blower GM Series

- Narrow V-belt drive
- V-belt drive guard
- First fill of Delta Lube 06 oil
- Service Accessories
- Inlet filter-silencer, G4 per EN 779 (equivalent to MERV 7)
- Discharge Silencer, Reactive type, integrated with base frame
- Spring loaded pressure relief valve(s), sized for full flow
- Set of vibration isolating mounts
- Discharge manifold with externally accessible integrated check valve
- Hinged motor support as automatic belt tensioning device
- Sound enclosure, powder-coated galvanized steel, fire retardant HDP foam construction
- Adder for larger sound enclosure accomodating F2 motor conduit box
- 3" ANSI Flanged discharge connection
- Domestic construction adder
- 3" BABA compliant BFV
- Simplified ISO-1217, Annex B test report(s)
- Package factory run test, 1 hr (unwitnessed)
- Submittal data, hard copy
- O&M manual, hard copy
- Factory set PRV to 10.9 psig
- PE stamped seismic calculations
- Blower Warranty 24/30
- Domestic packaging

Drive motor

- CUSTOM MOTOR
- Motor thermostats, one per phase @ 155 deg C
- Motor shaft grounding ring
- 5HP Baldor Electric Motor,F2
- Motor Warranty 3-Yr Motor

Instrumentation and Controls

- Set of instrumentation (4" gauges, P1 gauge, P2 gauge & switch, T2 gauge & switch)
- Discharge pressure switch
- Junction box

Spare Parts

- 3 spare air filter(s)
- 3 spare belt set(s)
- Set of 1 Delta Lube 06 - 1 gallon(s)

Start Up & Services

- 2 trip(s), 3 day(s) total installation inspection, startup, & training
- 2 trip(s), 2 day(s) total end of warranty return visit

Freight

- Estimated Freight to jobsite

AERZEN USA CORPORATION
108 Independence Way
Coatesville, PA 19320
Tel. (610) 380-0244 ♦ Fax. (610) 380-0278

Quantity: **3**

No.	Description
1	Quantity (3) Aerzen GM 4 S DN 80 package as described above
2	Spare Parts as described above
3	Start Up Services as described above
4	Freight as described above

Price does not include any tax or VAT.

Delivery Terms: **CIP Aerzen USA Coatesville, PA**

General Terms: **This offer is subject to Aerzen USA Corp. Terms and Conditions of Sale of Goods and Services (AMUSA.02.28.25)**

Payment Terms: **Net 30 days, 20% of order value with approved submittals. 75% of order value at shipment. 5% of order value upon startup.**

Submittals: **4-6 weeks after receipt of purchase order**

Delivery Time: **presently approximately 16 weeks after technical release by customer.**

Warranty: **24 months after start up, 30 months after delivery, whichever comes first.**

*Maintenance must be performed per the Instruction Manual using Aerzen spare parts.

*Equipment not manufactured by Aerzen will carry the manufacturer's standard warranty.

Quote Validity: **All prices and lead times quoted are valid for 30 days from the date stated on the quotation.**

*Please be advised that the quoted prices are contingent upon current market conditions and may be subject to change. In anticipation of potential new tariffs and/or associated fees on imported products, we reserve the right at any time to adjust our prices accordingly. We will inform you of any changes as soon as they are confirmed.

AERZEN USA CORPORATION
108 Independence Way
Coatesville, PA 19320
Tel. (610) 380-0244 ♦ Fax. (610) 380-0278

Confidential & Proprietary - this document shall not be distributed to anyone other than the intended recipients.

AERZEN Reference Number: ENV-379690.3 11-Jun-25
Re: Taylor Bay, WA

Thank you for the opportunity to bid the referenced project. The Aerzen scope of supply meets the intent of the plans and specification as well as complying with the requirements for power and flow within the stated margin.

11370; 1.4 Aerzen does not recommend the use of unloading valves while the unit is VFD driven therefore none will be provided.

11370; 2.1 Aerzen will supply their standard Dry fil 4 1/2" P1 and P2 gauges with appropriate snubbers.

11370; 2.16 Aerzen will not supply blower stage bearings, gaskets, and seals as these are available to ship within 24 hours from our Coatesville facility. Internal Bearings, gaskets, and seals are to be installed by a trained service technician and are not field serviceable.

11370; 2.17 Aerzen will supply their packages with standard paint and powder coating in RAL 5001 which is in line with the industries best practices.

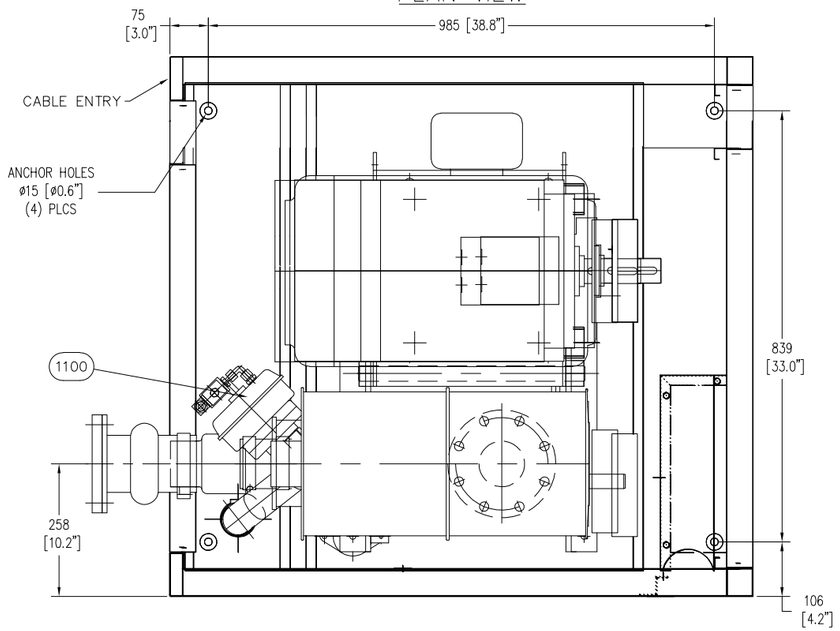
11370; 2.17 Aerzen packages will ship with finish coating installed on the package therefore there will be no field painting necessary.

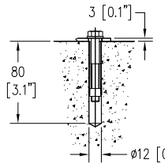
11000; 1.5 As no date of substantial completion was supplied Aerzen will supply their standard warranty period of 24 months from start-up or 30 months from delivery whichever comes first. If additional warranty is required this may be available during receipt of award.

General ; Section 11500 has not bee provided for review during time of Bid.

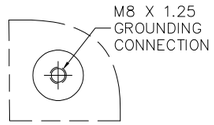
ITEM	QTY	DESCRIPTION	DESCRIPTION 2
100	1	BLOWER TORSO	GM4S, DN80
110	1	PRESSURE RELIEF VALVE	
200	1	SOUND ENCLOSURE	
300	1	ELECTRIC MOTOR	SHOWN WITH A 280 NEMA MOTOR
310	1	MOTOR MOUNTING	
320	1	BELT DRIVE	
400	1	BELT GUARD	
500	1	COOLING FAN	
600	1	DISCHARGE CONNECTION	3"-150# ANSI
800	1	INSTRUMENTATION	
1100	1	UNLOADING VALVE	(OPTIONAL)

PLAN VIEW



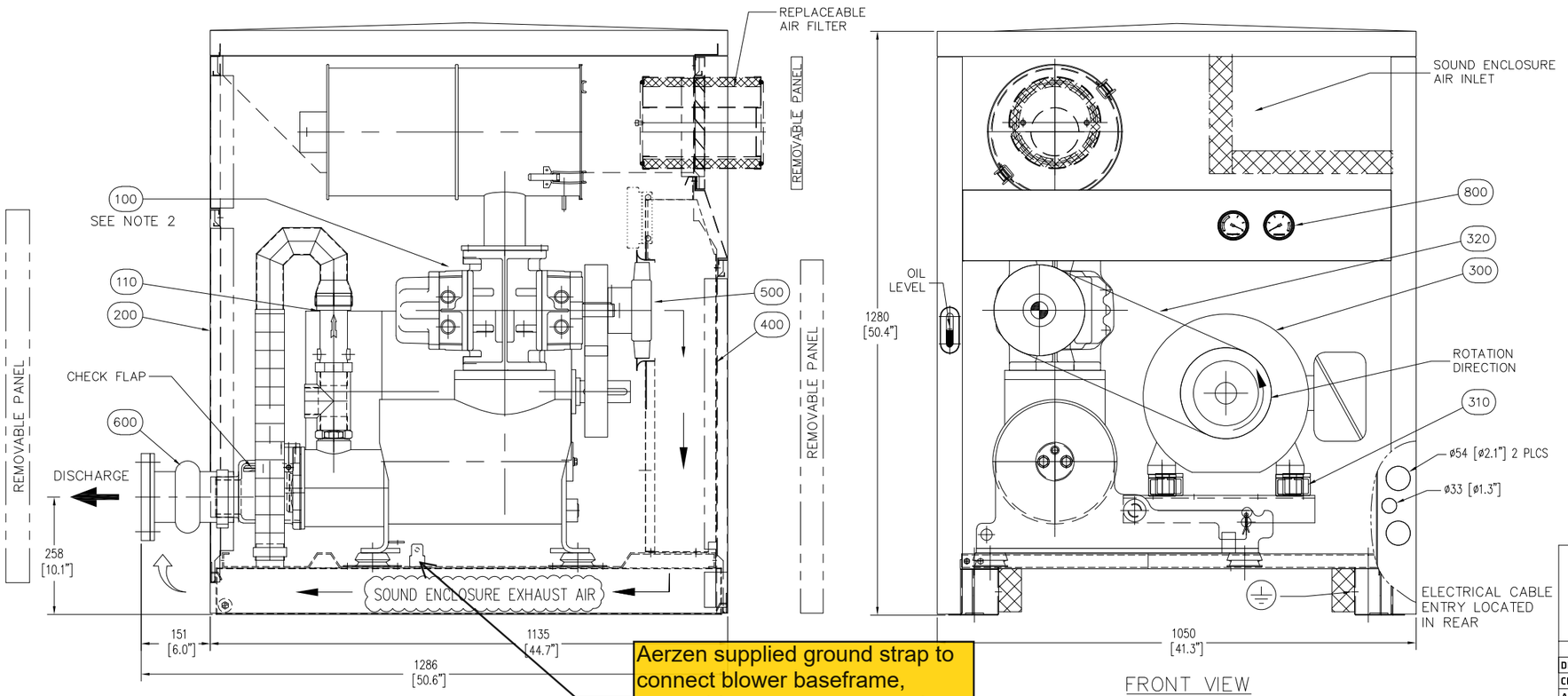


SOUND ENCLOSURE ANCHOR
RECOMMENDATION
SHOW WITH OPTIONAL ANCHOR
AERZEN PART NO. 2000053552
2X SCALE



EARTH GROUND
MAT'L: 304 SS
4X SCALE

Grounding lug provided at rear of package for customer earth grounding of package.



Aerzen supplied ground strap to connect blower baseframe, motor, blower stage to sound enclosure.

FRONT VIEW

NOTES:

1. TOLERANCE ON DIMENSIONS = ±12mm [0.5"]
2. ITEM 100 (BLOWER TORSO) INCLUDES BLOWER STAGE, INLET SILENCER, BASE FRAME/DISCHARGE SILENCER, VIBRATION ISOLATORS, & CONNECTION HOUSING WITH CHECK FLAP
3. CUSTOMER PIPING TO BE INDEPENDENTLY SUPPORTED
4. LIFT PACKAGE FROM BLOWER SIDE THROUGH FORK LIFT POCKETS IN BASE
5. SEE JOB DATA SHEETS FOR PERFORMANCE DATA, PART NUMBERS, TOTAL PACKAGE WEIGHT, INSTRUMENTATION, ANY OTHER OPTIONAL EQUIPMENT & OWNERS MANUAL
6. REGARDLESS OF THE OPERATING CONDITION, NO FORCES AND TORQUES MAY ACT ON THE MACHINE THROUGH THE CONNECTED SYSTEM PIPING. ALL CUSTOMER PIPING CONNECTIONS MUST BE DESIGNED AS FIXED POINTS AT THE AERZEN MACHINE LIMIT.

WEIGHT

BLOWER PACKAGE (LESS MOTOR)	306 kg	673 lbs
ELECTRIC MOTOR (ITEM 300)	-	-
TOTAL (WET WEIGHT)		

AERZEN

AERZEN USA *CORPORATION*
108 INDEPENDENCE WAY, COATESVILLE, PA.
PH: (610) 380-0244 FX: (610) 380-0278
WWW.AERZEN.COM

CLASS I

	NAME	DATE
DRAWN BY	JCH	11/25/2024
CHECKED BY	ACW	11/26/2024
APPROVED BY	-	-

DRAWING NO.
GB-006947-P2021000
NAVISION PN.
-

TITLE
GA DRAWING
GM4S, DN80, G5
F2 SOUND ENCL.
3"-150# ANSI (OUT)
PRESSURE
-

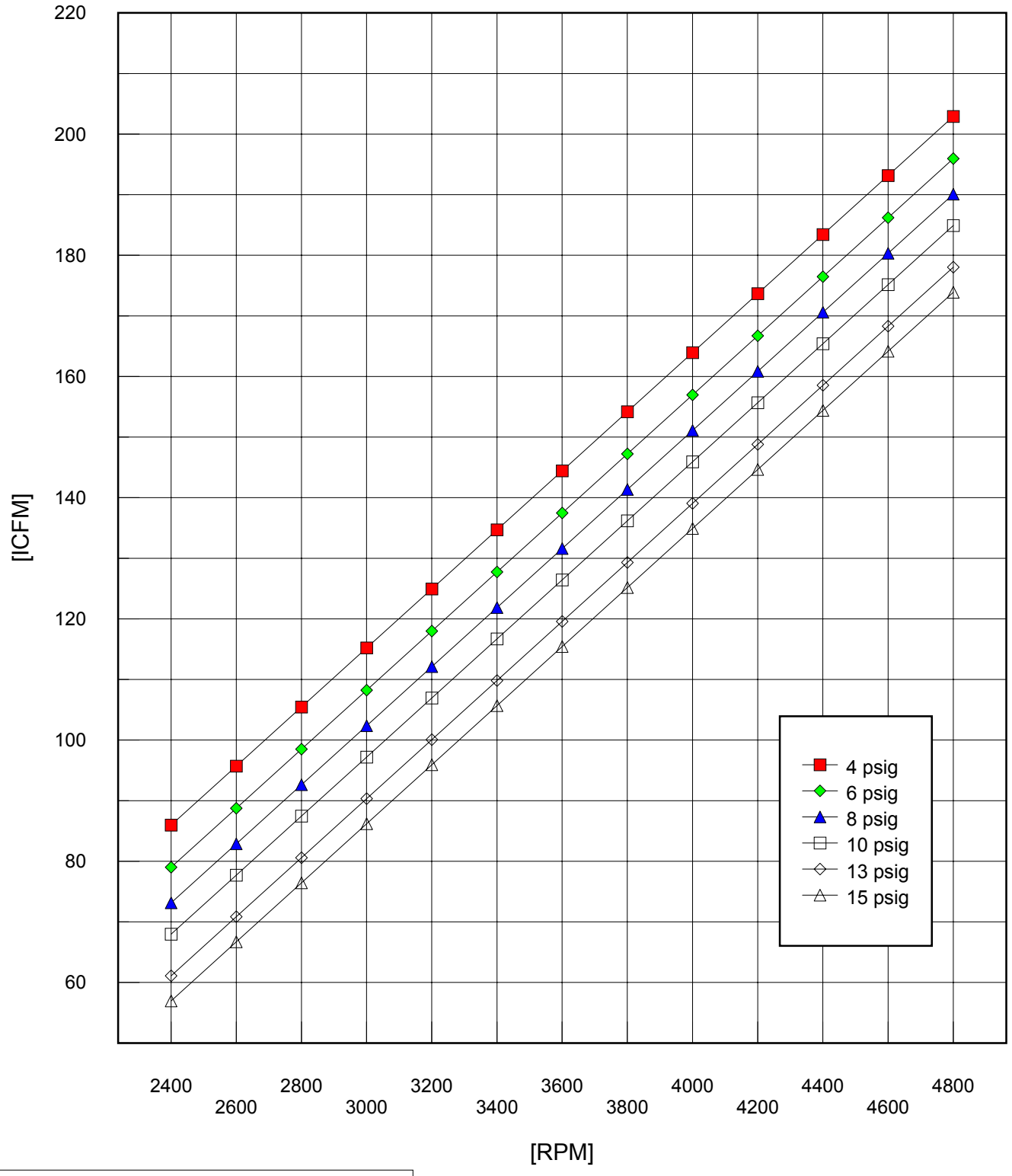
SCALE:- SHEET:1/ 1

REV.	NAME	DATE
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

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AERZEN GM 4S DELTA PACKAGE, PRESSURE

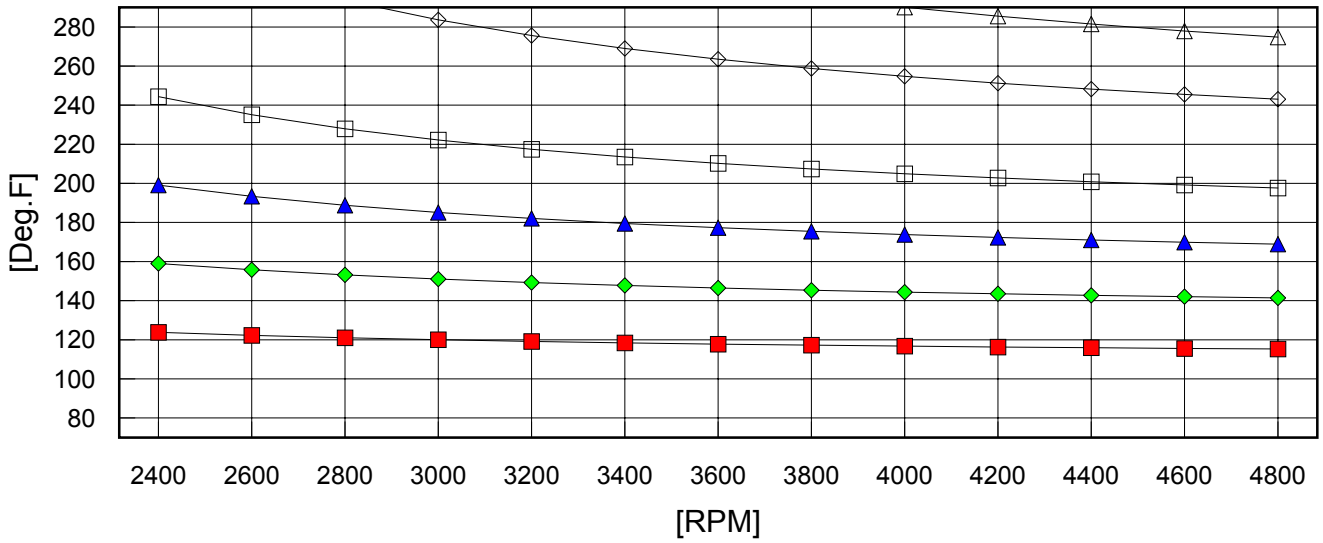
INLET FLOW



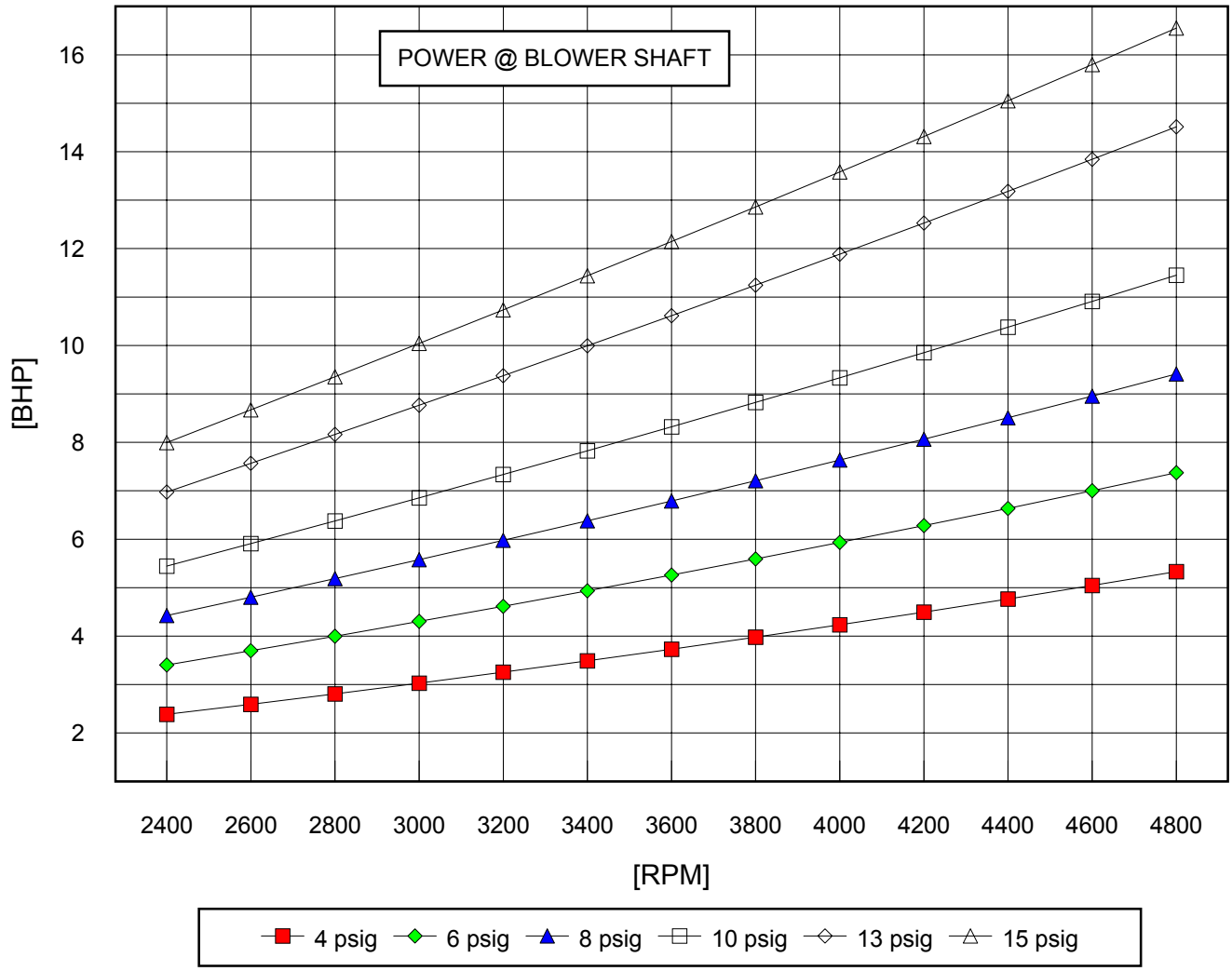
Performance data based on air @ 68 deg.F/ 14.7 psia inlet.

AERZEN GM 4S DELTA PACKAGE, PRESSURE

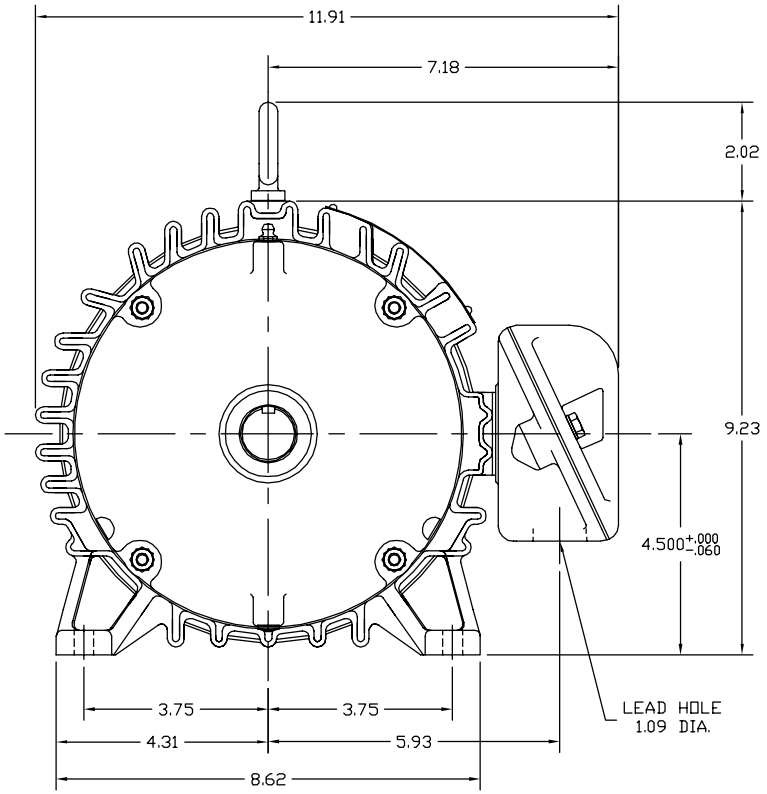
DISCHARGE TEMPERATURE

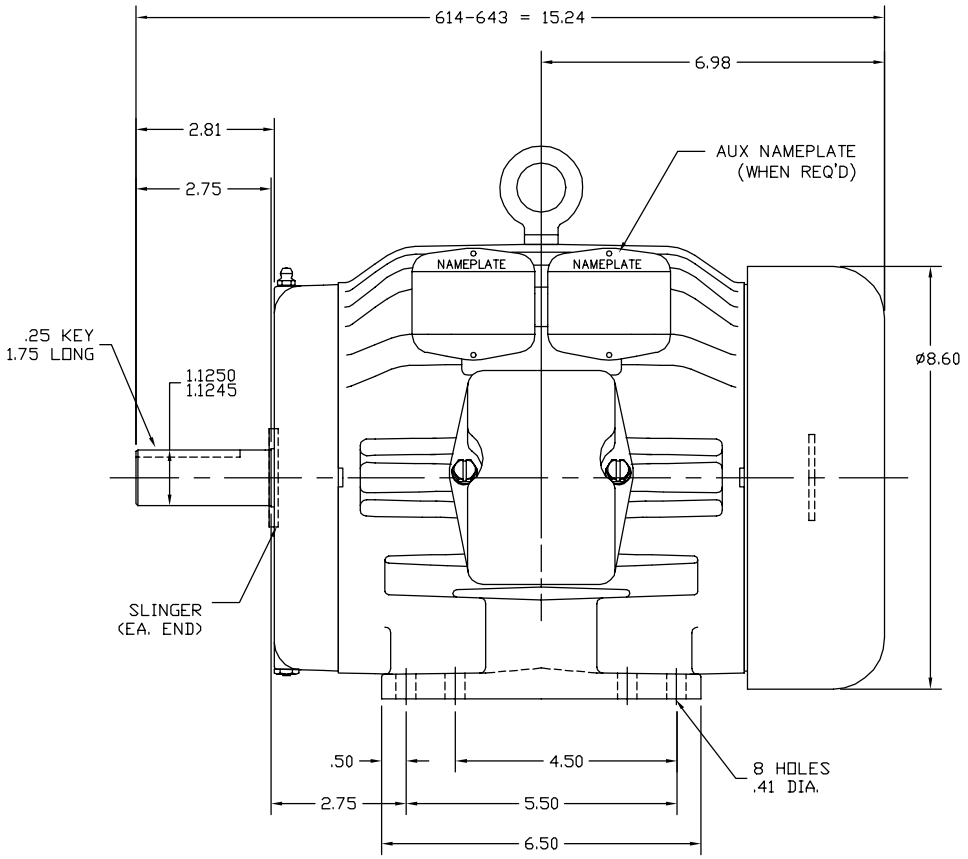


MAXIMUM ALLOWABLE DISCHARGE TEMPERATURE: 285 deg.F
Performance data based on air @ 68 deg.F/ 14.7 psia inlet.



06LY-000-110





CUSTOMER IS RESPONSIBLE FOR DETERMINING THAT BALDOR'S PRODUCT WILL PERFORM SUITABLY IN THE INTENDED APPLICATION.

REV. DESC: REMOVE GREASERS/RELIEF CALL OUTS FOR PROD BLDR		
REV. LTR: A	VERSION: 01	TDR: 000001160399
FILE: \AAA\00249\823	REVISED: 03:19:00 02/11/2021	BY: ENMICW1
MTL: –		

BALDOR - RELIANCE®

HOR 182-4T TEFC 306M F2 & SLINGERS

SH 1 of 1

06LY-000-110

BALDOR • RELIANCE

AC Induction Motor Performance Data

Record # 92406

Typical performance - not guaranteed values

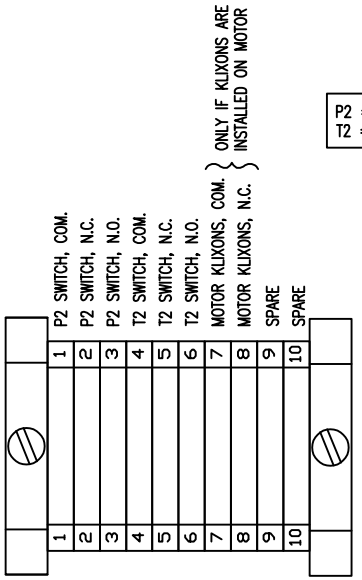
Winding: 06WGX203	**Type:** 0642M	**Enclosure:** TEFC

Nameplate Data				General Characteristics at 460 V, 60 Hz: Single Volt Motor	
Rated Output (HP)	5			Full Load Torque	15 LB-FT
Volts	460			Start Configuration	DOL
Full Load Amps	6.6			Break Down Torque	53.9 LB-FT
R.P.M.	1750			Pull-Up Torque	22.4 LB-FT
Hz	60	Phase	3	Locked-rotor Torque	31.8 LB-FT
NEMA Design Code	B	KVA Code	J	Starting Current	46 Amps
Service Factor	1.15			No-load Current	3.02 Amps
NEMA Nom. Eff.	89.5	P.F.	79	Line-line Res. @ 25°C.	2.63 Ohms
Rating - Duty	40C AMB-CONT			Temp. Rise @ Rated Load	53°C
S.F. Amps				Temp. Rise @ S.F. Load	65°C

Load Characteristics at 460 Volts, 60 Hz

% of Rated Load	25	50	75	100	125	150	S.F.
Power Factor	41	63	75	81	84	85	81
Efficiency	85.2	89.8	90.4	89.5	88.4	86.9	88.7
Speed	1789	1777	1765	1752	1737	1721	1739
Line Amperes	3.35	4.14	5.21	6.45	7.91	9.47	7.52

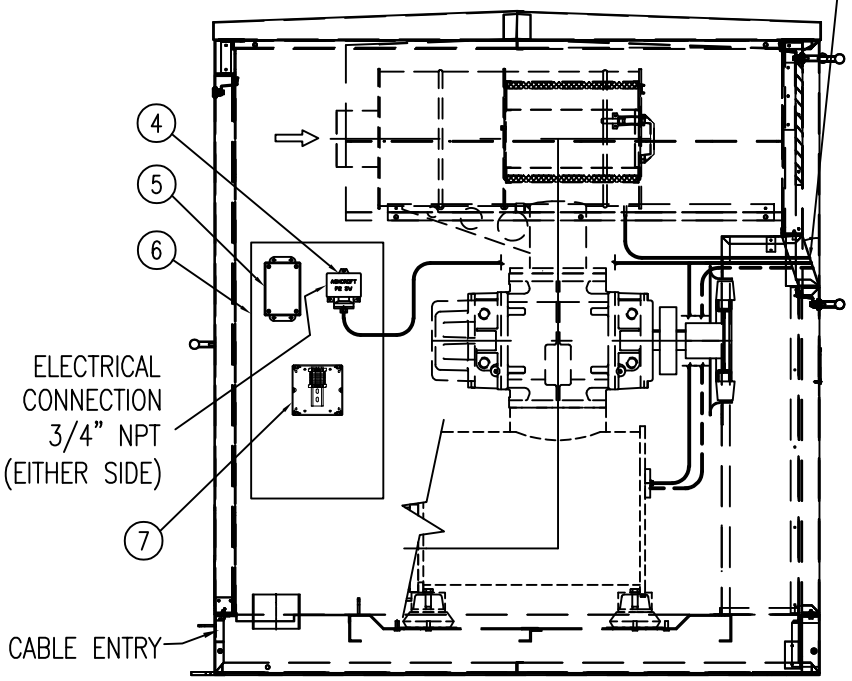
ABB Motors and Mechanical Inc.

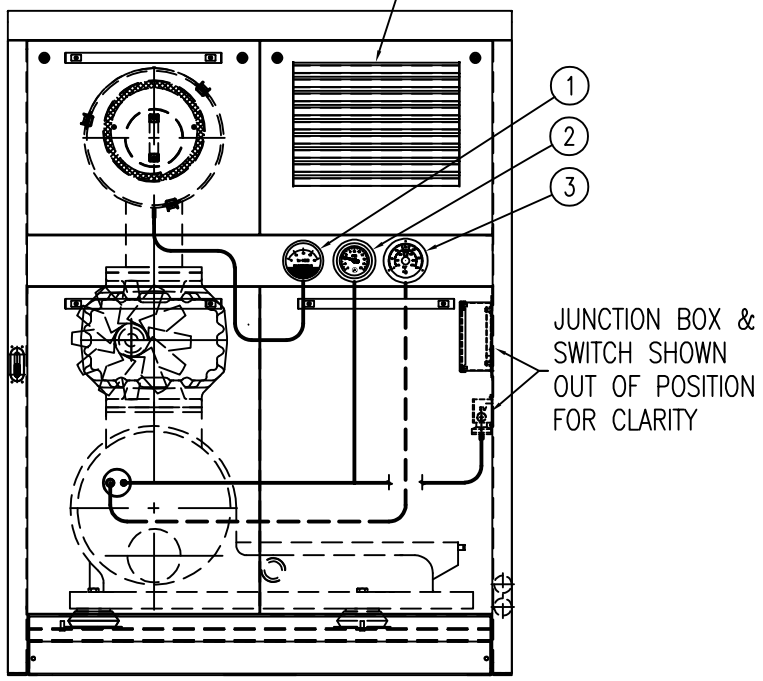


CUSTOMER CONNECTION SIDE
RATED: 30VDC/250VAC @ 2.0A

DETAIL
TERMINAL BLOCK DIAGRAM
FOR JUNCTION BOX

P2 = DISCHARGE PRESSURE
T2 = DISCHARGE TEMPERATURE





FRONT PANEL

NOTES:
1. ALL PRESSURE GAUGES & SWITCHES ARE INSTALLED WITH PULSATION DAMPERS. (EXCEPT IF GAUGE HAS A LIQUID FILL)
2. SHOWN INSTALLED ON A DELTA BLOWER, GM35S, DN150 PACKAGE.

MAIN COMPONENTS

ITEM	DESCRIPTION	PART NO.
1	GAUGE, FILTER MAINTENANCE INDICATOR	21-006757
2	GAUGE, DISCHARGE PRESSURE	21-006758
3	DISCHARGE TEMPERATURE GAUGE/SWITCH	21-006756
4	SWITCH, DISCHARGE PRESSURE	21-000746-02
5	JUNCTION BOX	21-000990_06X04_01
6	MOUNTING PANEL	21-002532
7	RTD JUNCTION BOX	SEE PAGE 2

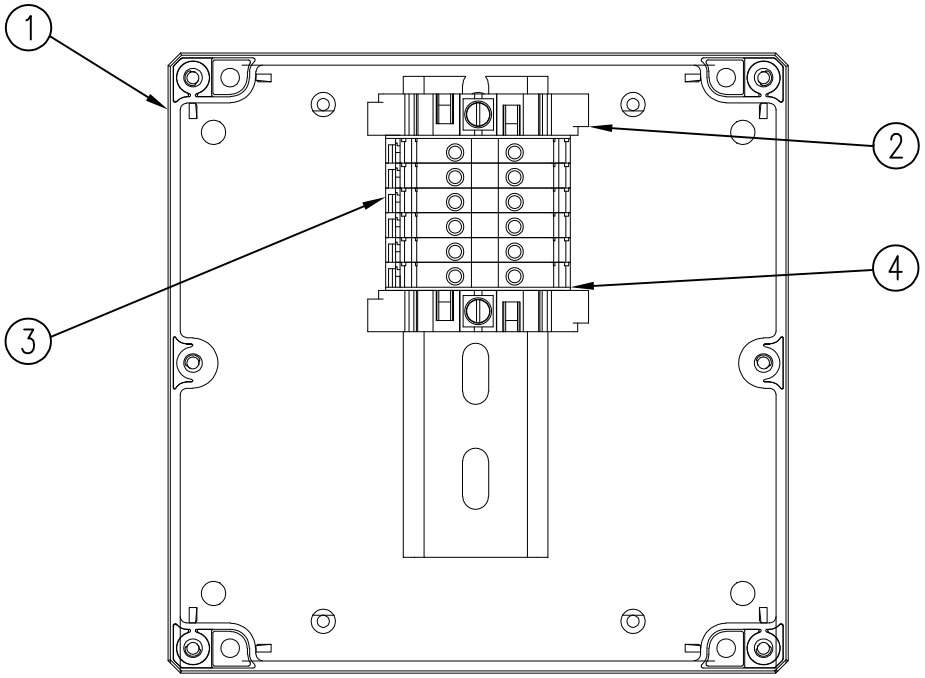
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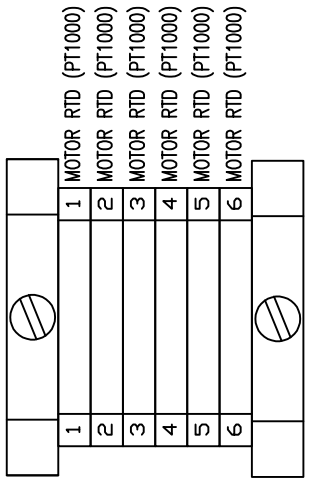
AERZEN USA CORP.
108 Independence Way, COATESVILLE PA 19320
(610) 380-0244 PH, (610) 380-0278 FX

TITLE
G-5 BLOWER - INSTR. (S.E.)
FILTER MAINTENANCE INDICATOR
DISCHARGE PRESSURE GAUGE & SWITCH
DISCHARGE TEMPERATURE GAUGE & SWITCH

DATE	DRAWN BY:	CHECKED BY:	P.M. APPROVAL :	SCALE:
03/10/2025	ACM	JCH	-	MSPACE 1 :1

DRAWING NO:	REVISION NO:	SHEET:
G5-IM-PS07-4001-07	-	1/2





CUSTOMER CONNECTION SIDE
RATED: 1000 OHM RESISTANCE

DETAIL
TERMINAL BLOCK DIAGRAM
FOR JUNCTION BOX

MAIN COMPONENTS

ITEM	DESCRIPTION	PART NO.
1	JUNCTION BOX	21-000990_06X06_01
2	TERMINAL STRIP END CLAMP	21-56-004-01
3	RTD TERMINAL BLOCK	21-011460
4	TERMINAL BLOCK END PARTITION	21-011461
5	CONNECTOR ON RTD (LANDED AT DRIVE MOTOR)	041-030167F
6	CONNECTOR ON CABLE (LANDED AT DRIVE MOTOR)	041-030167M
7	3 CONDUCTOR RTD CABLE (LANDED AT MOTOR)	21-011463

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AERZEN USA CORP.
108 Independence Way, COATESVILLE PA 19320
(610) 380-0244 PH, (610) 380-0278 FX

TITLE
G-5 BLOWER - INSTR. (S.E.)
FILTER MAINTENANCE INDICATOR
DISCHARGE PRESSURE GAUGE & SWITCH
DISCHARGE TEMPERATURE GAUGE & SWITCH

DATE	DRAWN BY:	CHECKED BY:	P.M. APPROVAL :	SCALE:
03/10/2025	ACM	JCH	–	MSPACE 1 :1

DRAWING NO:	REVISION NO:	SHEET:
G5-IM-PS07-4001-07	–	2/2

AERZEN

Compressed air, gas
and vacuum solutions

AERZEN USA Statement on BABA Compliance

May 2024

Aerzen USA, the primary supplier of high efficiency blowers for municipal wastewater treatment, will continue to support all municipal projects falling under BABA requirements until further direction and clarification from the EPA is provided regarding the blower technologies that serve this market. Aerzen USA manufactures multiple blower technologies out of our headquarters in Coatesville, Pennsylvania and has previously complied with similar federal and state laws such as ARRA (*American Recovery and Reinvestment Act*) and PA Steel.

We believe we have identified a path forward for our GM Blower product that complies with BABA requirements and have begun exploring options for producing a BABA compliant Hybrid blower package. Regarding high-speed turbo blower technologies, Aerzen and other manufacturers are petitioning for the EPA to issue a waiver for these technologies. As such, Aerzen USA will continue to support all municipal wastewater projects moving forward with our existing products and will also continue to work with EPA representatives and the Water and Wastewater Manufacturers Association (*WWEMA*) in providing industry guidance on the above. This includes working in tandem with other blower manufacturers to assist the EPA in defining requirements and issuing waivers as stated above. In the meantime, the current SRF waiver for projects in design prior to May 14, 2022 will exempt manufactured products from BABA compliance. Aerzen will continue to follow EPA guidance in their evaluation and update the market as necessary.

Aerzen USA
108 Independence Way
Coatesville, PA 19320 USA
www.aerzen.com

EQ-03

PERMEATE PUMP

For Earth, For Life
Kubota

Submittal Transmittal

Permeate Pump

Project Name	TAYLOR BAY BEACH CLUB WWTF UPGRADE
Project Site	8220 178TH AVENUE, LONGBRANCH, WA 98351
Engineer	Gray & Osborne, Inc 1130 RAINIER AVENUE SOUTH, SUITE 300
Submit to	Gray & Osborne, Inc
Prepared by	Shingo Kubo | Lead Project Manager KUBOTA Water and Environment U.S.A. Corporation 19910 N Creek Pkwy, Suite 100 Bothell, WA 98011
KMU Project #	KMU-OPID85
Issued Date	August 24, 2025
Package #	OPID85- EQ-03-B-Perneate Pump
Item	Tag # 01 PMP 01 01 PMP 02 01 PMP 03

Clarifications;

1. Section1 contains Kubota scope list. The subjected item for this submittal is marked in red.

2. Section2 contains the manufacture submittal and datasheet for review.

Deviations to the specification;

1. 11305; 2.2 “The pumps shall be of the positive displacement, rotary lobe type, designed to pump return activated sludge” should be corrected to “The pumps shall be of the positive displacement, rotary lobe type, designed to pump **MBR permeate**”
2. 11305; 2.3 Delete “and radial surfaces”- Radial liners are required for sludge applications, however, for MBR permeate applications we typically do not include radial liners as there is very little in the water to wear against the casing. We can provide the radial liners if the customer still wants them.
3. 11305; 2.4 “Rotors shall be tri lobe screw rotor design and shall consist of a non-sludge-wetted cast iron or machined steel core entirely coated with abrasion-resistant Buna-N” should be corrected to “Rotors shall be **dual** lobe screw rotor design and shall consist of a non-**pumped-fluid** -wetted cast iron or machined steel core entirely coated with abrasion-resistant Buna-N”
4. 11305; 2.4 Replace “non-sludge-wetted” with “non-pumped-fluid-wetted”
5. 11305; 2.4 “Sludge wetted rotor/shaft connections are not acceptable” should be corrected to “Wetted rotor/shaft connections are not acceptable”

Response to 60% review comment;

1) General – Make Corrections Noted

a. Note that BABA certifications from manufacturers should be included in the final

Kubota Response: BABA certificate is included at the last page of section 2. Please note that the certificate is subjected to be updated after the manufacturer receives the order.

b. Note that manufacturer services should be included in the final submittal.

Kubota Response: Manufacturer service is included per the specifications.

For Earth, For Life
Kubota

SECTION 1

KUBOTA Water and Environment U.S.A. Corporation
19910 N Creek Pkwy, Suite 100 Bothell, WA 98011| Phone: 425 898 2858 | Fax: 425-898-2853

No	Equipment Location	Tag	Category	Function	Name	Type	Chosen Size/Capacity	Unit	Material	Manufacturer	Model/ Specification	Motor HP	Voltage	FLA	QTY
	MBR Equipment	**x**													
1	MBR	02 MBR 01 02 MBR 02 02 MBR 03 02 MBR 04	SMU	Membrane Filtration	MBR SMU	Flat Plate			304SS	KUBOTA	FS150				4
2	MBR	n/a	SMU	SMU Maintenance	MBR SMU Lifting Tool	Lifting Tool			CS, SS	KUBOTA	TG150				1
3	MBR	n/a	SMU	SMU Maintenance	MBR SMU Lifting Chain	Lifting Tool			304SS	KUBOTA	CS30M				4
4	MBR	02 MOV 03 02 MOV 04	Auto Valve	Diffuser Cleaning	MBR Diffuser Cleaning Valve	ON/OFF Plug	3	inch	CI/CI	Auma/Pratt	SQ12.2-AC01.2/S601 w/extention stem	1/12	120 VAC	2.9	2
5	MBR	n/a	Other Valve	Isolation Valve	SMU Air Isolation Valve(inlet)	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S30				4
6	MBR	n/a	Other Valve	Isolation Valve	SMU Air Isolation Valve(outlet)	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S30				4
7	MBR	BV281 BV282 BV283 BV284	Other Valve	Isolation Valve	SMU PRMT Isolation Valve	Manual Butterfly	2	inch	DI, EPDM, Nylon Coat	Bray	S30				4
8	MBR	n/a	Other Valve	Manual Valves	Isolation Valves for CIP injection	Manual Ball	1	inch	PVC	ASAHI	Type21 True Union				4
9	MBR	02 LS 03 02 LS 04 02 LS 05 02 LS 06	Gauge, Switch	Level Measurement	MBR Level Switch	Float			PP, PU	Conery	2902-B8S1 w/ counter weight and brackets		Loop power		4
10	MBR	n/a	Fabrication	Fabrication	MBR SMU Guide & Stabilizer + Seismic Bracing				304SS	TBD					4
11	MBR	n/a	Fabrication	Fabrication	MBR SMU Fasteners				304SS	TBD					40
12	MBR	n/a	Fabrication	Fabrication	MBR In-Basin Pipe&Supports (Permeate Drop Pipe)				PVC	TBD					4
13	MBR	n/a	Fabrication	Fabrication	MBR In-Basin Pipe&Supports (Air Drop Pipe)				304SS	TBD					8
	Permeate (PRMT) Control Equipment	**x**													
14	PRMT	01 PMP 01 01 PMP 02 01 PMP 03	Permeate Pump	Permeate Extraction	PRMT Pump	Rotary Lobe	45	gpm		Boerger	AN 70 w/ piggyback mount	5	460 VAC	6.6	3
15	PRMT	PI169 PI170 PI171	Gauge, Switch	Pressure Gauge	PRMT Pump Pressuge Gauge(Inlet)		-15 - +15	psig	SS	Ashcroft or equivalent	1279 w/ grycelin filled				3
16	PRMT	PI172 PI173 PI174	Gauge, Switch	Pressure Gauge	PRMT Pump Pressuge Gauge (Inlet)		-15 - +15	psig	SS	Ashcroft or equivalent	1279 w/ grycelin filled				3
17	PRMT	01 PTR 01 01 PTR 02	Pressure Sensor	TMP Measurement	PRMT Pump Pressure Transmitter	Diaphragm	-15 - +15	psi	SS	Endress & Hauser	Cerabar PMCB51		Loop power		2
18	PRMT	01 MFM 01 01 MFM 02	Flow Sensor	Flow Measurement	PRMT Flow Meter	Electromagnetic	3	inch	PU	Endress & Hauser	Promag W 400		24VDC		2
19	MBR	n/a	Other Valve	Isolation Valve	MBR PRMT Pump isolation valve	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S30				8
20	MBR	CV261 CV261 CV261	Other Valve	Check valve	MBR PRMT Pump discharge check valve	Manual ball	3	inch	PVC, EPDM	ASAHI	True Union Ball Check				3
21	PRMT	01 TM 01	Other Instrument	Turbidity Measurement	PRMT Turbidity Meter	Laser	0-5	NTU		HACH	TU5300sc				1
22	PRMT	01 TM 01	Other Instrument	Turbidity Measurement	PRMT Turbidity Transmitter					HACH	SC4500		24VDC		1
23	PRMT	n/a	Other Instrument	Turbidity Measurement	Turbidity Meter Maintenance Kit					HACH					1
	Return Activated Sludge (RAS) Control	**x**													
24	MBR	Relocated from MBR 02 SLS02 02 SLS03	Other Instrument	Level Measurement	MBR Level Sensor	Hydrostatic	15	ft	SS	Endress & Hauser	Waterpilot FMX21 w/ brackets		Loop power		2
	MBR Blower	**x**													
25	MBR BLW	01 MSB 01 01 MSB 02 01 MSB 03	Blower	Blower	MBR Blower	Positive Displacement	114	scfm	CI	Aerzen	GM 4S DN 80	5	460 VAC	6.6	3

No	Equipment Location	Tag	Category	Function	Name	Type	Chosen Size/Capacity	Unit	Material	Manufacturer	Model/ Specification	Motor HP	Voltage	FLA	QTY
26	MBR BLW	n/a	Option	Noise Suppression	MBR Blower Sound Enclosure	With Blower									3
27	MBR BLW	n/a	Option	Blower Temperature	MBR Blower Temperature Gauge	With Blower									3
28	MBR BLW	n/a	Option	Blower Pressure	MBR Blower Pressure Gauge	With Blower									3
29	MBR BLW	n/a	Option	Blower Temperature	MBR Blower Temperature Switch	With Blower									3
30	MBR BLW	01 AFM 01 01 AFM 02	Flow Sensor	Air Flow Measurement	MBR Blower Flow Meter	Thermal Mass	3	inch	PU	Endress & Hauser	t-mass I 300, w/ flow conditioner plate		24VDC		2
31	MBR BLW	n/a	Other Valve	Manual Valves	Air Scour Blower Isolation Valves	Manual Butterfly	3	inch	DI, FKM, SS Disk	Bray	S30				4
	Clean-In-Place Equipment	**x**													
32	SMU CIP	n/a	Chemical Injection	Chemical Injection	SMU CIP System PVC pipes		1	inch	PVC	KUBOTA	Loose ship parts shown on xxx				1
33	SMU CIP	n/a	Flow Sensor	Flow Measurement	CIP solution Flow Meter	Electromagnetic	1	inch	PU				24 VDC		1
34	SMU CIP	n/a	Flow Sensor	Flow Measurement	CIP shelf chenical Flow Meter	Electromagnetic	3/8	inch	PU	Keyence	FD-Q10C		24VDC		1
35	SMU CIP	n/a	Auto Valve	Flow Control	CIP Flow Control Valve	ON/OFF Ball	1	inch	DI	ASAHI	S19-120VAC--1"-C20/S20		120VAC	0.18	1
36	SMU CIP	n/a	Other Valve	Manual Valves	Isolation Valves on CIP Station	Manual Ball	1, 0.5	inch	PVC	ASAHI	Type21 True Union				1
37	SMU CIP	n/a	Other Valve	Manual Valves	Pressure reducing valve	Pressure Reducing	1.5	inch	CI	Zurn	ZW209				1
	System Control Equipment	**x**													
38	CONTROL	n/a	Control Panel	Control Panel	Control Panel	OIT, PLC					NEMA 4/12, 72" x 72" x 18" floor mount enclosure (estimated size) , Allen Bradley 1756-L81E PLC (BABA-Version), FactoryTalk View SE		120VAC	TBD	1
39	D. SERVICE	n/a	D. Service	Direct Service	Direct Service						Design support, start-up, field service, remote service				1

SECTION 2

BÖRGER®

Boerger LLC - 2860 Water Tower Place - Chanhassen, MN 55317 - USA

KUBOTA Water and Environment U.S.A
19910 North Creek Pkwy S. Ste 100
Bothell, WA 98011

Quote

No.: **31013283**
Date: 06/05/2025

RFQ no.:	Taylor Bay, WA	**Inside Sales Person:**	Kaley Lindquist
RFQ date:	10/25/2024	**E-mail:**	kli@boergerllc.com
Customer No.:	110244	**Phone:**	612-435-7356
Contact:	Tommy Anderson	**Code:**	KLIFDH
Phone:	206-888-0556		
Cell phone:			

Pos.	Description		Quantity
100	71009100	**AN70 Pump Assembly** Lead Time: Consult Factory	3
200	K0002010	**AN70 Spare Parts & Tools** Lead Time: Consult Factory	1
300	K0002999	**Service - 2 Days** Lead Time: Consult Factory	2
400	K0001220	**Factory Testing/Documentation** Lead Time: Consult Factory	1

Quote

No.: 31013283

Pos.	Description	Quantity

100.0 71009100
Blueline AN Assembly
AN70 Pump Assembly

Medium specification:
Spec. pumped medium: Permeate .

Operational characteristics:
Location: dry, indoor .
Mode of operation: Continuous .

Performance data:

	gpm	Psi	rpm
Nom. Delivery rate:	45	18.6	284

101.0 PS7SARDPSE5E5CCC13 3 pc
Börger Rotary Lobe Pump AN070
Product series: BLUEline Nova
Version: Clean

Casing:
One-piece Blockcasing from Grey Cast Iron EN-GJL-250 (GG25)
The clean design features a minimum of dead space
MIP® Design

Rotor geometry:
Dius, dual-lobe, screw form for almost pulsation-free pumping
The wide sealing surface of the rotors guarantees a maximum volumetric efficiency
Rotor coating: NBR
Displacement: 0,7 l/rev
Free ball entry D = 30 mm

Shaft seal:
single-acting mechanical seals, type LW
Material code according EN 12756 [DIN 24960]: Q2 Q2 P G
Seal faces: SISIC/SISIC
Dynamic O-rings: NBR
Seal holding bushes: 1.4404
Stationary O-Rings: NBR

102.0 3000000004 6 pc
AN70 to 3in ANSI Flange
B1 Configuration, 1/2 NPT
Galvanized CS, Domestic Mat.

103.0 3000000016 3 pc
Dodge Reducer
HB482CN180TC 340RPM

104.0 3000000048 3 pc
Baldor CECP83665T-4
5hp,1750rpm,IEEE 841
3ph,60Hz,460V
TEFC,184TC,1.15SF
Add Grounding Ring
Add Thermostat

Quote

No.: 31013283

Pos.	Description	Quantity
105.0	**2510000277** **AN-SK32 Overhead Frame** Painted Door Max Torque: 242 Nm	3 pc
	AN70 Pump Assembly	
200.0	**K0002010** **Blueline Spare Parts** AN70 Spare Parts & Tools	
201.0	**B91013** **Casing protection plate AN** cover side 23MnCr4-3 (1.8714)	1 pc
202.0	**10065894** **Casing protection plate AN V2** gear side 23MnCr4-3 (1.8714)	1 pc
203.0	**10063525** **Dius rotor AN070 V2** dual-lobe scr. p ccw NBR	1 pc
204.0	**10063555** **Dius rotor AN070 V2** dual-lobe screw p cw NBR	1 pc
205.0	**10066623** **LW mechanical seal AN V2** Q2P SISIC/NBR Seal faces: SISIC auxiliary seals: NBR	2 pc
206.0	**O80515** **O-ring 195x3 NBR** Shore 70 P583 NBR 70	1 pc
207.0	**O80520** **O-ring 44x2,5 NBR** Shore 70 P583 NBR	1 pc

Quote

No.: 31013283

Pos.	Description	Quantity
208.0	**10062522** **O-ring 65x2 NBR** Shore 70 P583 NBR	2 pc
209.0	**Z38203** **Countersunk screw M6x10** DIN 965-TX A4-70	2 pc
210.0	**Z49604** **Hex.skt.head cap screw M12x25** DIN 6912, 10.9 Stahl	2 pc
211.0	**U32915** **Rotor puller, AL/BJ/AN** for rubber coated rotors	1 pc
212.0	**10063612** **Multitool AN V2** 16 grooves, assembled 1.4301 X5CrNi18 10 (1.4301)	1 pc

AN70 Spare Parts & Tools

300.0	**K0002999** **Accessories** Service - 2 Days	
301.0	**1500000007** **Service/Maintenance** Service For 2 Days	2 pc

Service

400.0	**K0001220** **Documentation** Factory Testing/Documentation	
401.0	**2600000018** **Seismic Calculations**	1 pc

Seismic Calculations

BÖRGER®

Quote

No.: 31013283

Pos.	Description	Quantity
402.0	**1700000035** **AN-PL-PN Performance Test** ANSI/HI 3.6-2022 Type IV, Level A w/ Certificate	3 pc

Performance Test

BOERGER LLC
2860 Water Tower Place
Chanhassen, MN 55317

p 612.435.7300
f 612.435.7301

e america@boerger.com
w www.boerger.com

MAINTENANCE IN PLACE MIP

Quote

No.: 31013283

Invoice address:
KUBOTA Water and Environment U.S.A
19910 North Creek Pkwy S. Ste 100
Bothell, WA

Delivery address:
KUBOTA Water and Environment U.S.A
19910 North Creek Pkwy S. Ste 100
Bothell, WA

Terms Of Payment:	60 days net
Dispatch Type:	Less than Truck Load
Price Valid To:	07/04/2025
Terms of Delivery:	FOT Minneapolis

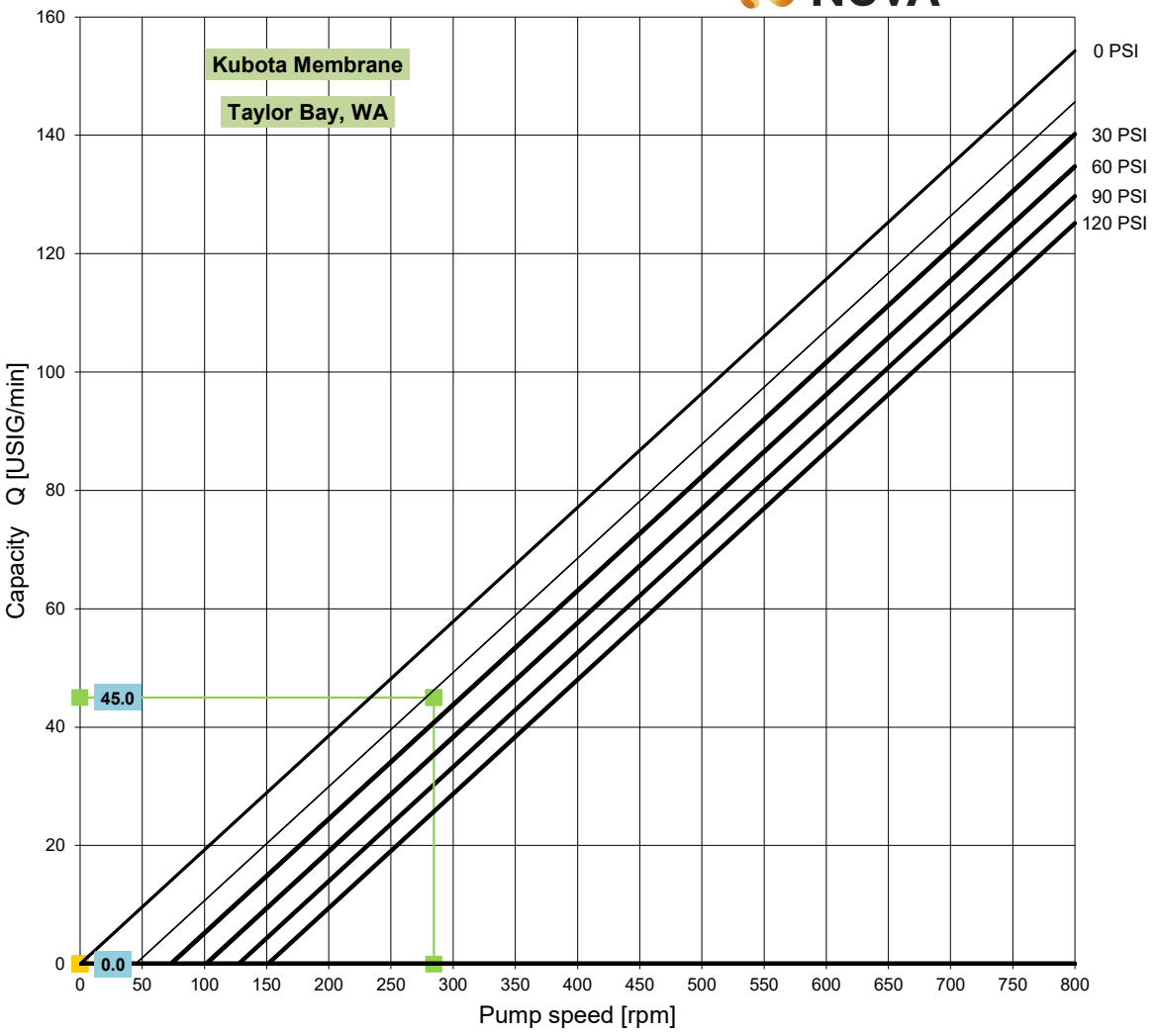
Best regards

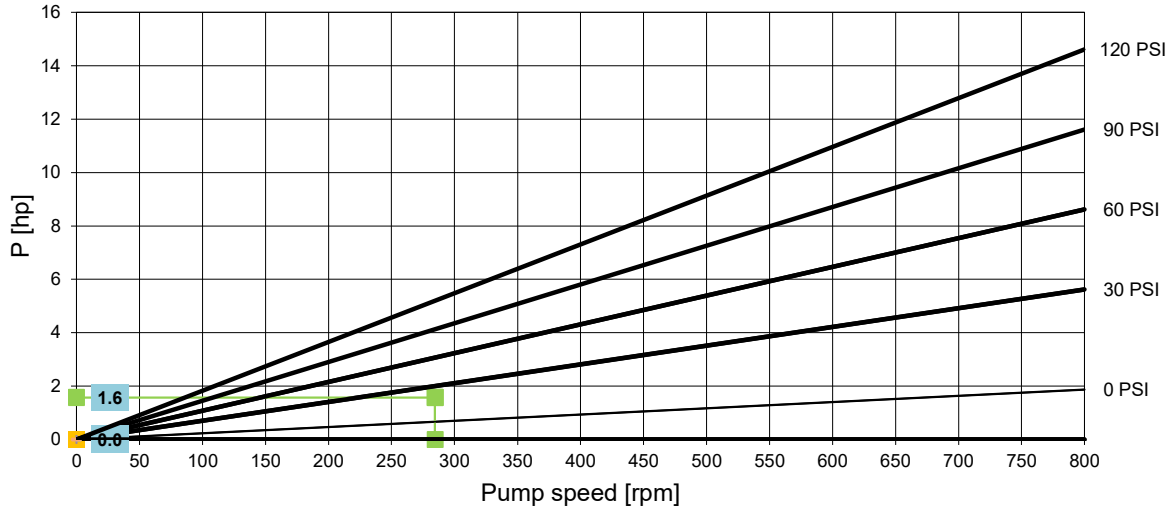
Boerger LLC
Kaley Lindquist
Phone: 612-435-7356
E-mail: kli@boergerllc.com
Website: www.boerger.com

Regional Manager:
Scott Mulinix
612-435-7319
smu@boergerllc.com

Notes:
1. BOERGER, LLC's standard Terms and Conditions apply and are an integral part of this quotation unless specifically noted otherwise in this proposal.
2. Delivery, installation, wiring, field painting, start-up and instructional services are not included unless specifically noted otherwise in this proposal.
3. Anchor bolts, pressure gauges, valves, drainage piping, starters, variable frequency drives and control equipment or any other items are not included unless specifically noted otherwise in this proposal.
4. BOERGER, LLC will review plans and specifications and will offer technical assistance and certified pump drawings for construction. The responsibility for pump station layout, access, seismic calculations including local PE stamp, etc., shall be by others.
5. This proposal is offered as an acceptable pumping system based upon descriptive items listed above. Deviations from the equipment described could result in price adjustment.
6. A BOERGER, LLC field engineer may be provided, as noted above, in a supervisory capacity only. Any and all costs associated with labor, set-up, etc., for the tests are to be by contractor.
7. Credit Card purchases will incur a 3% Processing Fee.

Performance Curve
AN70 Rotor Type 5

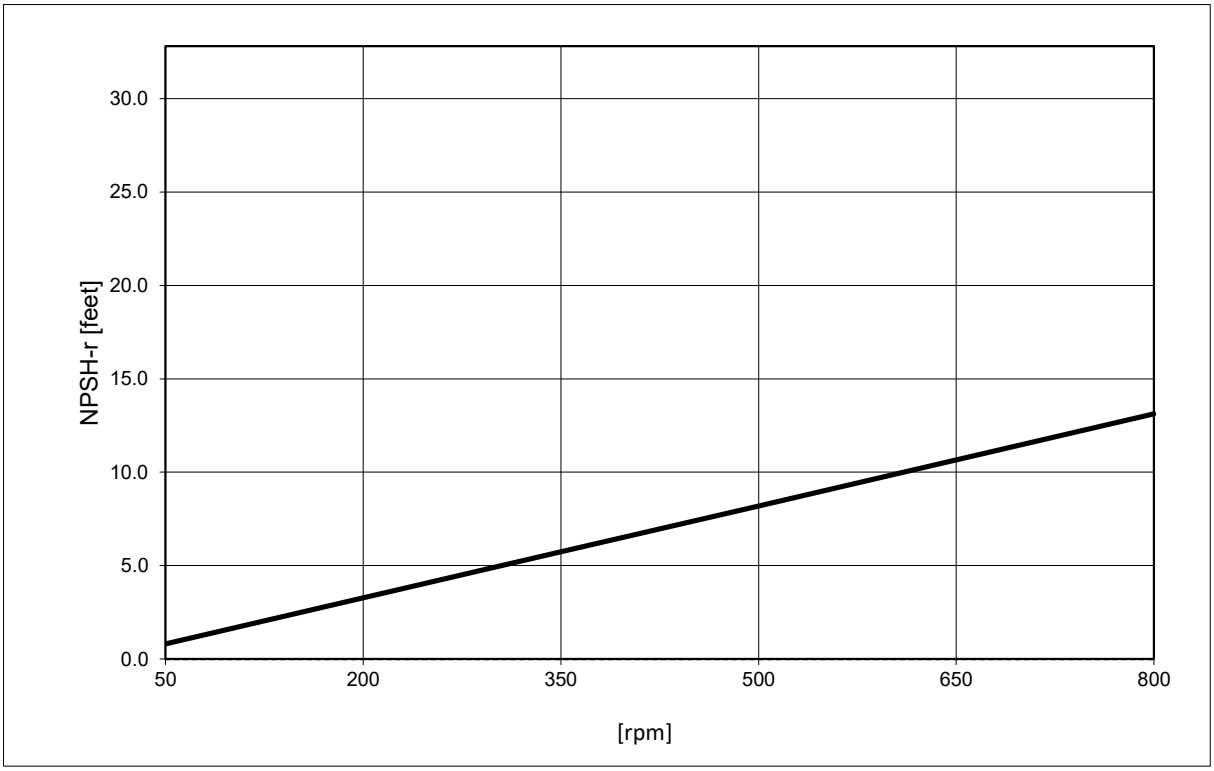




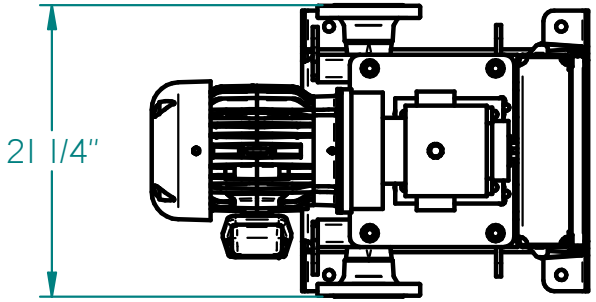
NPSH-Performance Curve

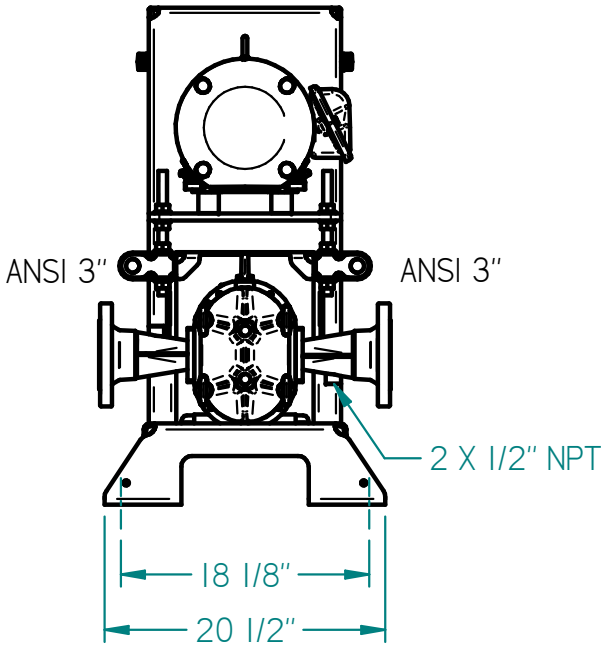
AN70	5	Kennlinienrechner-JMO-V-2.11

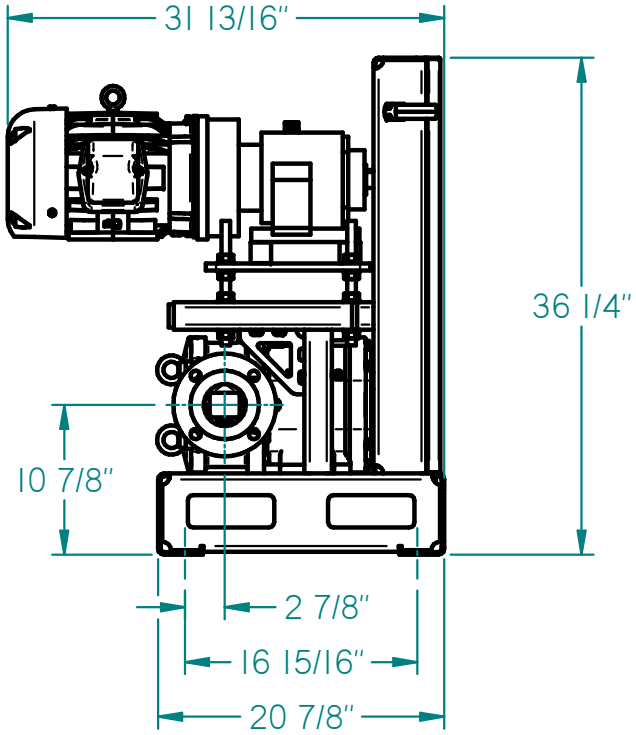
n [rpm]	50	200	350	500	650	800
NPSH-r [feet]	**0.8**	**3.3**	**5.7**	**8.2**	**10.7**	**13.1**
NPSH-a [feet] OP1= 32.8	32.0	29.5	27.1	24.6	22.1	19.7
NPSH-a [feet] OP2= 32.8						
NPSH-a [feet] OP3= 32.8						



NPSH-a	Fluid pressure at pump inlet in meter water columm [mws]
NPSH-r	Decrease of pressure due to fluid acceleration inside pump [mws]
NPSH-a > NPSH-r Delta > 0	Pump runs smooth and works with design flow
NPSH-a < NPSH-r Delta < 0	Runs with noise flow is beneath design flow - short-term operation allowed
NPSH-a < 0	flow of fluid impossible







NOTE:
1. TOTAL WEIGHT = 477 LBS

PROPRIETARY AND CONFIDENTIAL
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BOERGER, LLC
2860 Water Tower Place
Chanhassen, MN 55317
TEL: 612-435-7300
FAX: 612-435-7301

THIRD-ANGLE PROJECTION

BÖRGER®

Model: AN 70
Gear: Dodge HB482CNI80TC
Power: 5 HP CECP83665T

	NAME	DATE
DRAWN	mlindquist	06/05/25
CHECKED		

ALL DIMENSIONS IN INCHES UNLESS OTHERWISE NOTED
TOLERANCES ± 1/2"
DO NOT SCALE DRAWING

SHEET 1 OF 1

SIZE	DWG. NO.	REV
A	SD-043-308	0

BALDOR • RELIANCE

Customer information packet

CECP83665T-4

5HP, 1750RPM, 3PH, 60HZ, 184TC, 0641M, TEFC, F1
Class - CLI GP A,B,C,D
Division - Division II

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6/3/2025 11:42:16 AM

Specifications

Enclosure	TEFC
Frame	184TC
Frame Material	Iron
Frequency	60.00 Hz
Haz Area Class and Group	CLI GP A,B,C,D
Haz Area Division	Division II
Motor Letter Type	Three Phase
Output @ Frequency	5.000 HP @ 60 HZ
Phase	3
Synchronous Speed @ Frequency	1800 RPM @ 60 HZ
Voltage @ Frequency	460.0 V @ 60 HZ
Agency Approvals	CSA EEV NEMA PREMIUM NEMA_PREMIUM UR CCSA US
Ambient Temperature	40 °C
Auxillary Box	No Auxillary Box
Auxillary Box Lead Termination	None
Base Indicator	Rigid
Bearing Grease Type	Polyrex EM (-20F +300F)
Blower	None
Constant Torque Speed Range	1.7
Current @ Voltage	6.450 A @ 460.0 V
Design Code	B
Drip Cover	No Drip Cover
Duty Rating	CONT
Efficiency @ 100% Load	89.5 %
Electrically Isolated Bearing	Not Electrically Isolated
Enclosure Modification	841
Feedback Device	NO FEEDBACK
Front Face Code	Standard

Part detail

Revision	AH
Type	AC
Mech. spec.	06H770
Base	
Status	PRD/A
Elec. spec.	06WGX203
Layout	06LYH770
Eff. date	05-12-2025
CD Diagram	CD0006
Poles	04
Leads	3#16
Proprietary	False
Created date	04-04-2012

Front Shaft Indicator	None
Haz Area Temp Code	T3C
Heater Indicator	No Heater
High Voltage Full Load Amps	6.5 a
Insulation Class	F
Inverter Code	Inverter Duty
KVA Code	J
Lifting Lugs	Standard Lifting Lugs
Locked Bearing Indicator	Locked Bearing
Max Speed	2700 rpm
Motor Lead Exit	Ko Box
Motor Lead Quantity/Wire Size	3 @ 16 AWG
Motor Lead Termination	Flying Leads
Motor Standards	NEMA
Motor Type	0642M
Mounting Arrangement	F1
Number of Poles	4
Overall Length	16.69 IN
Power Factor	81
Product Family	Chem Process S/P 32-8 IEEE 841
Pulley End Bearing Type	Ball
Pulley Face Code	C-Face
Pulley Shaft Indicator	Standard
Rodent Screen	None
RoHS Status	ROHS COMPLIANT
Service Factor	1.15
Shaft Diameter	1.125 IN
Shaft Extension Location	Pulley End
Shaft Ground Indicator	No Shaft Grounding
Shaft Rotation	Reversible
Shaft Slinger Indicator	Shaft Slinger
Speed	1750 rpm
Speed Code	Single Speed
Starting Method	Direct on line

Thermal Device - Bearing	None
Thermal Device - Winding	None
Vibration Sensor Indicator	No Vibration Sensor
Winding Thermal 1	None
Winding Thermal 2	None

Nameplate

NP4328								
CAT.NO.	CECP83665T-4							
SPEC.	06H770X203G1							
HP	5 TE			**IP**	56			
VOLTS	460							
AMPS	6.45							
R.P.M.	1750							
FRAME	184TC	**HZ**	60			**PH**	3	
SER.F.	1.15	**CODE**	J	**DES.**	B	**CLASS**	F	
RATING	40C AMB-CONT							
SN								
DE	6206	**ODE**	6206					
NEMA NOM. EFF.	89.5	**P.F.**	81					
GUAR. MIN. EFF.	87.5	**CC**	010A					
T. CODE	T3C	**TEMP=**	160					

NP3186							
SPEC.	06H770X203G1						
ABMA DE BRG	30BC02XP30X						
ABMA ODE BRG	30BC02X30X						
GREASE	POLYREX EM						
MOTOR WEIGHT	131	**ROTOR BARS**	28	**STATOR BARS**	36		
MAX. R.P.M.	2700	**MAX. KVAR**	1				
INV.TYPE	PWM						
T=	160						
CHP	60	**TO**	90				
CT	1.7	**TO**	60				
VT	-0	**TO**	60				
HTR-VOLTS	N/A	**HTR-AMPS**	N/A				
HTR-WATTS		**MAX. SPACE HEATER TEMP.**			N/A		

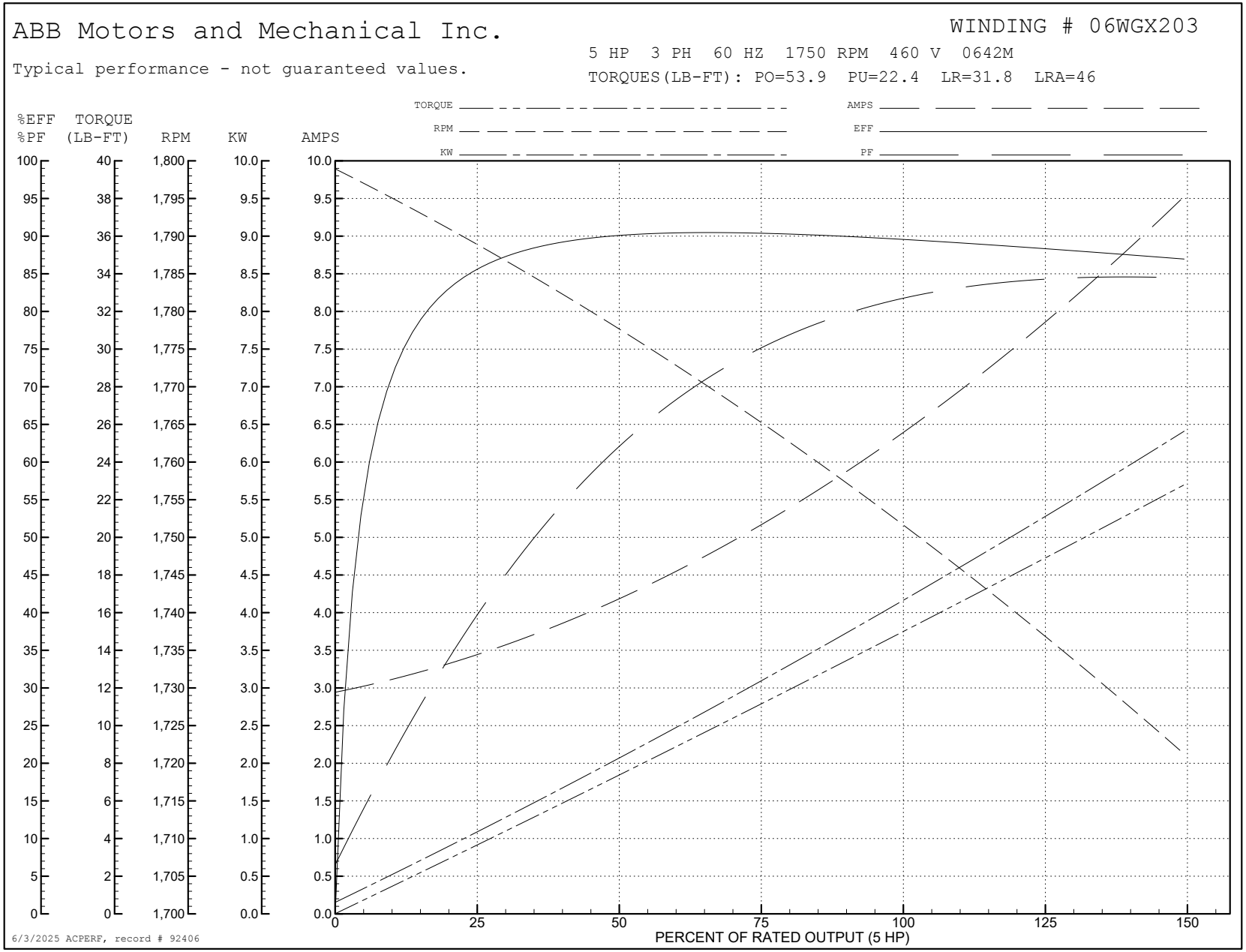
AC Induction Motor Performance Data
Record # 92406
Typical performance - not guaranteed values

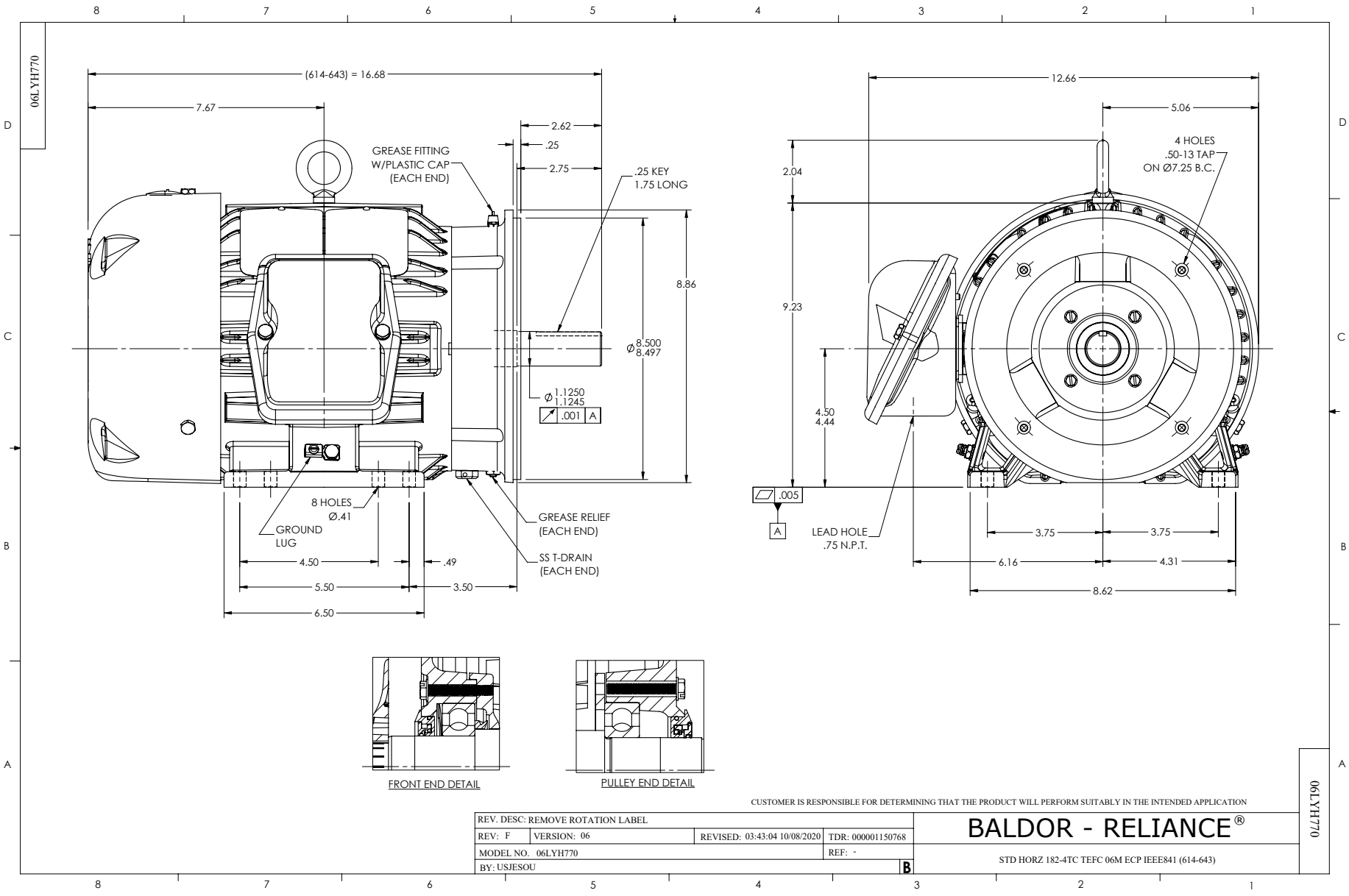
Winding: 06WGX203-R061	**Type:** 0642M	**Enclosure:** TEFC

Nameplate Data				**460 V, 60 Hz: Single Voltage Motor**	
Rated Output (HP)			5	**Full Load Torque**	15 LB-FT
Volts			460	**Start Configuration**	direct on line
Full Load Amps			6.6	**Breakdown Torque**	53.9 LB-FT
R.P.M.			1750	**Pull-up Torque**	22.4 LB-FT
Hz	60	**Phase**	3	**Locked-rotor Torque**	31.8 LB-FT
NEMA Design Code	B	**KVA Code**	J	**Starting Current**	46 A
Service Factor (S.F.)			1.15	**No-load Current**	3.02 A
NEMA Nom. Eff.	89.5	**Power Factor**	79	**Line-line Res. @ 25ºC**	2.63 Ω
Rating - Duty			40C AMB-CONT	**Temp. Rise @ Rated Load**	53°C
S.F. Amps				**Temp. Rise @ S.F. Load**	65°C
				Locked-rotor Power Factor	40.5
				Rotor inertia	0.391 lb-ft²

Load Characteristics 460 V, 60 Hz, 5 HP

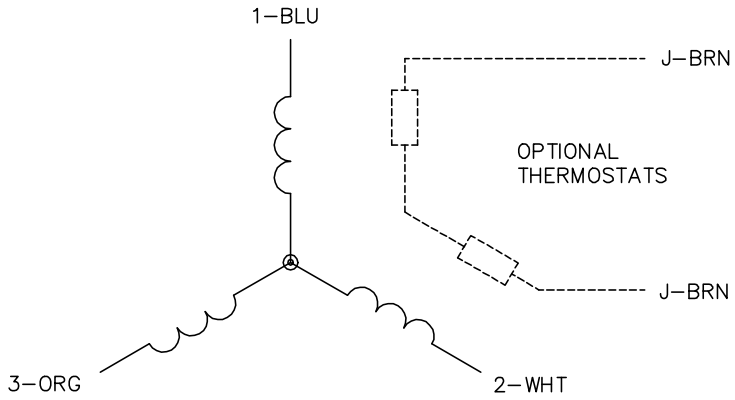
% of Rated Load	**25**	**50**	**75**	**100**	**125**	**150**	**S.F.**
Power Factor	41	63	75	81	84	85	81
Efficiency	85.2	89.8	90.4	89.5	88.4	86.9	88.7
Speed	1789	1777	1765	1752	1737	1721	1739
Line amperes	3.35	4.14	5.21	6.45	7.91	9.47	7.52

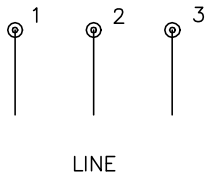

ABB Motors and Mechanical Inc.
WINDING # 06WGX203
5 HP 3 PH 60 HZ 1750 RPM 460 V 0642M
Typical performance - not guaranteed values.
TORQUES(LB-FT): PO=53.9 PU=22.4 LR=31.8 LRA=46
TORQUE
RPM
KW
AMPS
EFF
PF
%EFF
%PF
TORQUE (LB-FT)
RPM
KW
AMPS
PERCENT OF RATED OUTPUT (5 HP)
6/3/2025 ACPERF, record # 92406


06LYH770
(614-643) = 16.68
7.67
2.62
.25
2.75
GREASE FITTING
W/PLASTIC CAP
(EACH END)
.25 KEY
1.75 LONG
8.86
Ø8.500
8.497
Ø1.1250
1.1245
.001 A
8 HOLES
Ø.41
GROUND
LUG
4.50
.49
5.50
3.50
6.50
GREASE RELIEF
(EACH END)
SS T-DRAIN
(EACH END)
12.66
5.06
4 HOLES
.50-13 TAP
ON Ø7.25 B.C.
2.04
9.23
4.50
4.44
.005
A
LEAD HOLE
.75 N.P.T.
3.75
3.75
6.16
4.31
8.62
FRONT END DETAIL
PULLEY END DETAIL
CUSTOMER IS RESPONSIBLE FOR DETERMINING THAT THE PRODUCT WILL PERFORM SUITABLY IN THE INTENDED APPLICATION
REV. DESC: REMOVE ROTATION LABEL
REV: F
VERSION: 06
REVISED: 03:43:04 10/08/2020
TDR: 000001150768
MODEL NO. 06LYH770
REF: -
BY: USJESOU
B
BALDOR - RELIANCE®
STD HORZ 182-4TC TEFC 06M ECP IEEE841 (614-643)
06LYH770

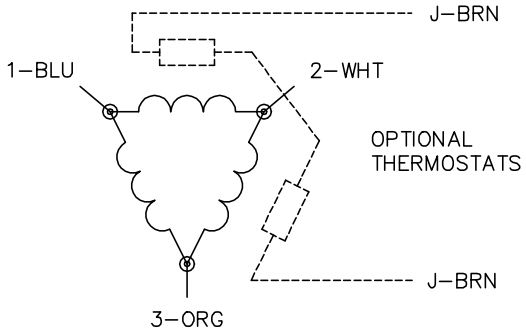
CD0006

TYPICAL WYE–CONNECTED MOTOR





TYPICAL DELTA–CONNECTED MOTOR



NOTES:

1. THREE LEAD MOTOR MAY BE EITHER WYE CONNECTED OR DELTA CONNECTED.
2. INTERCHANGE ANY TWO LINE LEADS TO REVERSE ROTATION.
3. OPTIONAL THERMOSTATS ARE PROVIDED WHEN SPECIFIED.
4. ACTUAL NUMBER OF INTERNAL PARALLEL CIRCUITS MAY VARY.
5. LEAD COLORS ARE OPTIONAL. LEADS MUST BE NUMBERED AS SHOWN.

CD0006

REV. DESC: ADD CLASS CONN00000007		
REV. LTR: E	VERSION: 01	TDR: 000001099922
FILE: \AAA\00005\141	REVISED: 10:24:49 02/19/2019	BY: ENBRIR0
MTL: –		

BALDOR - RELIANCE®

3PH, SV, 3 LEADS, WYE OR DELTA CONNECTED

SH 1 of 1

Date: January 1, 2025

Subject: BABA Compliance for Boerger, LLC

Contact Name
Company Name
Company Address
City, ST ZIP

Hello,

Thank you for reaching out to Boerger in regards to the wastewater pump and grinding equipment meeting Build America, By America (BABA) requirements.

As of January 1, 2025 Boerger does meet the requirements of 55% domestic content.

Boerger, LLC fully intends to adhere to BABA compliance for manufactured goods by satisfying equipment construction requirements.

If there are any further questions or comments, I will be happy to answer those via phone or email.

Sincerely,

Sincerely,
Jeff Seaton
Vice President

Boerger, LLC

BOERGER, LLC
2860 Water Tower Place
Chanhassen, MN 55317
p 612.435.7300
f 612.435.7301
e america@boerger.com
w www.boerger.com

EQ-04

DIFFUSER CLEANING VALVE

For Earth, For Life
Kubota

Submittal Transmittal

Diffuser Cleaning Valve

Project Name	TAYLOR BAY BEACH CLUB WWTF UPGRADE
Project Site	8220 178TH AVENUE, LONGBRANCH, WA 98351
Engineer	Gray & Osborne, Inc 1130 RAINIER AVENUE SOUTH, SUITE 300
Submit to	Gray & Osborne, Inc
Prepared by	Shingo Kubo | Lead Project Manager KUBOTA Water and Environment U.S.A. Corporation 19910 N Creek Pkwy, Suite 100 Bothell, WA 98011
KMU Project #	KMU-OPID85
Issued Date	August 19, 2025
Package #	OPID85- EQ-04-B-Diffuser Cleaning Valve
Item	Tag # 02 MOV 03 02 MOV 04

Clarifications;

1. Section1 contains Kubota scope list. The subjected item for this submittal is marked in red.
2. Section2 contains the manufacture submittal and datasheet for review.

Response to 60% review comment;

a. Note that BABA certifications from manufacturers should be included in the final

Kubota Response: BABA certificate is included at the last page of section 2. Please note that the certificate is subjected to be updated after the manufacturer receives the order.

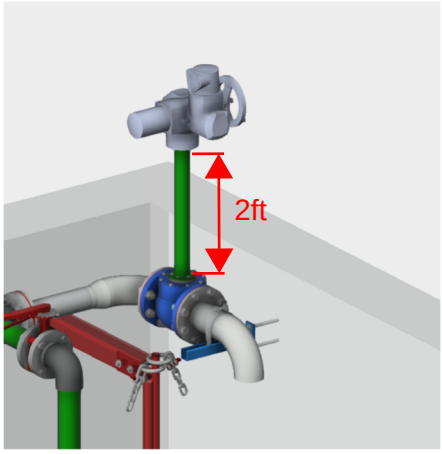
b. Note that manufacturer services should be included in the final submittal.

Kubota Response: Manufacturer service is included per the specifications.

10) EQ-04-A-Diffuser Cleaning Valve – Make Corrections Noted

a. Submittal page 12 shows the valve with a non-indicating floor stand and motor operator. Note this valve and actuator will need to be supported from the walls of the tank and that the FRP cover will have a penetration hole for the extension but will not support the unit. Please clarify how the valve and actuator are intended to be mounted.

Kubota Response: The valve system supplier said no support is needed for the extension stem because the stem is not long (less than 2ft). The actuator is supported by the stem itself.



For Earth, For Life
Kubota

SECTION 1

KUBOTA Water and Environment U.S.A. Corporation
19910 N Creek Pkwy, Suite 100 Bothell, WA 98011| Phone: 425 898 2858 | Fax: 425-898-2853

No	Equipment Location	Tag	Category	Function	Name	Type	Chosen Size/Capacity	Unit	Material	Manufacturer	Model/ Specification	Motor HP	Voltage	FLA	QTY
	MBR Equipment	**x**													
1	MBR	02 MBR 01 02 MBR 02 02 MBR 03 02 MBR 04	SMU	Membrane Filtration	MBR SMU	Flat Plate			304SS	KUBOTA	FS150				4
2	MBR	n/a	SMU	SMU Maintenance	MBR SMU Lifting Tool	Lifting Tool			CS, SS	KUBOTA	TG150				1
3	MBR	n/a	SMU	SMU Maintenance	MBR SMU Lifting Chain	Lifting Tool			304SS	KUBOTA	CS30M				4
4	MBR	02 MOV 03 02 MOV 04	Auto Valve	Diffuser Cleaning	MBR Diffuser Cleaning Valve	ON/OFF Plug	3	inch	CI/CI	Auma/Pratt	SQ12.2-AC01.2/S601 w/extention stem	1/12	120 VAC	2.9	2
5	MBR	n/a	Other Valve	Isolation Valve	SMU Air Isolation Valve(inlet)	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S30				4
6	MBR	n/a	Other Valve	Isolation Valve	SMU Air Isolation Valve(outlet)	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S30				4
7	MBR	BV281 BV282 BV283 BV284	Other Valve	Isolation Valve	SMU PRMT Isolation Valve	Manual Butterfly	2	inch	DI, EPDM, Nylon Coat	Bray	S30				4
8	MBR	n/a	Other Valve	Manual Valves	Isolation Valves for CIP injection	Manual Ball	1	inch	PVC	ASAHI	Type21 True Union				4
9	MBR	02 LS 03 02 LS 04 02 LS 05 02 LS 06	Gauge, Switch	Level Measurement	MBR Level Switch	Float			PP, PU	Conery	2902-B8S1 w/ counter weight and brackets		Loop power		4
10	MBR	n/a	Fabrication	Fabrication	MBR SMU Guide & Stabilizer + Seismic Bracing				304SS	TBD					4
11	MBR	n/a	Fabrication	Fabrication	MBR SMU Fasteners				304SS	TBD					40
12	MBR	n/a	Fabrication	Fabrication	MBR In-Basin Pipe&Supports (Permeate Drop Pipe)				PVC	TBD					4
13	MBR	n/a	Fabrication	Fabrication	MBR In-Basin Pipe&Supports (Air Drop Pipe)				304SS	TBD					8
	Permeate (PRMT) Control Equipment	**x**													
14	PRMT	01 PMP 01 01 PMP 02 01 PMP 03	Permeate Pump	Permeate Extraction	PRMT Pump	Rotary Lobe	45	gpm		Boerger	AN 70 w/ piggyback mount	5	460 VAC	6.6	3
15	PRMT	PI169 PI170 PI171	Gauge, Switch	Pressure Gauge	PRMT Pump Pressuge Gauge(Inlet)		-15 - +15	psig	SS	Ashcroft or equivalent	1279 w/ grycelin filled				3
16	PRMT	PI172 PI173 PI174	Gauge, Switch	Pressure Gauge	PRMT Pump Pressuge Gauge (Inlet)		-15 - +15	psig	SS	Ashcroft or equivalent	1279 w/ grycelin filled				3
17	PRMT	01 PTR 01 01 PTR 02	Pressure Sensor	TMP Measurement	PRMT Pump Pressure Transmitter	Diaphragm	-15 - +15	psi	SS	Endress & Hauser	Cerabar PMCB51		Loop power		2
18	PRMT	01 MFM 01 01 MFM 02	Flow Sensor	Flow Measurement	PRMT Flow Meter	Electromagnetic	3	inch	PU	Endress & Hauser	Promag W 400		24VDC		2
19	MBR	n/a	Other Valve	Isolation Valve	MBR PRMT Pump isolation valve	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S30				8
20	MBR	CV261 CV261 CV261	Other Valve	Check valve	MBR PRMT Pump discharge check valve	Manual ball	3	inch	PVC, EPDM	ASAHI	True Union Ball Check				3
21	PRMT	01 TM 01	Other Instrument	Turbidity Measurement	PRMT Turbidity Meter	Laser	0-5	NTU		HACH	TU5300sc				1
22	PRMT	01 TM 01	Other Instrument	Turbidity Measurement	PRMT Turbidity Transmitter					HACH	SC4500		24VDC		1
23	PRMT	n/a	Other Instrument	Turbidity Measurement	Turbidity Meter Maintenance Kit					HACH					1
	Return Activated Sludge (RAS) Control	**x**													
24	MBR	Relocated from MBR 02 SLS02 02 SLS03	Other Instrument	Level Measurement	MBR Level Sensor	Hydrostatic	15	ft	SS	Endress & Hauser	Waterpilot FMX21 w/ brackets		Loop power		2
	MBR Blower	**x**													
25	MBR BLW	01 MSB 01 01 MSB 02 01 MSB 03	Blower	Blower	MBR Blower	Positive Displacement	114	scfm	CI	Aerzen	GM 4S DN 80	5	460 VAC	6.6	3

No	Equipment Location	Tag	Category	Function	Name	Type	Chosen Size/Capacity	Unit	Material	Manufacturer	Model/ Specification	Motor HP	Voltage	FLA	QTY
26	MBR BLW	n/a	Option	Noise Suppression	MBR Blower Sound Enclosure	With Blower									3
27	MBR BLW	n/a	Option	Blower Temperature	MBR Blower Temperature Gauge	With Blower									3
28	MBR BLW	n/a	Option	Blower Pressure	MBR Blower Pressure Gauge	With Blower									3
29	MBR BLW	n/a	Option	Blower Temperature	MBR Blower Temperature Switch	With Blower									3
30	MBR BLW	01 AFM 01 01 AFM 02	Flow Sensor	Air Flow Measurement	MBR Blower Flow Meter	Thermal Mass	3	inch	PU	Endress & Hauser	t-mass I 300, w/ flow conditioner plate		24VDC		2
31	MBR BLW	n/a	Other Valve	Manual Valves	Air Scour Blower Isolation Valves	Manual Butterfly	3	inch	DI, FKM, SS Disk	Bray	S30				4
	Clean-In-Place Equipment	**x**													
32	SMU CIP	n/a	Chemical Injection	Chemical Injection	SMU CIP System PVC pipes		1	inch	PVC	KUBOTA	Loose ship parts shown on xxx				1
33	SMU CIP	n/a	Flow Sensor	Flow Measurement	CIP solution Flow Meter	Electromagnetic	1	inch	PU				24 VDC		1
34	SMU CIP	n/a	Flow Sensor	Flow Measurement	CIP shelf chenical Flow Meter	Electromagnetic	3/8	inch	PU	Keyence	FD-Q10C		24VDC		1
35	SMU CIP	n/a	Auto Valve	Flow Control	CIP Flow Control Valve	ON/OFF Ball	1	inch	DI	ASAHI	S19-120VAC--1"-C20/S20		120VAC	0.18	1
36	SMU CIP	n/a	Other Valve	Manual Valves	Isolation Valves on CIP Station	Manual Ball	1, 0.5	inch	PVC	ASAHI	Type21 True Union				1
37	SMU CIP	n/a	Other Valve	Manual Valves	Pressure reducing valve	Pressure Reducing	1.5	inch	CI	Zurn	ZW209				1
	System Control Equipment	**x**													
38	CONTROL	n/a	Control Panel	Control Panel	Control Panel	OIT, PLC					NEMA 4/12, 72" x 72" x 18" floor mount enclosure (estimated size) , Allen Bradley 1756-L81E PLC (BABA-Version), FactoryTalk View SE		120VAC	TBD	1
39	D. SERVICE	n/a	D. Service	Direct Service	Direct Service						Design support, start-up, field service, remote service				1

SECTION 2

Solutions for a world in motion

Product Configuration (4IN_MILLIKEN_651_QT2997770_TAYLOR_BAY)

Configured by: Unit Process Company
Configured on: 8/8/2025
Printed: 8/11/2025

DESCRIPTION	SQ10.2/AC01.2
INDUSTRY	
Industry code	Water, Wastewater
DEVICE CHARACTERISTICS	
AUMA product	Quarter-turn electric actuator
Rated output torque [lbs.ft.]	450
Rated output torque [inch.lbs.]	5,400
Rated output torque [Nm]	610
Approximate weight (lbs.)	77
SERVICE CONDITIONS	
Version	Weatherproof
Operating mode	OPEN - CLOSE duty
Enclosure protection	NEMA type 6P
Color	AUMA silver-grey (similar to RAL 7037)
Ambient temperature	-30 °C to +70 °C (-22 °F to +158 °F)
Nameplates	English - aluminum (US-AL)
Sealing elements	NBR - Nitrile Butadiene Rubber
Corrosion protection	KS
ELECTRICAL DATA	
Mains voltage	120 Volts AC
Phase	1-Ph
Frequency	60 Hz
Type of duty	S2 - 10 min.
Motor protection	(W-1T-O140) 1Ph-1 thermal switch 140°C N.C., class F insulation, tropicalized winding
MOTOR DATA	
Caution	Ensure that the power conductors, and power source are sized according to the max. current Imax [A].
Motor designation	SW00063-4-0,04
Nominal power (HP)	1/16
Nominal power (kW)	0.04
Nominal speed (RPM)	1,680
Nominal current In [A]	2.7
Max. current Imax [A]	3
Starting current Ia [A]	5.4
COS	0.98
Capacitor uF	50

ACTUATOR FEATURES

SQ model	SQ 10.2
Valve coupling	Unbored valve shaft coupling
Swing angle	Setting range 75 - 105 degrees
Set to degrees	92
Operation time	35 seconds for 90°
Valve attachment	FA10, US flange with female pilot
Coupling type	steel
Mechanical position indicator	(11.2) self-adjusting continuous indication, with symbols OPEN and CLOSED
Torque switches	(0-M) torque sensing via MWG
Limit switches	(0-M) limit sensing via MWG
Position transm.	(30.5) MWG absolute encoder for AC 01.2
Heater	(22.5) 24 V in combination with controls: 5 W
Motor heater	(0) without
Torque switching	Setting range 150-450 lbs.ft.
Set to close lbs.ft.	150
Set to open lbs.ft.	150
Handwheel	7.9" (200mm)
Close direction	RH - clockwise
Limit switching	(240) SQ with MWG
Lubricant	F15 Shell ALVANIA 1029
Special version TPA	(000) without
Electrical connection	(S0-000) actuator plug for mounting AM/SEM/AC

ACTUATOR CONTROLS

AUMATIC version	AC 01.2
Feedback E2	MWG magnetic limit/ torque sensor (non-intrusive setting)
Max. motor power	(B00.02) Contactors for power class A2
Motor protection	(C00.01) thermal switch, automatic reset
Interface	(D00.01) Parallel I/O Interface
Positioner	(F00.00) Without
Input signals	(R00.01) CLOSE, OPEN, STOP, EMERGENCY •
Control voltage	(E00.02) 100 - 120 V AC
Electronics supply	(A10.01) 24 V DC internal •
Output aux. voltage	(A30.02) 115 V AC - 30mA (internally powered) •
Output contacts	(H00.03) 6 output contacts: 6 NO/NC without common 250V AC/5A •
Output signals	(S00.01) default setting: K1=Fault, K2=End pos. CLOSED, K3=End pos. OPEN, K4=Selector sw. REMOTE, K5=Torque fault CLOSE, K6=Torque fault OPEN
Local controls	(L00.01) selector switch LOCAL-OFF-REMOTE with padlock; push buttons OPEN-STOP-CLOSE-RESET; large graphical LCD with a resolution of 200 x 100 pixels
Activ. Bluetooth	(L90.01) Switched on
Indication lights	(L10.02) 1 CLOSED:green, 2 TRQ-CL:blue, 3 TH:yellow, 4 TRQ-OP:violet, 5 OPEN:red, BLUETOOTH:blue (with numbers) •
Face plate	(US-ES-FR) English-Spanish-French •
Tolerance mains voltage	(A40.01) +/- 10%
Electrical connection	(SB-080) plug/socket 100mm, 2 x ¾" NPT; 1 x 1 ¼" NPT •
Heater	(Q00.01) heater 24 V, internal supply •
Analog input 1	(P22.00) without

Analog input 2	(P30.00) without
Analog output 1	(P00.02) Position feedback: 4-20mA
Analog output 2	(P10.02) Torque feedback: 4-20mA
Blinker version	(N00.02) lights illuminated in mid travel (electronic)
Display language	English
Switch off in CLOSE	(042.01) Limit
Switch off in OPEN	(043.01) Limit
Self retaining LOCAL	(033.03) In direction OPEN and CLOSE
Self retaining REMOTE	(052.00) OFF
Safety mode	(153.01) OFF
Emergency function	(140.01) OFF
Torque by-pass	Function not active
Mounting position	Position A
Mounting pos. local controls	Position A-1, selector switch at 6 o'clock in relation to base of controls (standard for SA/SQ)
Electrical connection mounting position	Position A

OPTIONAL EXTRAS

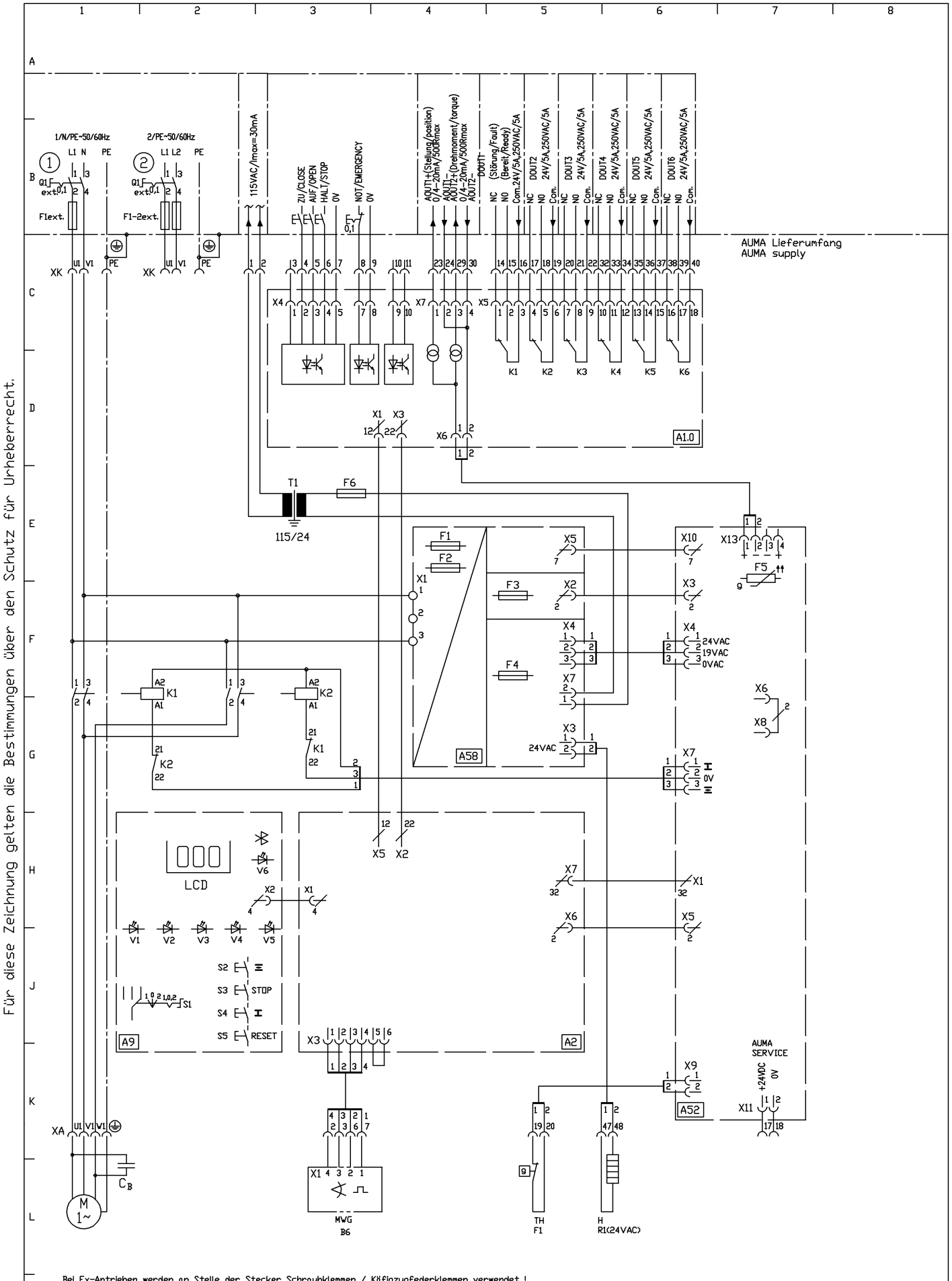
Double sealed at customer connection XK	Yes
Inspection reports reqd.	Yes

DRAWINGS

POINT-TO-POINT WIRING DWG	TPCA-0A2-1D1-A000TPA01R100-0I1-000
OUTPUT DRIVE/MOUNTING FLANGE DWG	SK099594
ACTUATOR DIMENSIONAL DWG	DDS000004B3ADL341

OPERATION MANUALS

WIRING DIAGRAM LEGEND	Legend for AUMATIC AC 01.2/ACExC 01.2
DEVICE INTEGRATION MANUAL	Actuator controls AUMATIC AC 01.2/ACExC 01.2 Parallel Non-Intrusive Parallel
ACTUATOR OPERATION MANUAL	SQ 05.2 - SQ 14.2/SQR 05.2 - SQR 14.2, Control unit: electronic (MWG), with actuator controls AUMATIC AC 01.2
SUPPLEMENT_ELECTRIC_INSTALL	Electrical installation guide



Für diese Zeichnung gelten die Bestimmungen über den Schutz für Urheberrecht.

Bei Ex-Antrieben werden an Stelle der Stecker Schraubklemmen / Käfigzugfederklemmen verwendet !
For explosion-proof actuators terminals / cage clamps are used instead of plug / socket connector !

Rev	Description	Date	Name
4	MATCH -S	09/16/15	TK
3	MATCH -S	04/07/15	MK
2	MATCH -S	07/28/14	MK

Date	09/15/2015
Draft	TK
Check	PM 09/15
First Issue	2012.08.20

auma ®
Wiring Diagram

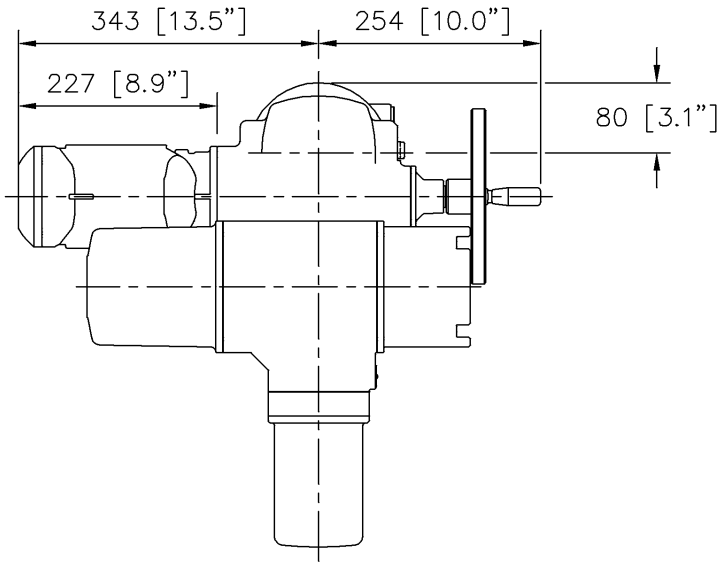
TPCA-0A2-1D1-A000

TPA01R100-0I1-000

Legend | Order Line Item

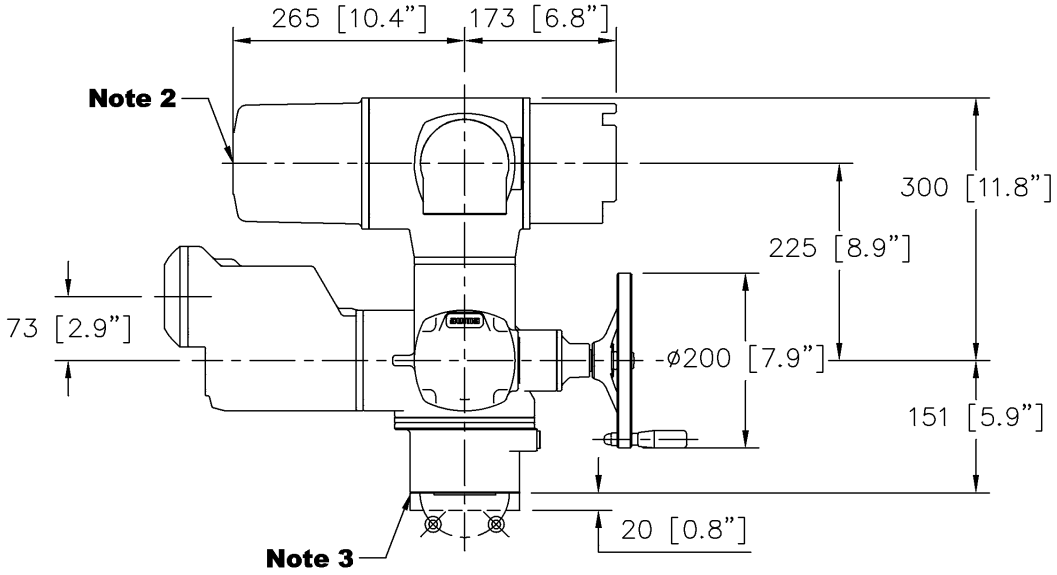
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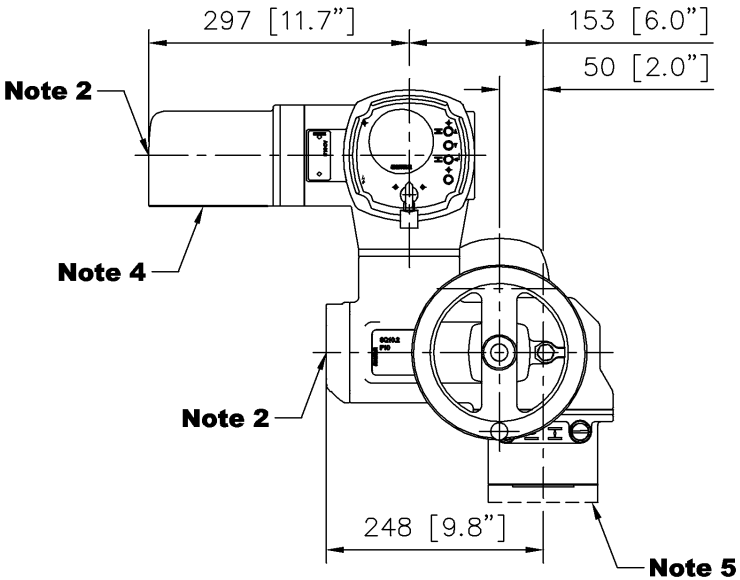
Project



Notes:

1. **Metric tolerance per ISO 2768-m. Dimensions in brackets [] are in inches and rounded to one decimal place.**
2. **Seven inch minimum clearance recommended for removal of access cover and equipment adjustment.**
3. **See appropriate mounting flange drawing for detail.**
4. **See data sheets for conduit entries.**
5. **Optional SG replacement ring.**

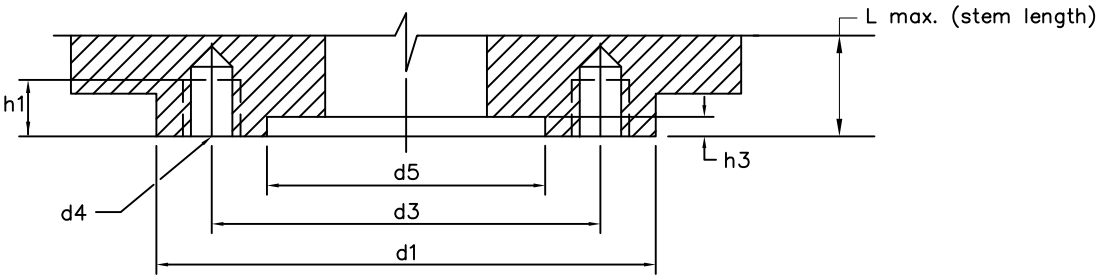


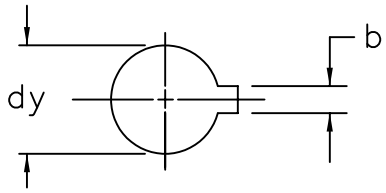


auma AUMA ACTUATORS, INC.	**Torque only** **No gearbox**	**SQ(R) 10.2** **Motor 1 phase** **Handwheel - 7.9"**	**AC 01.2** **P&S - SB - 100mm - DS** **Matic Pos. - A / P&S Pos. - A**	FIRST ISSUE DESCRIPTION	MC 04/10/2018 | GF 04/10/2018 | 0 BY / DATE | APP / DATE | REV **DDS000004B3ADL341**

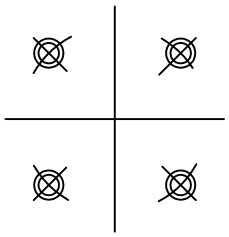
AUMA ACTUATORS, INC.

FA05 – FA16

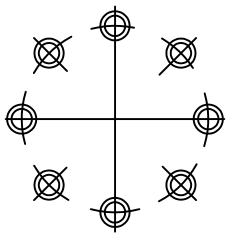




DIMENSIONS 'b' BASED
ON ANSI B17.1
AT MAX. BORE 'dy'



4 HOLE PATTERN
(FA05 – FA10)



8 HOLE PATTERN
(FA10 – FA16)

ACTUATOR MODEL	FLANGE TYPE	d1	d3 ± 0.01	(qty.) d4	d5	h1	h3	L max.	SQ. KEY		RECT. KEY	
									b	dy max.	b	dy max.
SQ05.2	FA05	3.54	2.00	(4) 1/4 – 20	-	0.47	-	1.575	1/4	1.0	1/4 x 3/16	1.063
	FA07	3.54	2.75	(4) 5/16 – 18	-	0.59	-	1.575				
	FA10	4.92	4.00	(4) 3/8 – 16	3.346	0.63	0.157	2.598				
SQ07.2	FA05	3.54	2.00	(4) 1/4 – 20	-	0.47	-	1.575	1/4	1.0	1/4 x 3/16	1.063
	FA07	3.54	2.75	(4) 5/16 – 18	-	0.59	-	1.575				
	FA10	4.92	4.00	(4) 3/8 – 16	3.346	0.63	0.157	2.598				
SQ10.2	FA10	4.92	4.00	(8) 3/8 – 16	3.346	0.71	0.157	1.969	3/8	1.438	3/8 x 1/4	1.5
	FA12	5.91	4.95	(8) 1/2 – 13	4.134	0.75	0.157	3.228				
SQ12.2	FA12	5.91	4.95	(8) 1/2 – 13	4.134	0.87	0.157	2.402	1/2	1.875	1/2 x 3/8	2.0
	FA14	6.89	5.50	(8) 5/8 – 11	4.528	0.98	0.197	3.976				
	FA16	8.27	6.50	(8) 3/4 – 10	5.512	1.26	0.197	4.370				
SQ14.2	FA14	6.89	5.50	(8) 5/8 – 11	4.528	1.14	0.197	2.953	5/8	2.375	5/8 x 7/16	2.5
	FA16	8.27	6.50	(8) 3/4 – 10	5.512	1.26	0.197	4.921				

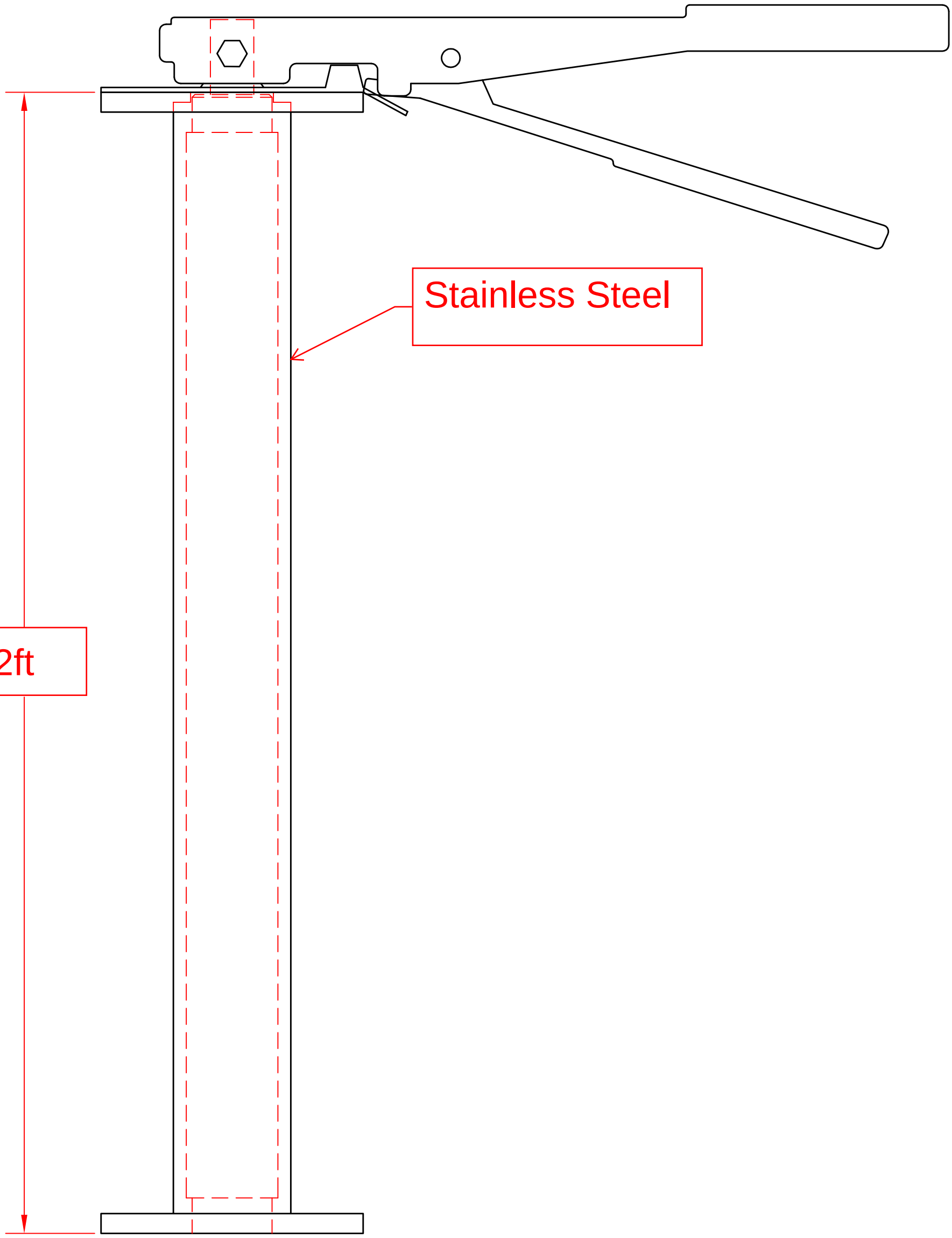
Notes:

1. All dimensions are in inches.
2. Contact AUMA Engineering for tolerances
3. FA Flange per MSS STANDARD SP-101

FA MOUNTING FLANGE DIMENSIONS

SQ05.2- SQ14.2	BY/DATE MC 02/03/20	APP/DATE PM 02/03/20	DWG. NO. SK099594	REV 8

DWG NO.

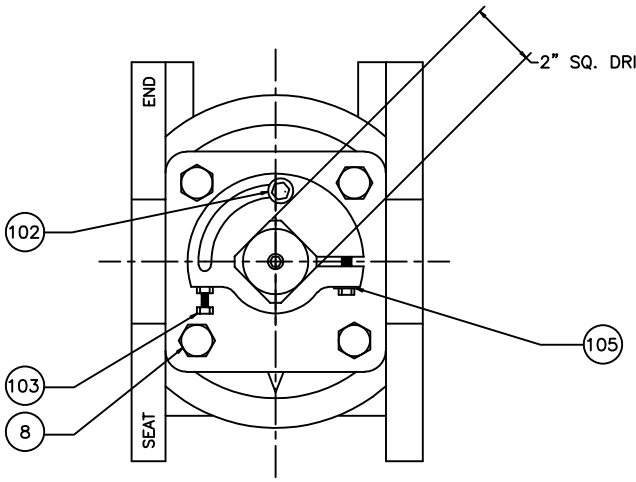


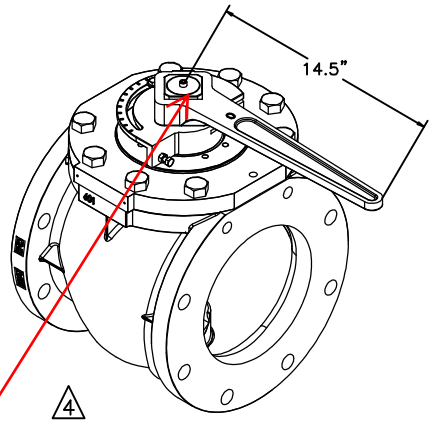
NVH Nitz Valve Hardware Inc.			EXTENSION EXAMPLE WITH HANDLE & 10 POS. PLATE	
THIS DOCUMENT AND THE DATA DISCLOSED HEREIN OR HEREWITH IS NOT TO BE REPRODUCED, USED, OR DISCLOSED IN WHOLE OR IN PART WITHOUT THE WRITTEN CONSENT OF NITZ VALVE HARDWARE, INC.	DRAWN BY:	PART NO.		REV -
	APPROVED BY:	SCALE 1:1		SHEET 1 OF 1

REV | DESCRIPTION | DATE | APPRVD

VALVE SIZE	A	B	C	D	E	F	G	H	J	K	L
2 1/2	7.50	6.19	3.50	2.50	5.50	7	0.75	4	--	–	0.69
3	8	6.19	3.75	3	6.00	7.50	0.75	4	--	–	0.75
4	9	7.25	4.50	4	7.50	9	0.75	6	0.63	2	0.94
5	10	8.38	5.75	5	8.50	10	0.88	6	0.75	2	0.94
6	10.50	8.38	5.75	6	9.50	11	0.88	6	0.75	2	1
8	11.50	10.69	7.63	8	11.75	13.50	0.88	6	0.75	2	1.13

REFERENCE ONLY



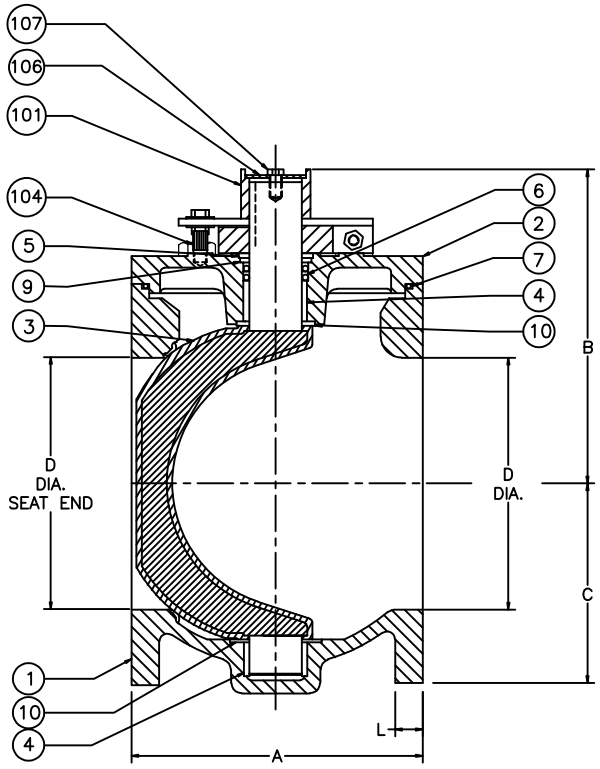


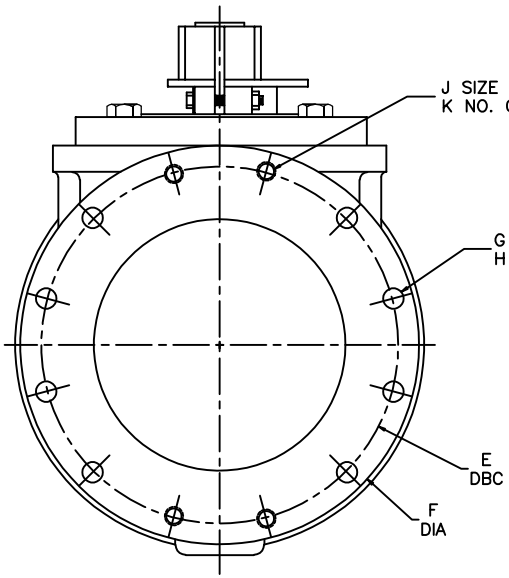
4

VALVE WITH TORQUE COLLAR
AND OPTIONAL "D" WRENCH
(WRENCH SUPPLIED ONLY IF ORDERED)

AUMA SQ10.2/AC01.2 is mounted with extension rod

THIS DRAWING IS THE PROPERTY OF
HENRY PRATT COMPANY
AND MUST NOT BE USED IN ANY WAY
PREJUDICIAL TO THEIR INTERESTS





4

ITEM	QTY	DESCRIPTION	MATERIAL
107	1	S.H. CAP SCREW	STL/ZINC
106	1	RETAINING WASHER	STL/ZINC
105	1	TORQUE ADJ. BOLT	STL/ZINC
104	1	BODY STOP	STL/ZINC
103	1	ADJ. CLOSE STOP	STL/ZINC
102	1	ADJ. OPEN STOP	STL/ZINC
101	1	TORQUE COLLAR	DUCTILE IRON
10	2	GRIT SEAL	PTFE
9	1	SEAL REATINING RING	BRASS
8	AR	H.H. CAP SCREW	☐STEEL ☐STN. STEEL
7	1	O RING	ELAS AS SPEC.
6	2	U CUP SEAL	ELAS AS SPEC.
5	1	SNAP RING	SPRING STEEL
4	2	SLEEVE BEARING	STN. STEEL
3	1	PLUG ELASTOMER AS SPEC.	DUCTILE IRON
2	1	CAP	CAST IRON
1	1	BODY	CAST IRON

PRATT

BY	DATE	SCALE
CR	7/97	NONE
CHK'D		DIMENSIONS INCHES

ISSUE No.	DATE	REVISIONS	BY
		ORIGINAL DWG. BY JD ON 3/89	
1	10/93	CHANGED SHAFT	CR
2	7/97	REDRAWN ON CADD	CR
2	1/99	REDID ITEMS 10-107 ROTATED OPEN STOP 90 DEGREES ADD CAP SCREW 107	CR
3	11/99	ITEM 8 WAS BRONZE	CR
4	11/13	ADDED ISOMETRIC VIEW	AA

TITLE:
2 1/2"-8" PLUG VALVE, FULL PORT, FLANGED, WRENCH OPERATED

DWG. NO. HP49010-FP

PRATT®

a MUELLER brand

BALLCENTRIC® PLUG VALVE

Engineering Creative Solutions for Fluid Systems Since 1901



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SCOPE OF LINE

The Pratt criteria of quality, reliability, safety and value are embodied in the Ballcentric® plug valve, setting higher standards for dependable performance with excellent features achieved by the utilization of the very latest design and manufacturing techniques.

- Computer aided design
- High integrity casting
- CNC manufacturing delivers consistent sizes on all components

All complemented by rigorous Quality Control System

BODY

Conforming to AWWA C517 wall thickness, the Ballcentric® plug valve body casting is in ASTM A126 CL B cast iron using high pressure molding techniques. Alternative flanged, grooved or mechanical joint ends are available.

Flange diameter, thickness and drilling conform to ANSI B16.1 Class 125 or 250.

Grooved ends meet AWWA C-606 for ductile or steel pipe. Mechanical joints to AWWA C111 (ANSI A21.11).

SEAT

The Ballcentric® plug valve incorporates as standard, on 3″ and larger, a 1/8″ thick welded 99% nickel seat for corrosion and erosion resistance specifically profiled for low torque and extended seat life.

STEM SEAL

High integrity sealing by combining the advantages of a resilient and abrasion resistant U-Cup seal. From vacuum to high pressure, the self-adjusting sealing system (per AWWA C504) gives positive, trouble-free service and is retained independently of the plug stem or external torque device, thereby eliminating periodic maintenance.

BEARINGS

The plug rotates in permanently lubricated 316 grade stainless steel bearings, located in the body and bonnet, along with upper and lower PTFE thrust washers, which ensure consistently low operating torque.

PLUG

Supported on integral trunnions, the plug is totally encapsulated with an elastomer that is molded on 2-1/2″ – 48″ and vulcanized on 54″ and larger to the casting providing tight shut off even under vacuum conditions. High integrity corrosion-free sealing is achieved by a variety of abrasion resistant elastomers which protect the plug right up to the trunnions. When assembled, the light compression of the elastomers onto PTFE thrust washers, prevents entry of abrasive materials into the bearings.

BONNET SEAL

Superior “O” ring sealing with metal / metal contact means lower bolting stresses compared with compression gaskets.

FLOW

The port design (round on 2-1/2″ – 12″ and rectangular on 14″ and larger) with streamlined internal contours gives the highest industry capacity straight through flow in the full open position, reducing turbulence and pressure drop and the effect of erosive media. Handling of sludges and slurries is therefore enhanced.

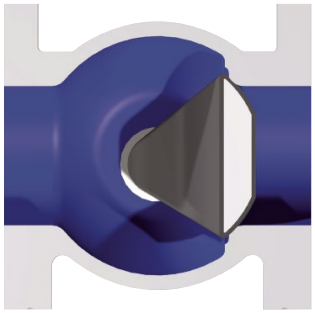
INTERCHANGEABLE

Because of the common face to face dimension with wedge gate valves (3″ – 12″), fitting the tight shut-off rotary Ballcentric® plug valve into existing systems is accomplished without pipeline modifications.

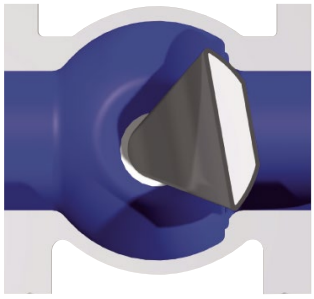
TRAVEL STOPS

Adjustable open and closed travel stops are fitted as standard on both wrench and gear operated Ballcentric® plug valves.

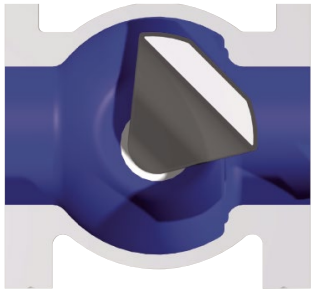
FEATURES AND BENEFITS



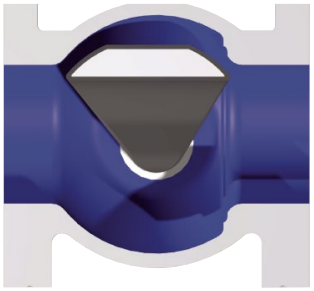
- Valve in closed position for bubble tight shut-off
- Normal flow direction gives pressure assisted sealing
- Torques are low even in reverse flow



- Plug rotates away from the seat for instant opening
- Seat wear and operating torque reduced
- No further seat contact until valve is closed again



- Design of Ballcentric® plug valve allows modulating control over the full 90° travel
- Ideally suited for balancing service
- Standard rotary valve provides control and tight shut off in one valve



- Plug is out of flow path when fully open
- Straight through, uninterrupted smooth flow
- Round port reduces turbulence and erosion, lowers pumping costs and can be "pigged" to clean the pipeline

INSTALLATION

The Ballcentric® plug valve is suitable for flow and shut-off in either direction. Seat end downstream is the preferred orientation and any reverse flow requirement should be stated at the time of order. For use on fluids with suspended solids, it is recommended that the valve should be installed with the seat upstream and the valve stem horizontal with plug rotation to the top of the valve ensuring smooth operation.

IN-LINE MAINTENANCE

In the unlikely event of stem leakage, the stem seals can be easily replaced without removing the bonnet. Access to the body for cleaning or inspection does not require removal from the line.

MODULAR CONSTRUCTION

Design of the bonnet and stem allows for on-site adaption of gear operators, power actuators, or extension devices on to standard valves. Conversion can be easily undertaken without removing the valve bonnet, thereby minimizing downtime.

POWER OPERATION

Pneumatic, electric or hydraulic operation is available, complete with accessories such as limit switches, solenoid valves and positioners when required.



DIMENSIONAL DATA

ORDERING INFORMATION

VALVE TYPES	DESIGNATION
Mechanical Joint Cast Iron	600
Mechanical Joint Ductile Iron	620
ANSI 125 Flanged Cast Iron Flat Face	601
ANSI 125 Flanged Ductile Iron Flat Face	611
ANSI 150 Flanged Ductile Iron Raised Face	621
ANSI 250 Flanged Ductile Iron Raised Face	602
ANSI 125 Grooved for Steel Pipe	606S
ANSI 125 Grooved for Ductile Pipe	606D
ANSI 150 Flanged 316SS	601S
SEAT	
Nickel (3″ & Larger)	N
Epoxy (2-1/2″ ONLY)	E
316SS (On Stainless Steel Valve ONLY)	S
Rubberlined	RL
Glasslined	GL
ELASTOMER TRIM	
EPDM	0
Buna-Nitrile	1
Viton	2
Neoprene	3
Natural	4
MANUAL OPERATORS	
Above Ground Gear and Handwheel	AGHW
Above Ground Gear with 2″ Nut	AGNUT
Buried Gear with 2″ Nut	BG
Memory Stop Gear with Handwheel	MGHW
Lever / Wrench (8″ & smaller)	L
Direct Nut (8″ & smaller)	TC

Example: 4″ 601N3AGHW = 4″ ANSI 125 Flanged, Nickel Seat, Neoprene plug with Above Ground Gear and Handwheel.

Valves are only tested for bi-directional shut-off if specified at time of order. Contact Pratt for bi-directional ratings.

Note: We recommend mechanical joint or buried flanged valves to have gear operators.

Note: We recommend valves for bi-directional service to have gear operators.

PRESSURE RATING		
12″ and Smaller	ANSI 125	175 psi
14″ and Larger	ANSI 125	150 psi
14″ and Larger	ANSI 150	235 psi
20″ and Smaller	ANSI 150	285 psi
12″ and Smaller	ANSI 250	400 psi
14″ and Larger	ANSI 250	300 psi

Body Hydrotest = 150% of Rated Pressure / Seat Test = 100% of Rated Pressure Testing per AWWA C517

ELASTOMERS AVAILABLE FOR BALLCENTRIC® PLUG VALVE

Natural rubber is also available.

NITRILE

A general purpose material sometimes referred to as BUNA-N or HYCAR with a –20°F to 212°F temperature range. Used on sewage, water, hydrocarbon and mineral oils.

EPDM

An excellent polymer for use on chilled water through to LP steam applications having a temperature range of –35°F to 250°F. Resistance to many acids, alkalies, detergents, phosphate esters, alcohols and glycols is an added benefit.

NEOPRENE

This versatile material shows outstanding resistance to abrasion and ozone. Chemical resistance to a wide range of petroleum base products and dilute acids and alkalies. Temperature range –20°F to 225°F.

VITON

Retention of mechanical properties at high temperature is an important feature of this elastomer: temperature range is –10°F to 300°F. It also has excellent resistance to oils, fuels, lubricants and most mineral acids and aromatic hydrocarbons.

Note: Not for water or steam applications.

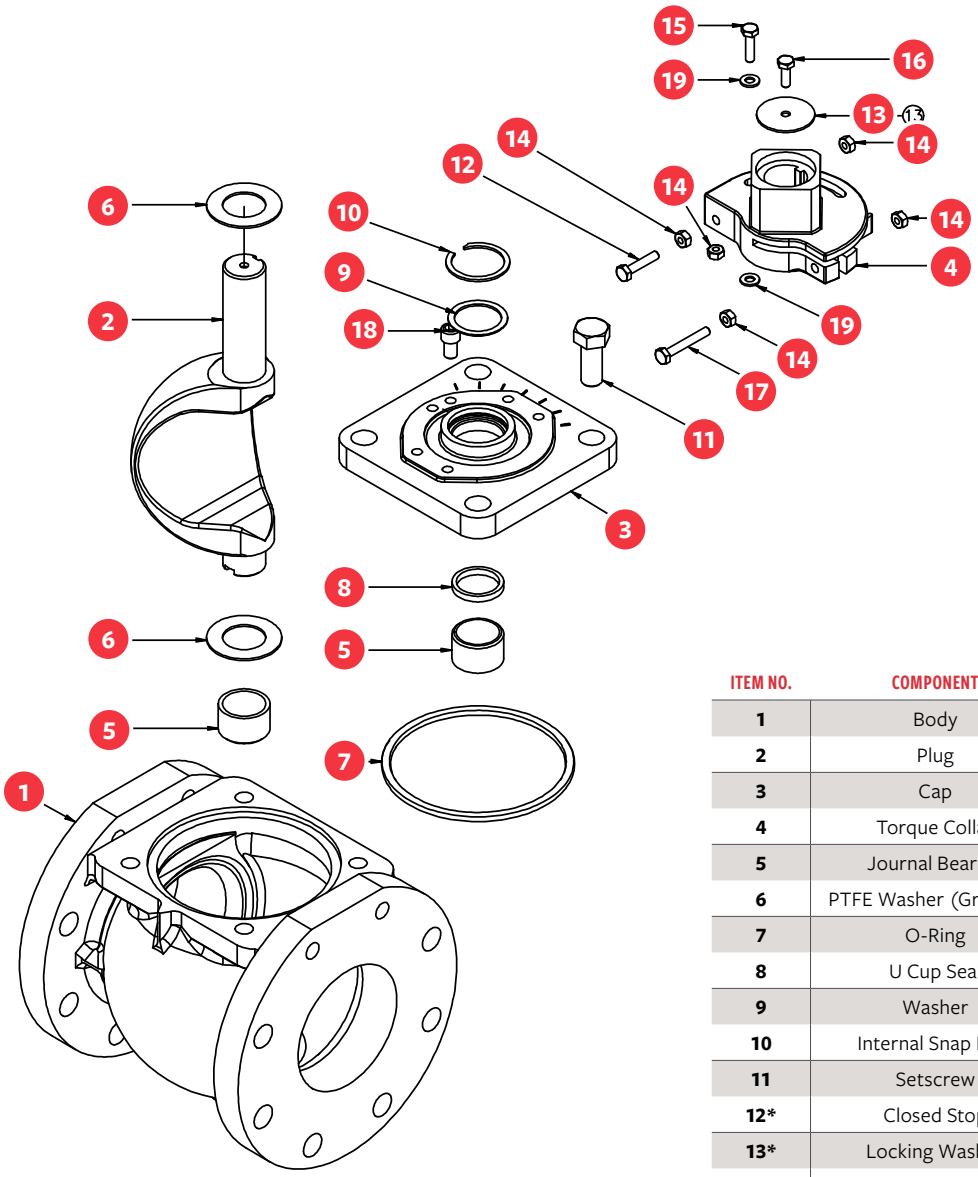
AUMA SQ10.2/AC01.2 is mounted with extension rod

ELASTOMER SELECTION CHART

SERVICE	ELASTOMER	AVERAGE USEFUL TEMP. RANGE	SERVICE	ELASTOMER	AVERAGE USEFUL TEMP. RANGE	SERVICE	ELASTOMER	AVERAGE USEFUL TEMP. RANGE
Acetone	EPDM	–35°F to 250°F	Cement Slurry	EPDM	–35°F to 250°F	Oil, Animal	Nitrile	–20°F to 212°F
Alcohol AMYL	EPDM	0°F to 212°F	Copper Sulphate	EPDM	–35°F to 250°F	Oil, Mobil Therm Light	Viton	10°F to 250°F
Alcohol Aromatic	Viton	10°F to 250°F	Creosote (Coal)	Nitrile	–20°F to 212°F	Oil, Mobil Therm 600	Viton	10°F to 250°F
Alcohol Butyl	Neoprene	–20°F to 225°F	Coal Slurry	Nitrile	–20°F to 212°F	Oil, Mobil Therm 603	Nitrile	–20°F to 212°F
Alcohol Denatured	Nitrile	–20°F to 212°F	Diesel Fuel No. 3	Nitrile	–20°F to 212°F	Oil, Lubricating	Nitrile	–20°F to 212°F
Alcohol Ethyl	EPDM	–20°F to 250°F	Diethylene Glycol	EPDM	–35°F to 250°F	Oil, Vegetable	Nitrile	–20°F to 212°F
Alcohol Grain	Nitrile	–20°F to 212°F	Ethylene Glycol	EPDM	–35°F to 250°F	Paint, Latex	Nitrile	–20°F to 212°F
Alcohol Isopropyl	Neoprene	–20°F to 225°F	Fatty Acid	Nitrile	–20°F to 212°F	Phosphate Ester	EPDM	–35°F to 250°F
Alcohol Methyl	EPDM	–20°F to 250°F	Fuel Oil No. 2	Nitrile	–20°F to 212°F	Propane	Nitrile	–20°F to 212°F
Ammonia Anhydrous	Neoprene	–20°F to 225°F	Fertilizer Liquid H4N2O2	EPDM	–35°F to 250°F	Rape Seed Oil	EPDM	–35°F to 250°F
Ammonium Nitrate	EPDM	–20°F to 250°F	Gasoline Keg	Nitrile	–20°F to 212°F	Sewage with Oils	Nitrile	–20°F to 212°F
Ammonia, Water	EPDM	–20°F to 250°F	Gas Natural	Nitrile	–20°F to 212°F	Sodium Hydroxide 20%	EPDM	–35°F to 250°F
Animal Fats	Nitrile	–20°F to 212°F	Glue, Animal	Nitrile	–20°F to 212°F	Starch	EPDM	–35°F to 250°F
Black Liquor	EPDM	–20°F to 250°F	Green Liquor	EPDM	–20°F to 212°F	Steam to 250°F	EPDM	–35°F to 250°F
Blast Furnace Gas	Neoprene	–20°F to 225°F	Hydraulic Oil (Petro)	Nitrile	–20°F to 212°F	Stoddard, Solvent	Nitrile	–20°F to 80°F
Butane	Nitrile	–20°F to 212°F	Hydrogen	Nitrile	–20°F to 212°F	Sulphuric Acid 10% 50%	Neoprene	–20°F to 158°F
Bunker Oil "C"	Nitrile	–20°F to 212°F	JF4, JP5	Viton	–20°F to 212°F	Sulphuric Acid 100%	Viton	10°F to 300°F
Calcium Chloride	EPDM	–20°F to 250°F	Kerosene	Nitrile	0°F to 212°F	Trichloroethylene Dry	Viton	10°F to 300°F
Carbon Dioxide	EPDM	–20°F to 250°F	Ketone	EPDM	–35°F to 250°F	Triethanol Amine	EPDM	–35°F to 250°F
Carbon Monoxide (Cold)	Neoprene	–20°F to 150°F	Lime Slurry	EPDM	–35°F to 250°F	Varnish	Viton	10°F to 300°F
Carbon Monoxide (Hot)	Viton	10°F to 300°F	Methane	Nitrile	–20°F to 212°F	Water, Fresh	EPDM	–35°F to 250°F
Carbon Tetrachloride	Viton	10°F to 300°F	Methyl Ethyl Ketone	EPDM	–35°F to 250°F	Water, Salt	EPDM	–35°F to 250°F
Caustic Soda	EPDM	–35°F to 250°F	Naptha (Berzin)	Nitrile	–20°F to 212°F	Xylene	Viton	10°F to 300°F

Note: Above elastomer / temperature chart are guidelines only. Contact Pratt for specific applications.

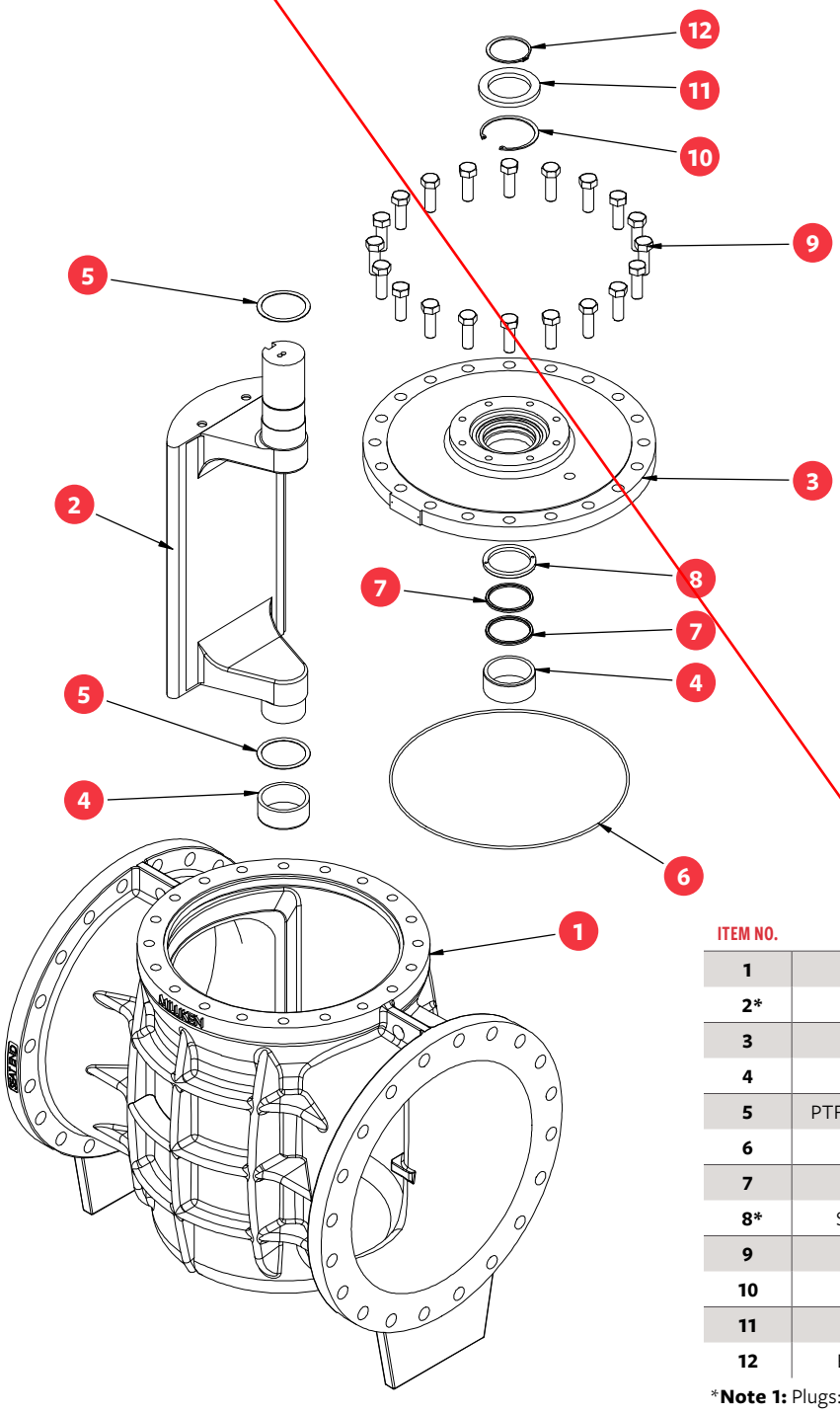
STANDARD MATERIALS OF CONSTRUCTION, FIG. 601 / 600, 12" & SMALLER



ITEM NO.	COMPONENT	MATERIAL
1	Body	Cast Iron A126 Class B
2	Plug	Rubber Coated Ductile Iron ASTM A536
3	Cap	Cast Iron A126 Class B
4	Torque Collar	Ductile Iron ASTM A536
5	Journal Bearing	St.Steel — ANSI 316
6	PTFE Washer (Grit Seal)	PTFE
7	O-Ring	Elas. as Spec.
8	U Cup Seal	Elas. as Spec.
9	Washer	Brass — ASTM B-138-675
10	Internal Snap Ring	Spring Steel
11	Setscrew	Steel (Zinc Plated)
12*	Closed Stop	Steel (Zinc Plated)
13*	Locking Washer	Steel
14*	Nut	Steel (Zinc Plated)
15*	Open Stop	Steel (Zinc Plated)
16*	Setscrew	Steel (Zinc Plated)
17*	Torque Bolt	Steel (Zinc Plated)
18*	Travel Stop	Steel
19*	Washer	Steel

*__Note:__ Torque Collar Assembly on 8" and Smaller

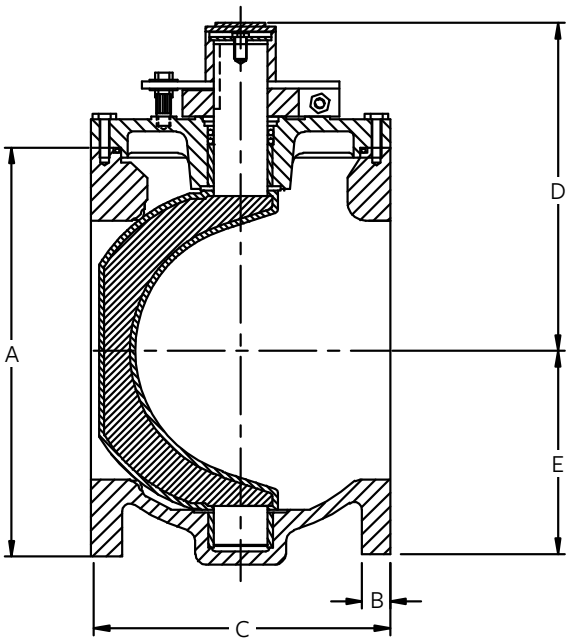
STANDARD MATERIALS OF CONSTRUCTION, FIG. 601 / 600, 14" & LARGER



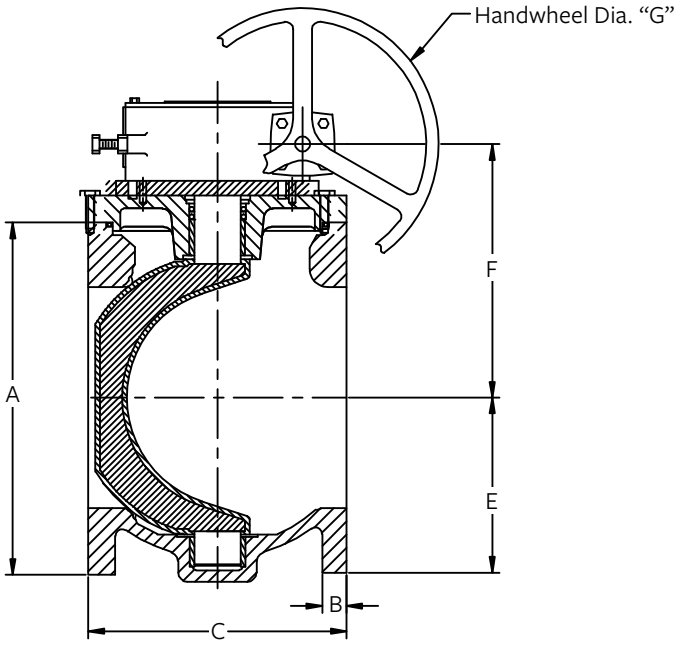
ITEM NO.	COMPONENT	MATERIAL	QTY.
1	Body	Cast Iron A126 Class B	1
2*	Plug	Rubber Coated See Note 1	1
3	Cap	Cast Iron A126 Class B	1
4	Sleeve Bearing	Stainless Steel / Bronze	2
5	PTFE Washer (Grit Seal)	PTFE	2
6	Cap "O" Ring	Elas. as Spec.	1
7	U Cup Seal	Elas. as Spec.	2
8*	Seal Retaining Ring	See Note 2	1
9	Cap Screw	Steel (Zinc Plated)	A/R
10	Internal Snap Ring	Spring Steel	1
11	Support Collar	Steel	1
12	External Snap Ring	Spring Seal	1

*__Note 1:__ Plugs: Ductile Iron — ASTM A536 on 14" – 20"
Cast Iron — A126 Class B on 24" and larger
*__Note 2:__ Seal Retaining Ring: Brass — ASTM B-138-675 on 14" – 20"
Steel on 24" and larger

FIG. 601 CAST IRON / 611 DUCTILE IRON – FLANGED END (175 PSI) / 621 DUCTILE IRON RAISED FACE (285 PSI) 2 1/2" – 12"



2-1/2" – 8" VALVES ONLY



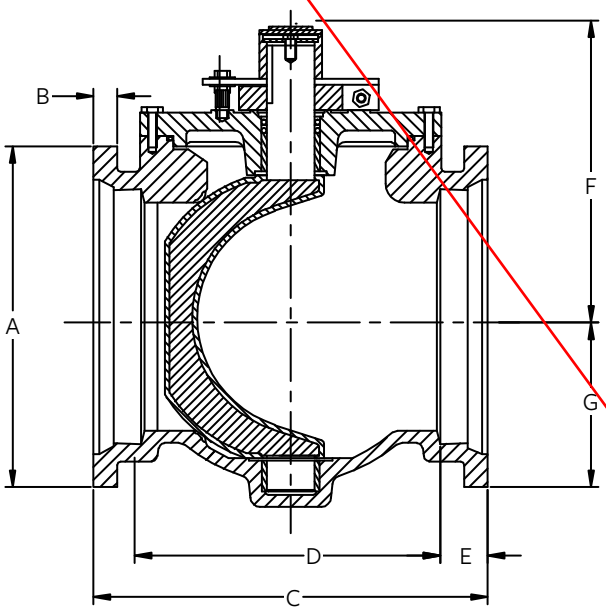
2-1/2" – 12" VALVES

FLANGED END – ANSI 125

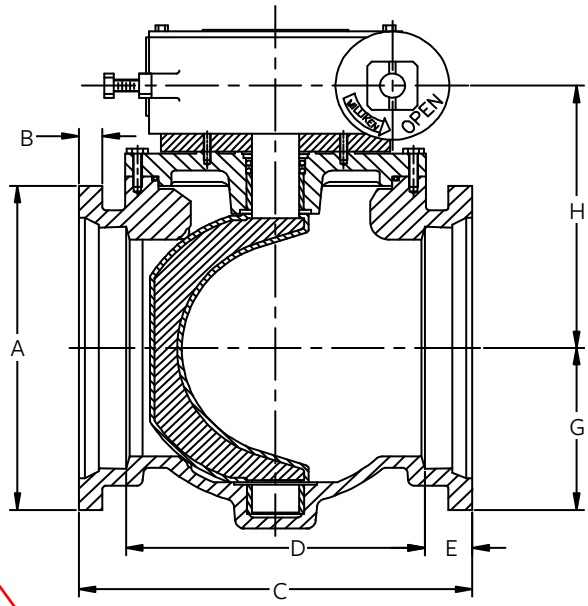
SIZE	2.50	3	4	5	6	8	10*	12*
A	7.00	7.50	9.00	10.00	11.00	13.50	16.00	19.00
B	.69	.75	.94	.94	1.00	1.13	1.19	1.25
C	7.50	8.00	9.00	10.00	10.50	11.50	13.00	14.00
D	6.19	6.19	7.25	8.38	8.38	10.69	—	—
E	3.50	3.75	4.50	5.75	5.75	7.63	8.88	10.00
F	5.35	5.35	6.31	7.56	7.56	9.63	11.13	12.81
G	6.00	6.00	6.00	6.00	6.00	12.00	12.00	12.00
WEIGHT (approx.)	30	40	70	105	115	190	345**	440**

*10" & above have gear operators as standard
**Weight includes gear operator
Note: Drawings are for information purposes only; please request certified drawings before preparing piping diagrams

FIG. 600 CAST IRON (175 PSI) / 620 DUCTILE IRON (285 PSI) – MECHANICAL JOINT 3″ – 12″



3″ – 8″ VALVES ONLY



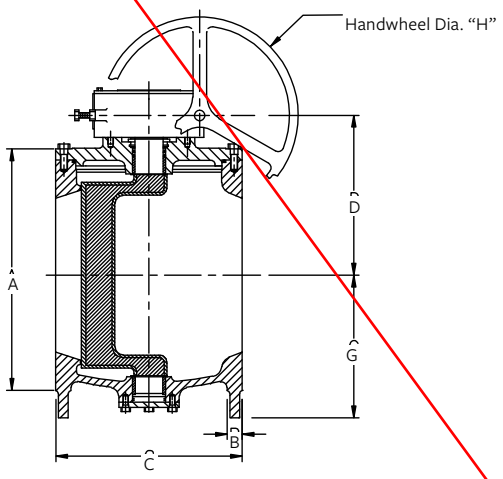
3″ – 12″ VALVES

MECHANICAL JOINT END

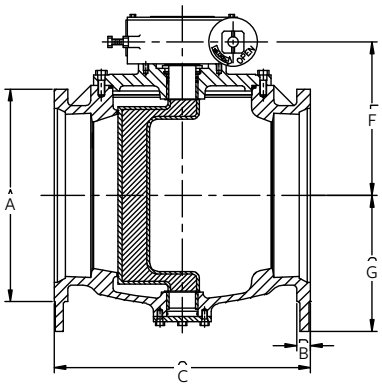
SIZE	3	4	6	8	10*	12*
A	7.69	9.00	11.13	13.38	15.63	17.94
B	.94	1.00	1.06	1.13	1.19	1.25
C	11.50	14.25	15.75	17.38	19.38	20.75
D	6.00	9.25	10.75	12.39	14.39	15.75
E	2.75	2.50	2.50	2.50	2.50	2.50
F	6.19	7.25	8.38	10.69	—	—
G	3.84	4.50	5.56	6.69	7.81	8.97
H	5.16	6.31	7.56	9.63	11.13	12.81
WEIGHT (approx.)	50	80	125	200	360**	480**

*10″ & above have gear operators as standard
**Weight includes gear operator
We recommend gears on all mechanical joint valves
Note: Drawings are for information purposes only; please request certified drawings before preparing piping diagrams

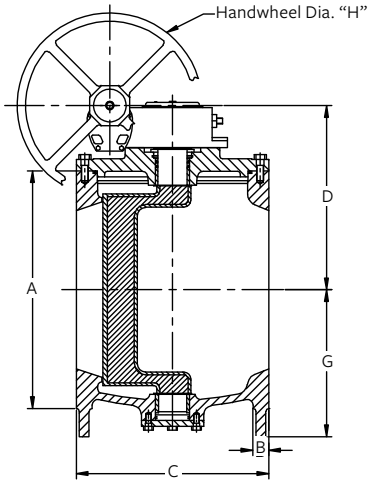
FIG. 601 CAST IRON / 611 DUCTILE IRON FLANGED END (150 PSI) FIG. 600 (150 PSI) / 620 (250 PSI) DUCTILE IRON MECHANICAL JOINT END 14" & LARGER



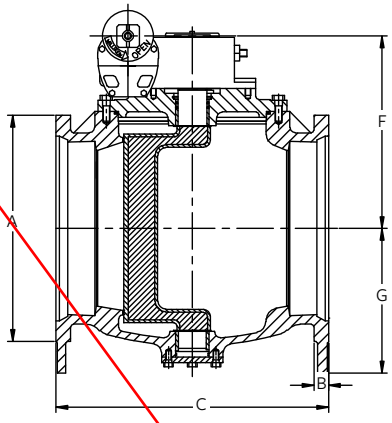
14" –20" VALVES



14" –20" VALVES



24" VALVES AND LARGER



24" VALVES AND LARGER

FLANGED END — ANSI 125

SIZE	14	16	18	20	24	30	36	42	48	54
A	21.00	23.50	25.00	27.50	32.00	38.75	46.00	53.00	59.00	66.25
B	1.38	1.44	1.56	1.69	1.88	2.13	2.38	2.63	2.75	3.00
C	17.00	17.75	21.50	23.50	42.00	51.00	60.00	72.00	84.00	96.00
D	14.56	15.81	16.36	17.63	25.13	29.00	33.51	33.88	39.57	50.86
G	13.00	14.00	15.00	16.00	21.62	24.43	29.00	29.00	36.00	36.00
H	18.00	18.00	18.00	18.00	24.00	24.00	24.00	30.33	30.00	30.00
WEIGHT (approx.)	905	1030	1355	1880	3800	5200	6950	10160	13350	15100

Flanged Valves Meet ANSI B16.1

MECHANICAL JOINT END

SIZE	14	16	18	20	24	30	36	42	48
A	20.13	22.56	24.84	27.06	31.50	39.13	46.00	53.13	60.00
B	1.31	1.38	1.43	1.50	1.62	1.68	2.00	2.00	2.00
C	24.50	27.25	29.25	31.00	42.00	51.00	60.00	72.00	84.00
F	14.56	15.81	16.36	17.63	25.13	29.00	33.51	33.88	39.57
G	13.00	14.00	15.00	16.00	21.62	24.75	29.00	29.00	36.00
WEIGHT (approx.)	905	1030	1355	1880	3800	5200	6950	10160	13350

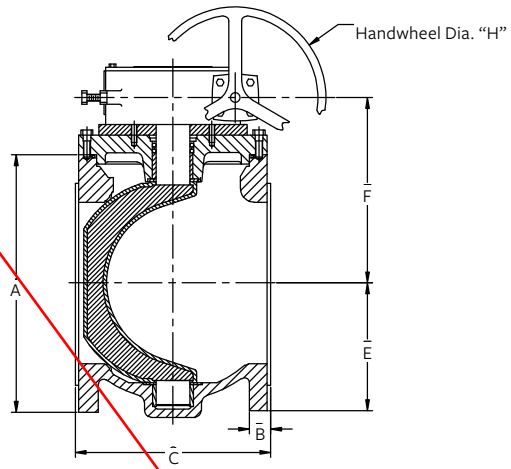
Mechanical Joint Valves Meet ANSI 21.11 & AWWA C-111

Weight includes gear operator

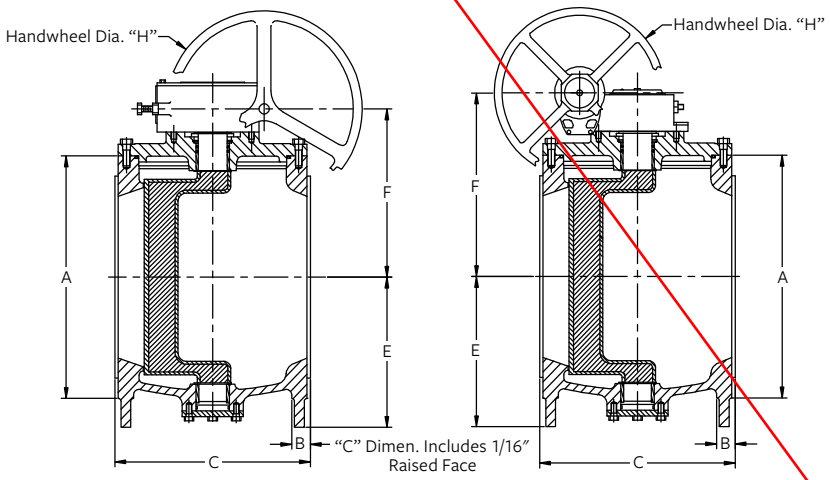
Note: Drawings are for information purposes only; please request certified drawings before preparing piping diagrams.

Note: Dimensions on 60" and larger available upon request.

FIG. 602 CLASS 250 RAISED FACE FLANGED END 2 1/2" – 12", 400 PSI, 14" – 36", 300 PSI



2-1/2" – 12" VALVES



14" – 20" VALVES

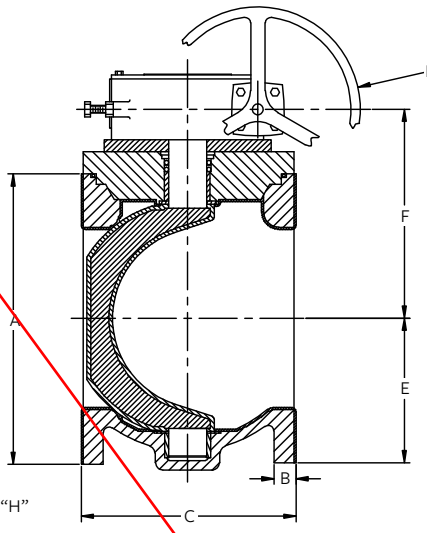
24" AND LARGER VALVES

FLANGED END — ANSI 250

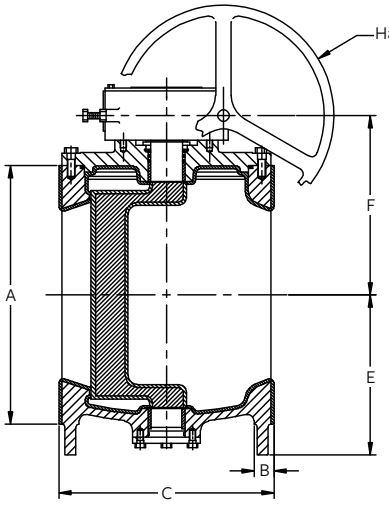
SIZE	2.50	3	4	5	6	8	10	12	14	16	18	20	24	30	36
A	7.50	8.25	10.00	11.00	12.50	15.00	17.50	20.50	23.00	25.50	28.00	30.50	36.00	43.00	50.00
B	1.06	1.13	1.25	1.38	1.44	1.63	1.88	2.00	2.12	2.25	2.38	2.50	2.75	3.00	3.38
C	9.50	11.13	12.00	15.00	15.88	16.50	18.00	19.75	18.50	19.38	23.13	25.00	42.88	51.88	61.00
E	3.50	3.75	4.50	5.75	5.75	17.63	8.88	10.00	13.00	14.00	15.00	16.00	21.62	24.75	29.00
F	5.16	5.16	6.31	7.56	7.56	9.63	11.13	12.81	14.56	15.81	16.36	17.63	22.81	27.59	33.00
H	6.00	6.00	6.00	6.00	6.00	12.00	12.00	12.00	18.00	18.00	18.00	18.00	24.00	24.00	24.00
WEIGHT (approx.)	70	80	120	162	170	275	398	590	980	1125	1830	2060	4160	5700	7670

All above have gear operators as standard
Weight includes gear operator
Note: Drawings are for information purposes only; please request certified drawings before preparing piping diagrams
Note: Dimensions on 42" and larger available upon request

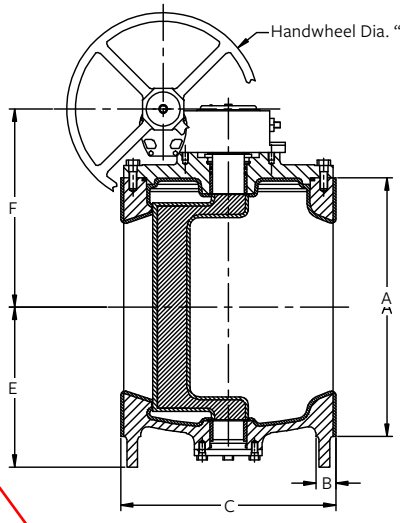
RUBBERLINED – FLANGED END – 3″ – 12″, 175 PSI, 14″ & LARGER, 150 PSI



3″ – 12″ VALVES



14″ – 20″ VALVES



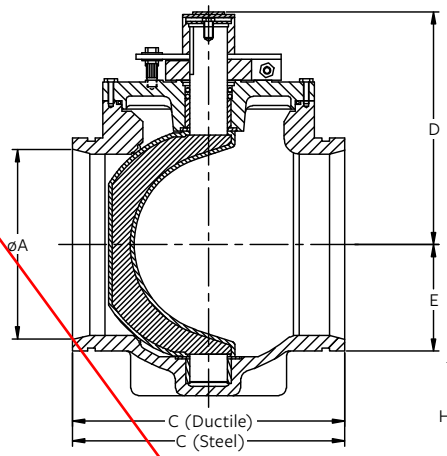
24″ AND LARGER VALVES

FLANGED END — ANSI 125 RUBBER LINED

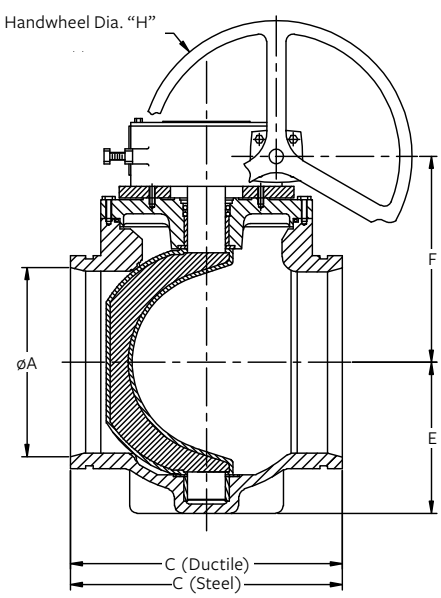
SIZE	3	4	5	6	8	10	12	14	16	18	20	24	30	36	42
A	7.50	9.00	10.00	11.00	13.50	16.00	19.00	21.00	23.25	25.00	27.50	32	38.75	46.00	53.00
B	.88	1.07	1.07	1.13	1.26	1.32	1.38	1.26	2.25	2.38	2.50	2.75	3.00	3.38	3.38
C	8.25	9.25	10.25	10.75	11.75	13.25	14.25	17.25	18.00	21.75	23.75	42.25	51.25	60.25	72.25
E	3.75	4.50	7.75	7.75	7.63	8.88	10.00	13.00	14.00	15.00	16.00	21.63	24.75	29.00	29.00
F	5.16	6.31	7.56	7.56	9.63	11.13	12.81	14.56	15.81	16.36	17.63	25.13	29.00	33.51	33.88
H	6.00	6.00	6.00	6.00	12.00	12.00	12.00	18.00	18.00	18.00	18.00	24.00	24.00	24.00	24.00
WEIGHT (approx.)	70	100	135	145	240	345	440	905	1030	1355	1880	3800	5200	6940	10160

All above have gear operators as standard
Weight includes gear operator
Note: Drawings are for information purposes only; please request certified drawings before preparing piping diagrams
Note: Dimensions on 48″ and larger available upon request

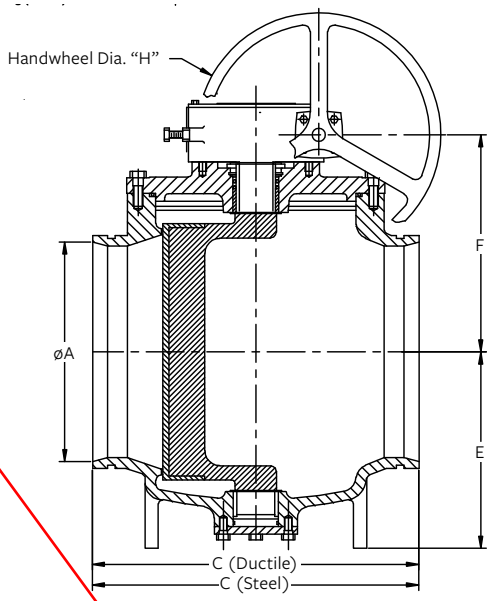
FIG. 606 GROOVED END – 2 1/2" – 12", 175 PSI, 14" – 20", 150 PSI



2-1/2" – 8" VALVES



2-1/2" – 12" VALVES



14" – 20" VALVES

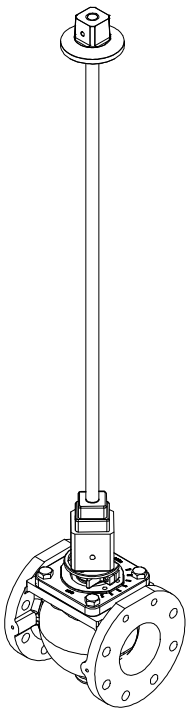
GROOVED END — AWWA 606

SIZE	2.50	3	4	5	6	8	10*	12*	14*	16*	18*	20*
A	2.50	3.00	4.00	5.00	6.00	8.00	10.00	12.00	14.00	15.25	16.19	18.06
C (Duct.)	N/A	9.06	10.25	N/A	12.50	14.00	16.56	18.00	21.63	N/A	27.50	30.00
C (Steel)	7.13	8.50	10.13	12.38	12.38	13.88	16.44	17.88	21.63	22.50	27.50	30.00
D	6.19	6.19	7.25	8.38	8.38	10.69	—	—	—	—	—	—
E	3.50	3.75	4.50	5.75	5.75	7.63	8.88	10.00	10.00	14.00	15.00	16.00
F	5.16	5.16	6.31	7.56	7.56	9.63	11.13	12.86	13.56	15.81	16.35	17.63
H	6.00	6.00	6.00	6.00	6.00	12.00	12.00	12.00	12.00	18.00	18.00	18.00
WEIGHT (approx.)	20	30	50	70	80	145	325**	420**	RTF	RTF	RTF	RTF

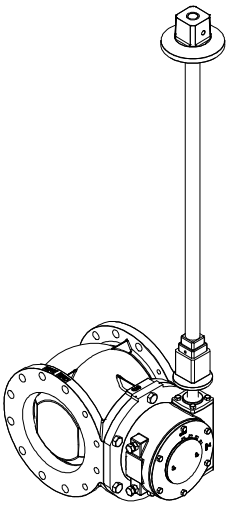
*10" & above have gear operators as standard
**Weight includes gear operator
Note: Drawings are for information purposes only; please request certified drawings before preparing piping diagrams
Note: Larger sizes are available. Contact Pratt Valve for data.

ADAPTION

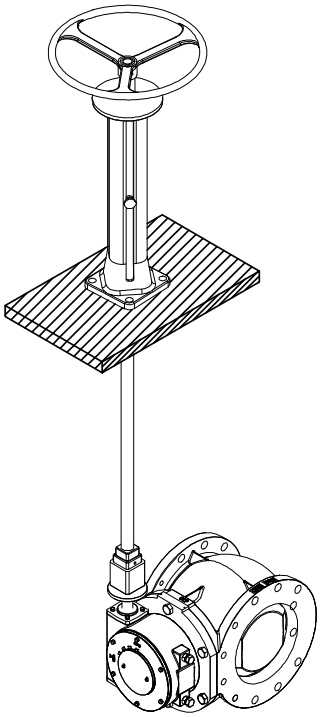
A range of extended stems & floor mounted stands for remote operation, particularly in buried service, are available. Chainwheels & locking devices are readily incorporated onto the Ballcentric® Plug Valve.



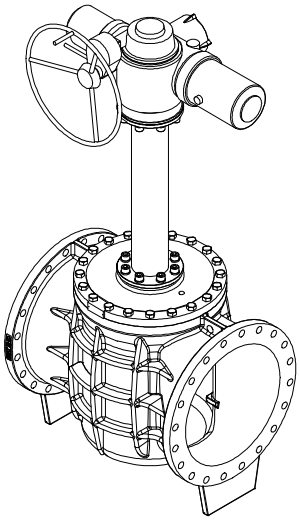
VALVE WITH EXTENDED STEM & 2" NUT
(ONLY FOR 8" AND SMALLER VALVES)



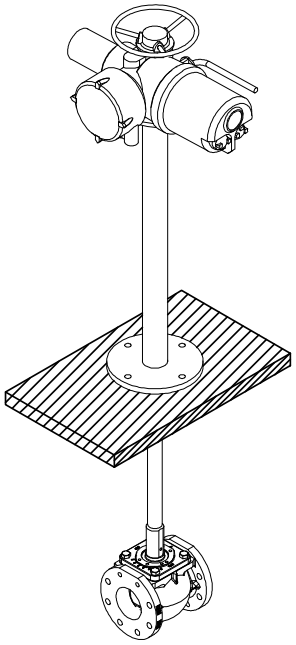
VALVE WITH EXTENDED STEM,
BURIED GEAR AND 2" NUT



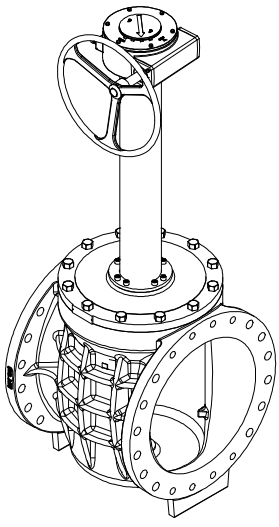
VALVE WITH INDICATING FLOORSTAND



VALVE WITH EXTENDED BONNET & MOTOR OPERATOR



VALVE WITH NON-INDICATING FLOORSTAND
AND MOTOR OPERATOR



VALVE WITH EXTENDED BONNET WITH GEAR

TECHNICAL SPECIFICATION

Ballcentric® Series 601 / 600 Plug Valves

AWWA C-517 STANDARDS

Valves shall be of the non-lubricated eccentric type with an elastomer covering all seating surfaces. The elastomer shall be suitable for the service intended. Flanged valves shall be manufactured in accordance with **ANSI B16.1 Class 125 / 150** including facing, drilling and flange thickness. Mechanical joint ends shall be in compliance with **AWWA / ANSI C-111**. Grooved ends shall be manufactured to the dimensions of **ANSI / AWWA C606** for ductile or steel pipe as required. Ports shall be round on sizes 2-1/2″-12″ and rectangular port design on valves 14″ and larger. All valves shall be capable of being "pigged" with a soft pig when required.

Valve bodies shall be of **ASTM A-126 Class B** cast iron and thickness in accordance with **AWWA C-517 Section 4.4.1.4**. Valves 3″ and larger shall be furnished with a welded-in overlay seat of 1/8″ thick of not less than 99% nickel in accordance with **AWWA C-517, Section 4.3.3.4**. Sprayed, plated or screwed-in seats are not acceptable.

Plugs shall be of **ASTM A-536-Grade 65-45-12** for all sizes in compliance with **AWWA C-517 Section 4.3.3.2**. The plugs shall be of one piece solid construction with PTFE thrust bearings on the upper and lower bearing journals to reduce torque and prevent dirt and grit from entering the bearing and seal area.

Valves shall be furnished with replaceable sleeve type bearings conforming to **AWWA C-517, Section 4.3.3.6**. Bearings shall be of sintered, oil impregnated type stainless steel. Valve shaft seals shall be of the "U" cup type in accordance with **AWWA C-517 Section 4.4.7**. Seals shall be self adjusting and repackable without removing the bonnet from the valve.

Wrench operated valves 2-1/2″-8″ shall be capable of being converted to worm gear or automated operation without removing the bonnet or plug from the valve. All wrench operated valves shall be equipped with a 2″ square nut for use with removeable levers or extended "T" handles.

Worm gear operators, where required, shall be of the heavy duty construction with the ductile iron quadrant supported on the top and bottom by oil impregnated bronze bearings. The worm gear and shaft shall be manufactured of hardened steel and run on high efficiency roller bearings.

Valves shall be designed and manufactured to shut off bubble tight at 175 psi for valves 2-1/2″-12″ and 150 psi for valves 14″ and larger. Each valve shall be given a hydrostatic and seat test with the test results being certified when required by the customer. Certified copies of Proof-of-Design test reports shall be furnished as outlined in **AWWA C-517 Section 5.2.2** when requested.

Plug valves shall be Ballcentric® Plug Valve **Series 601 / 600** as manufactured by Pratt.

TECHNICAL SPECIFICATION

Ballcentric® Series 602 ANSI Class 250 Raised Face Plug Valves

AWWA C-517 STANDARDS

Valves shall be of the non-lubricated eccentric type with an elastomer covering all seating surfaces. The elastomer shall be suitable for the service intended. Flanged valves shall be manufactured in accordance with **ANSI B16.1 Class 250** including facing, drilling and flange thickness. Ports shall be round on sizes 2-1/2″ through 12″ to facilitate "pigging" when required. Valves 14″ and larger shall be of a rectangular port design.

Valve bodies shall be of **ASTM A-536 Grade 65-45-12** ductile iron and thickness in accordance with **AWWA C-517 Section 4.4.1.4**. Valves 3″ and larger shall be furnished with a welded-in overlay seat of 1/8″ thick of not less than 99% nickel in accordance with **AWWA C-517 Section 4.3.3.4**. Sprayed, plated or screwed-in seats are not acceptable.

Plugs shall be of **ASTM A-536-Grade 65-45-12** in compliance with **AWWA C-517 Section 4.3.3.2**. The plugs shall be of one piece solid construction with PTFE thrust bearings on the upper and lower bearing journals to reduce torque and prevent dirt and grit form entering the bearing and seal area.

Valves shall be furnished with replaceable sleeve type bearings conforming to **AWWA C-517 Section 4.3.3.6**. Bearings shall be of sintered, oil impregnated type stainless steel. Valve shaft seals shall be of the "U" cup type in accordance with **AWWA C-517 Section 4.4.7**. Seals shall be self adjusting and repackable without removing the bonnet from the valve.

Worm gear operators shall be of the heavy duty construction with the ductile iron quadrant supported on the top and bottom by oil impregnated bronze bearings. The worm gear and shaft shall be manufactured of hardened steel and run on high efficiency roller bearings. All worm gear operators shall be sized for bi-directional shutoff at the valves design pressure rating.

Valves shall be designed and manufactured to shut off bubble tight at 400 psi for valves 2-1/2″-12″ and 300 psi for valves 14″-36″ with pressure behind the plug.

Each valve shall be given a hydrostatic and seat test with the test results being certified when required by the customer. Certified copies of Proof-of-Design test reports shall be furnished as outlined in **AWWA C-517 Section 5.2.2** when requested.

Plug valves shall be Ballcentric® Plug Valve **Series 602** as manufactured by Pratt.

TECHNICAL SPECIFICATION

Ballcentric® Rubberlined Plug Valves

AWWA C-517 STANDARDS

Valves shall be of the non-lubricated eccentric type with an elastomer covering all seating surfaces. The elastomer shall be suitable for the service intended. Flanged valves shall be manufactured in accordance with **ANSI B16.1 Class 125 / 150** including facing, drilling and flange thickness. Mechanical joint ends shall be in compliance with **AWWA / ANSI C-111- 92**. Grooved ends shall be manufactured to the dimensions of **ANSI / AWWA C606** for ductile or steel pipe as required. Ports shall be round on sizes
2-1/2″-12″ and rectangular port design on valves 14″ and larger. All valves shall be capable of being "pigged" with a soft pig when required.

Valve bodies shall be of **ASTM A-126 Class B** cast iron and thickness in accordance with **AWWA C-517 Section 4.4.1.4**. The interior of the valve bodies shall be covered with a suitable elastomer with a minimum thickness of 1/8″. The elastomer shall extend through the valve flow way and onto the flanges to ensure a positive seal.

Plugs shall be of **ASTM A-536-Grade 65-45-12** for all sizes in compliance with AWWA C-517 Section 4.3.3.2. The plugs shall be of one piece solid construction with PTFE thrust bearings on the upper and lower bearing journals to reduce torque and prevent dirt and grit from entering the bearing and seal area.

Valves shall be furnished with replaceable sleeve type bearings conforming to **AWWA C-517, Section 4.3.3.6**. Bearings shall be of sintered, oil impregnated type stainless steel. Valve shaft seals shall be of the "U" cup type in accordance with **AWWA C-517 Section 4.4.7**. Seals shall be self adjusting and repackable without removing the bonnet from the valve.

Worm gear operators shall be of the heavy duty construction with the ductile iron quadrant supported on the top and bottom by oil impregnated bronze bearings. The worm gear and shaft shall be manufactured of hardened steel and run on high efficiency roller bearings. All worm gear operators shall be sized for bi-directional shutoff at the valves design pressure rating.

Valves shall be designed and manufactured to shut off bubble tight at 175 psi for valves 2-1/2″-12″ and 150 psi for valves 14″ and larger. Each valve shall be given a hydrostatic and seat test with the test results being certified when required by the customer. Certified copies of Proof-of-Design test reports shall be furnished as outlined in **AWWA C-517 Section 5.2.2** when requested.

Plug valves shall be Ballcentric® Plug Valve as manufactured by Pratt.

TECHNICAL SPECIFICATION

Ballcentric® Series 601S – Stainless Steel Plug Valves

AWWA C-517 STANDARDS

Valves shall be of the non-lubricated eccentric type with an elastomer covering all seating surfaces. The elastomer shall be suitable for the service intended. Flanged valves shall be manufactured in accordance with ANSI B16.1 Class 125 including facing, drilling and flange thickness. Ports shall be round on sizes 2-1/2″-12″ and rectangular port design on valves 14″ and larger. All valves shall be capable of being "pigged" with a soft pig when required.

Valve bodies shall be of **CF8M (316 stainless steel)**. Valves shall be furnished with 316 stainless steel seat in accordance with **AWWA C-517 Section 4.3.3.4**.

Plugs shall be of **CF8M (316 stainless steel)**. The plugs shall be of one piece solid construction with PTFE thrust bearings on the upper and lower bearing journals to reduce torque and prevent dirt and grit from entering the bearing and seal area.

Valves shall be furnished with replaceable sleeve type bearings conforming to **AWWA C-517 Section 4.3.3.6**. Bearings shall be of sintered, oil impregnated type stainless steel. Valve shaft seals shall be of the "U" cup type in accordance with **AWWA C-517 Section 4.4.7**. Seals shall be self adjusting and repackable without removing the bonnet from the valve.

Wrench operated valves 2-1/2″-8″ shall be capable of being converted to worm gear or automated operation without removing the bonnet or plug from the valve. All wrench operated valves shall be equipped with a 2″ square nut for use with removable levers or extended "T" handles.

Worm gear operators, where required, shall be of the heavy duty construction with the ductile iron quadrant supported on the top and bottom by oil impregnated bronze bearings. The worm gear and shaft shall be manufactured of hardened steel and run on high efficiency roller bearings. All worm gear operators shall be sized for bi-directional shutoff at the valves design pressure rating.

Valves shall be designed and manufactured to shut off bubble tight at 275 psi. Each valve shall be given a hydrostatic and seat test with the test results being certified when required by the customer. Certified copies of Proof-of-Design test reports shall be furnished as outlined in **AWWA C-517 Section 5.2.2** when requested.

Plug valves shall be Ballcentric® Plug Valve **Series 601S** as manufactured by Pratt.

TECHNICAL SPECIFICATION

Ballcentric® Series 611 – Ductile Iron Plug Valves

AWWA C-517 STANDARDS

Valves shall be of the non-lubricated eccentric type with an elastomer covering all seating surfaces. The elastomer shall be suitable for the service intended. Flanged valves shall be manufactured in accordance with **ANSI B16.1 Class 125 / 150** including facing, drilling and flange thickness. Mechanical joint ends shall be in compliance with **AWWA / ANSI C-111-92**. Grooved ends shall be manufactured to the dimensions of **ANSI / AWWA C606** for ductile or steel pipe as required. Ports shall be round on sizes
2-1/2″-12″ and rectangular port design on valves 14″ and larger. All valves shall be capable of being "pigged" with a soft pig when required.

Valve bodies shall be of **ASTM A-536 Grade 65-45-12** and thickness in accordance with **AWWA C-517 Section 4.4.1.4**. Valves 3″ and larger shall be furnished with a welded-in overlay seat of 1/8″ thick of not less than 99% nickel in accordance with **AWWA C-517, Section 4.3.3.4**. Sprayed, plated or screwed-in seats are not acceptable.

Plugs shall be of **ASTM A-536-Grade 65-45-12** for all sizes in accordance with **AWWA C-517 Section 4.3.3.2**. The plugs shall be of one piece solid construction with PTFE thrust bearings on the upper and lower bearing journals to reduce torque and prevent dirt and grit from entering the bearing and seal area.

Valves shall be furnished with replaceable sleeve type bearings conforming to **AWWA C-517, Section 4.3.3.6**. Bearings shall be of sintered, oil impregnated type stainless steel. Valve shaft seals shall be of the "U" cup type in accordance with **AWWA C-517 Section 4.4.7**. Seals shall be self adjusting and repackable without removing the bonnet from the valve.

Wrench operated valves 2-1/2″-8″ shall be capable of being converted to worm gear or automated operation without removing the bonnet or plug from the valve. All wrench operated valves shall be equipped with a 2″ square nut for use with removeable levers or extended "T" handles.

Worm gear operators, where required, shall be of the heavy duty construction with the ductile iron quadrant supported on the top and bottom by oil impregnated bronze bearings. The worm gear and shaft shall be manufactured of hardened steel and run on high efficiency roller bearings. All worm gear operators shall be sized for bidirectional shutoff at the valves design pressure rating.

Valves shall be designed and manufactured to shut off bubble tight at 175 psi for valves 2-1/2″-12″ and 150 psi for valves 14″ and larger. Each valve shall be given a hydrostatic and seat test with the test results being certified when required by the customer. Certified copies of Proof-of-Design test reports shall be furnished as outlined in **AWWA C-517 Section 5.2.2** when requested.

Plug valves shall be Ballcentric® Plug Valve **Series 611** as manufactured by Pratt.

TECHNICAL SPECIFICATION

Ballcentric® Glass Lined Plug Valves

AWWA C517-09 STANDARDS

Valves shall be of the non-lubricated eccentric type with an elastomer covering all seating surfaces. The elastomer shall be suitable for the service intended. Flanged valves shall be manufactured in accordance with **ANSI B16.1 Class 125 / 150** including facing, drilling and flange thickness. Mechanical joint ends shall be in compliance with **AWWA / ANSI C-111-92.** Grooved ends shall be manufactured to the dimensions of **ANSI / AWWA C606** for ductile or steel pipe as required. Ports shall be round on sizes 3″-12″ and rectangular port design on valves 14″ and larger. All valves shall be capable of being "pigged" with a soft pig when required.

Valve bodies shall be of **ASTM A-126 Class B** cast iron and thickness in accordance with **AWWA C-517 Section 4.4.1.4**. Interior of valves shall be glass lined at .008-.012 mils thickness, covering the entire interior of valve bodies and stopping at the flange faces.

Plugs shall be of **ASTM A-536-Grade 65-45-12** for all sizes in compliance with AWWA C-517 Section 4.3.3.2. The plugs shall be of one piece solid construction with PTFE thrust bearings on the upper and lower bearing journals to reduce torque and prevent dirt and grit from entering the bearing and seal area.

Valves shall be furnished with replaceable sleeve type bearings conforming to **AWWA C-517, Section 4.3.3.6**. Bearings shall be of sintered, oil impregnated type stainless steel. Valve shaft seals shall be of the "U" cup type in accordance with **AWWA C-517 Section 4.4.7**. Seals shall be self adjusting and repackable without removing the bonnet from the valve.

Wrench operated valves 2-1/2″-8″ shall be capable of being converted to worm gear or automated operation without removing the bonnet or plug from the valve. All wrench operated valves shall be equipped with a 2″ square nut for use with removeable levers or extended "T" handles.

Worm gear operators, where required, shall be of the heavy duty construction with the ductile iron quadrant supported on the top and bottom by oil impregnated bronze bearings. The worm gear and shaft shall be manufactured of hardened steel and run on high efficiency roller bearings. All worm gear operators shall be sized for bi-directional shutoff at the valves design pressure rating.

Valves shall be designed and manufactured to shut off bubble tight at 175 psi for valves 2-1/2″-12″ and 150 psi for valves 14″ and larger. Each valve shall be given a hydrostatic and seat test with the test results being certified when required by the customer. Certified copies of Proof-of-Design test reports shall be furnished as outlined in AWWA C-517 Section 5.2.2 when requested.

Plug valves shall be Ballcentric® Plug Valve Series as manufactured by Pratt.

NOTES

NOTES

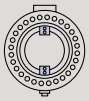
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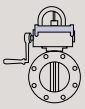
PRATT® PRODUCT GUIDE


Model 2FII

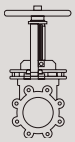

Monoflange MKII


Plug Valve

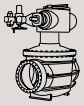

Triton® XR70

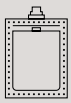

Indicating Butterfly Valve UL & FM approved


Tilting Disc Check Valve


Knife Gate Valve


N-Stamp Nuclear Butterfly Valve

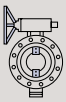

Cone Valve

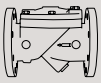

Rectangular

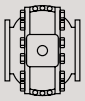

PIVA Post Indicating Valve Assembly UL & FM approved


Sleeve Valve


Rubber Seated Ball Valve

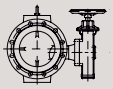

Triton® HP250

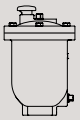

Check Valve


Metal Seated Ball Valve



Control Systems


Plunger Valve


Air Valve

401 S. Highland Ave., Aurora, IL 60506, moreinfo@prattvalve.com, **P:** 1.800.423.1323

For more information about Pratt or to view our full line of water products, please visit www.prattvalve.com or call Pratt customer service at 1.800.423.1323.

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MUELLER

F 13271 11/18

auma®
Solutions for a world in motion

January 29, 2025

BABA Act Certificate of Compliance as manufactured products:

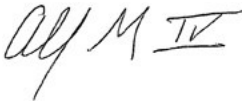
The following products and/or materials shipped/provided are in full compliance with the Build America, Buy America Act (BABAA) requirement as mandated in the Infrastructure Investment and Job Act (IIJA) Pub. L. No. 117-58-§§ 70901-52. The Items, Products, or Models, excluding labor and overhead, provided below contains 55% domestic content.

Items, Products, or Models:

- SA07.2 thru SA16.2 Actuators with AM01.1 or AC01.2 Controls
- SAEX07.2 thru SAEX16.2 Actuators with AMEX or ACEX01.2 Controls
- SQ05.2 thru SQ14.2 Actuators with AM01.1 or AC01.2 controls
- GS50 thru GS250 Gearboxes when assembled to any of the above products.
- PF-Q 80 thru PF-Q 600

The manufacturing process for the above Items, Products, or Models takes place at the following location: Canonsburg, PA

Kind regards,



Alfred Midgley IV
Vice President of Sales

AUMA Actuators, Inc. • 100 Southpointe Blvd. Canonsburg, PA 15317 USA
Phone: 724-743-2862 • Fax: 724-743-4711 • www.auma.com • mailbox@auma-usa.com

Mueller Water Products Headquarters
1200 Abernathy Road NE,
Suite 1200
Atlanta, GA 30328

Phone: 770-206-4200

Build America, Buy American Act Certification

4/28/25

SAMPLE CERTIFICATE

As of the date of this certification, I certify as of the date hereof, the following iron and steel products shipped/provided to the3 subject project are in full compliance with the Build America, Buy America Act (BABAA) requirement as mandated in the3 Infrastructure Investment and Job Act (IIJA) Pub. L. No. 117-58-§§ 70901-52, as implemented by the EPA (to include EPA's3 standing waiver for minor components).

Items, Products and/or Materials:

Part#	Description	Size	Qty	Product Type	Location
101FF-0134ESS#10451DB	10 150B FL BFV P/S	10"	1	Iron and Steel	Kimball, TN

Sincerely,



Karli Peadro
Manager, Regulatory Compliance
kpeadro@muellerwp.com

EQ-05

CIP STATION

For Earth, For Life
Kubota

Submittal Transmittal

CIP Station

Project Name	TAYLOR BAY BEACH CLUB WWTF UPGRADE
Project Site	8220 178TH AVENUE, LONGBRANCH, WA 98351
Engineer	Gray & Osborne, Inc 1130 RAINIER AVENUE SOUTH, SUITE 300
Submit to	Gray & Osborne, Inc
Prepared by	Shingo Kubo | Lead Project Manager KUBOTA Water and Environment U.S.A. Corporation 19910 N Creek Pkwy, Suite 100 Bothell, WA 98011
KMU Project #	KMU-OPID85
Issued Date	August 24, 2025
Package #	OPID85- EQ-05-B-CIP Station
Item	Tag # 02 MOV 03 02 MOV 04

Clarifications;

1. Section1 contains Kubota scope list. The subjected item for this submittal is marked in red.

2. Section2 contains the manufacture submittal and datasheet for review.

Response to 60% review comment;

1) General – Make Corrections Noted

a. Note that BABA certifications from manufacturers should be included in the final

Kubota Response: Kubota Standard CIP system does not comply with BABA requirement as shown in ATTACHMENT B.

ATTACHMENT B

SCOPE OF SUPPLY COMPONENTS THAT DO NOT COMPLY WITH BABA REQUIREMENTS

Part Identification (Name)	Equipment Description and Type	Manufacturer	Number of Units	Total Lump Sum Equipment Cost for Line Item
Kubota SMU Equipment	FS150 SMU Units + Associated Lifting Tool	Kubota	4 SMUs 1 Lifting Tool + Chains	$80,400.00
SMU Basin Associated Endress + Hauser Instrumentation	1. Air Pressure Transmitters 2. Blower Flow Meters 3. Permeate Flow Meter 4. Pump Pressure Transmitter 5. Level Transmitter	Endress + Hauser	Type 1 - QTY 3 Type 2 - QTY 2 Type 3 - QTY 1 Type 4 - QTY 2 Type 5 - QTY 2	$33,896.00
SMU Basin Hach Instrumentation	1. Air Pressure Transmitters 2. Blower Flow Meters 3. Permeate Flow Meters	Hach	Type 1 - QTY 1 Type 2 - QTY 1 Type 3 - QTY 1	$12,633.00
Kubota Standard CIP System	Kubota CIP system based around Mazzei injector, rotometer and flow control valve	Various	1 System of Supply	$18,500.00
PVC Isolation Valves + Check Valves	3 inch PVC Ball Valves 3 inch PVC Check Valves	Asahi	11 Ball Valves 3 Check Vavles	$11,072.00

b. Note that manufacturer services should be included in the final submittal.

Kubota Response: Manufacturer service for the entire system is included per the specifications.

a. CIP Plan, Elevations, and Isometric drawings: We will provide requested revisions.

Kubota Response: The drawing has been updated accordingly. See section 2.

b. Pressure reducing valve: no exceptions taken.

Kubota Response: Noted.

c. Electrical Actuator: The submitted valve actuator does not meet the requirements of the specifications for electric valve operators, 15110-2.1. We are willing to accept the submitted valve if an uninstalled spare unit is supplied.

Kubota Response: Kubota will provide a shelf spare of the actuated valve.

d. Venturi Injector: no exceptions taken.

Kubota Response: Noted.

e. Pressure gauges: submitted units do not meet the requirements of 13417-1, with 4-1/2" dial size, stainless steel bourdon tube with stainless steel selector, Ashcroft Duragage 1279 or equal. Please revise

Kubota Response: The pressure gauge and the diaphragm seal have been updated. The same liquid fill (Silicone) is selected for both gauge and the diaphragm seal for operator convenience.

f. Electronic Flow Meter: The model number listed is acceptable. Please edit the PDF to indicated only those items, models, or series of equipment that are being supplied and cross out all extraneous material per 01300.

Kubota Response: Cross-out has been added. Please see section 2. Also, the selection has been updated to match those installed permeate pump discharge (except for the size).

For Earth, For Life
Kubota

SECTION 1

KUBOTA Water and Environment U.S.A. Corporation
19910 N Creek Pkwy, Suite 100 Bothell, WA 98011| Phone: 425 898 2858 | Fax: 425-898-2853

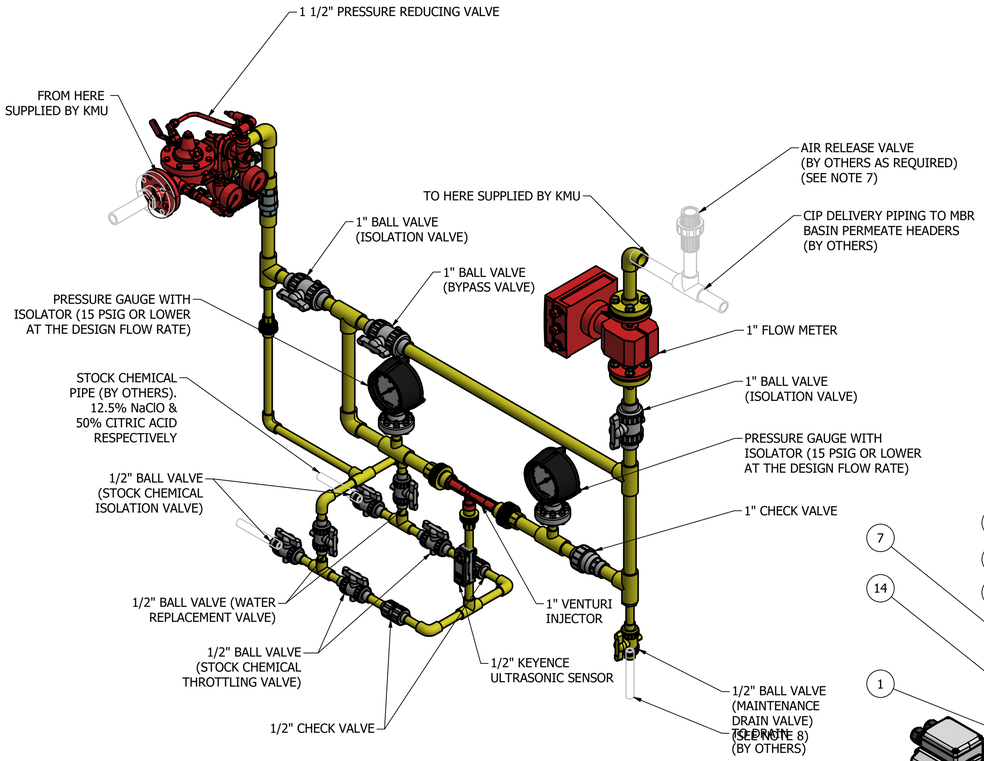
No	Equipment Location	Tag	Category	Function	Name	Type	Chosen Size/Capacity	Unit	Material	Manufacturer	Model/ Specification	Motor HP	Voltage	FLA	QTY
	MBR Equipment	**x**													
1	MBR	02 MBR 01 02 MBR 02 02 MBR 03 02 MBR 04	SMU	Membrane Filtration	MBR SMU	Flat Plate			304SS	KUBOTA	FS150				4
2	MBR	n/a	SMU	SMU Maintenance	MBR SMU Lifting Tool	Lifting Tool			CS, SS	KUBOTA	TG150				1
3	MBR	n/a	SMU	SMU Maintenance	MBR SMU Lifting Chain	Lifting Tool			304SS	KUBOTA	CS30M				4
4	MBR	02 MOV 03 02 MOV 04	Auto Valve	Diffuser Cleaning	MBR Diffuser Cleaning Valve	ON/OFF Plug	3	inch	CI/CI	Auma/Pratt	SQ12.2-AC01.2/S601 w/extention stem	1/12	120 VAC	2.9	2
5	MBR	n/a	Other Valve	Isolation Valve	SMU Air Isolation Valve(inlet)	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S30				4
6	MBR	n/a	Other Valve	Isolation Valve	SMU Air Isolation Valve(outlet)	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S30				4
7	MBR	BV281 BV282 BV283 BV284	Other Valve	Isolation Valve	SMU PRMT Isolation Valve	Manual Butterfly	2	inch	DI, EPDM, Nylon Coat	Bray	S30				4
8	MBR	n/a	Other Valve	Manual Valves	Isolation Valves for CIP injection	Manual Ball	1	inch	PVC	ASAHI	Type21 True Union				4
9	MBR	02 LS 03 02 LS 04 02 LS 05 02 LS 06	Gauge, Switch	Level Measurement	MBR Level Switch	Float			PP, PU	Conery	2902-B8S1 w/ counter weight and brackets		Loop power		4
10	MBR	n/a	Fabrication	Fabrication	MBR SMU Guide & Stabilizer + Seismic Bracing				304SS	TBD					4
11	MBR	n/a	Fabrication	Fabrication	MBR SMU Fasteners				304SS	TBD					40
12	MBR	n/a	Fabrication	Fabrication	MBR In-Basin Pipe&Supports (Permeate Drop Pipe)				PVC	TBD					4
13	MBR	n/a	Fabrication	Fabrication	MBR In-Basin Pipe&Supports (Air Drop Pipe)				304SS	TBD					8
	Permeate (PRMT) Control Equipment	**x**													
14	PRMT	01 PMP 01 01 PMP 02 01 PMP 03	Permeate Pump	Permeate Extraction	PRMT Pump	Rotary Lobe	45	gpm		Boerger	AN 70 w/ piggyback mount	5	460 VAC	6.6	3
15	PRMT	PI169 PI170 PI171	Gauge, Switch	Pressure Gauge	PRMT Pump Pressuge Gauge(Inlet)		-15 - +15	psig	SS	Ashcroft or equivalent	1279 w/ grycelin filled				3
16	PRMT	PI172 PI173 PI174	Gauge, Switch	Pressure Gauge	PRMT Pump Pressuge Gauge (Inlet)		-15 - +15	psig	SS	Ashcroft or equivalent	1279 w/ grycelin filled				3
17	PRMT	01 PTR 01 01 PTR 02	Pressure Sensor	TMP Measurement	PRMT Pump Pressure Transmitter	Diaphragm	-15 - +15	psi	SS	Endress & Hauser	Cerabar PMCB51		Loop power		2
18	PRMT	01 MFM 01 01 MFM 02	Flow Sensor	Flow Measurement	PRMT Flow Meter	Electromagnetic	3	inch	PU	Endress & Hauser	Promag W 400		24VDC		2
19	MBR	n/a	Other Valve	Isolation Valve	MBR PRMT Pump isolation valve	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S30				8
20	MBR	CV261 CV261 CV261	Other Valve	Check valve	MBR PRMT Pump discharge check valve	Manual ball	3	inch	PVC, EPDM	ASAHI	True Union Ball Check				3
21	PRMT	01 TM 01	Other Instrument	Turbidity Measurement	PRMT Turbidity Meter	Laser	0-5	NTU		HACH	TU5300sc				1
22	PRMT	01 TM 01	Other Instrument	Turbidity Measurement	PRMT Turbidity Transmitter					HACH	SC4500		24VDC		1
23	PRMT	n/a	Other Instrument	Turbidity Measurement	Turbidity Meter Maintenance Kit					HACH					1
	Return Activated Sludge (RAS) Control	**x**													
24	MBR	Relocated from MBR 02 SLS02 02 SLS03	Other Instrument	Level Measurement	MBR Level Sensor	Hydrostatic	15	ft	SS	Endress & Hauser	Waterpilot FMX21 w/ brackets		Loop power		2
	MBR Blower	**x**													
25	MBR BLW	01 MSB 01 01 MSB 02 01 MSB 03	Blower	Blower	MBR Blower	Positive Displacement	114	scfm	CI	Aerzen	GM 4S DN 80	5	460 VAC	6.6	3

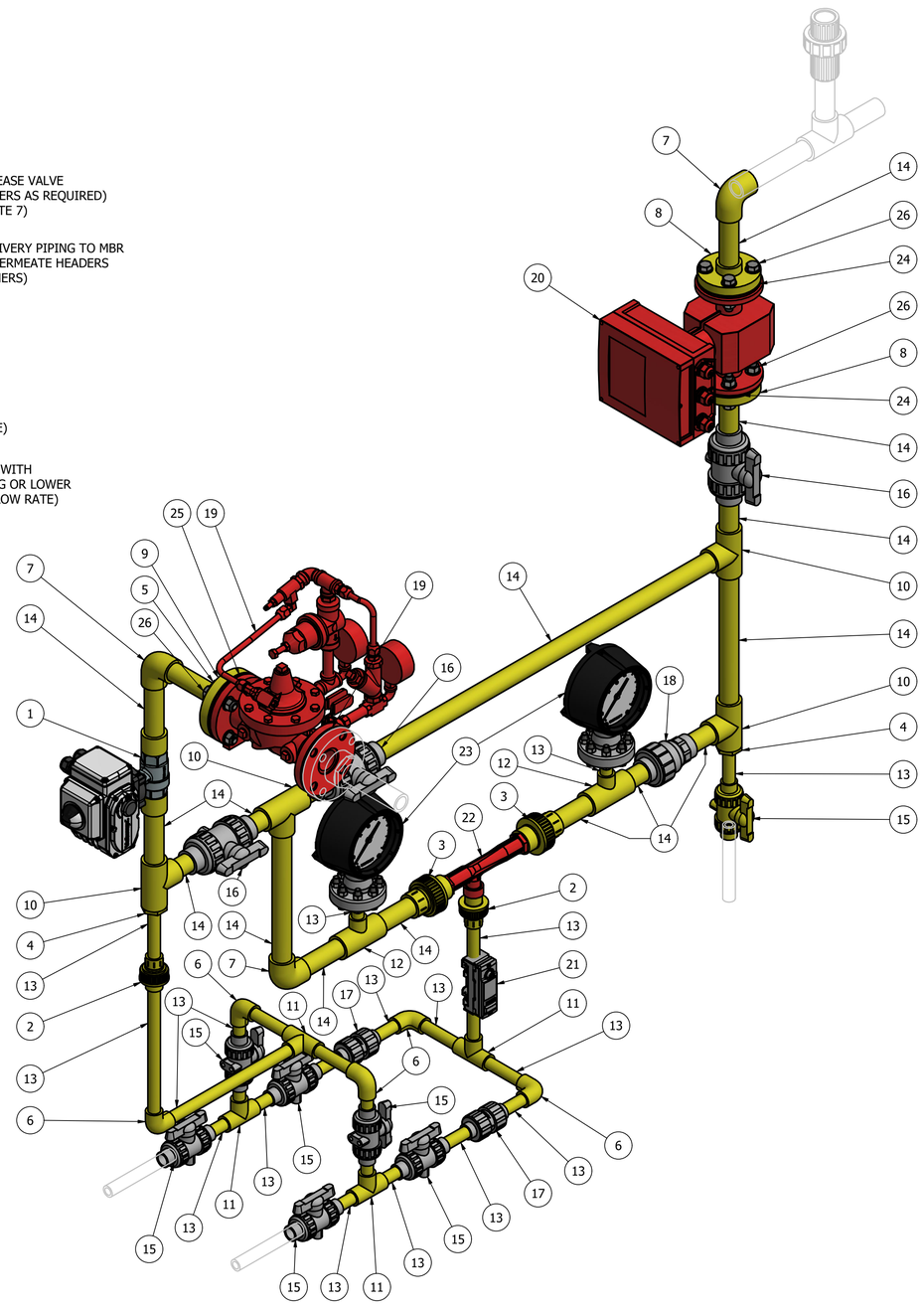
No	Equipment Location	Tag	Category	Function	Name	Type	Chosen Size/Capacity	Unit	Material	Manufacturer	Model/ Specification	Motor HP	Voltage	FLA	QTY
26	MBR BLW	n/a	Option	Noise Suppression	MBR Blower Sound Enclosure	With Blower									3
27	MBR BLW	n/a	Option	Blower Temperature	MBR Blower Temperature Gauge	With Blower									3
28	MBR BLW	n/a	Option	Blower Pressure	MBR Blower Pressure Gauge	With Blower									3
29	MBR BLW	n/a	Option	Blower Temperature	MBR Blower Temperature Switch	With Blower									3
30	MBR BLW	01 AFM 01 01 AFM 02	Flow Sensor	Air Flow Measurement	MBR Blower Flow Meter	Thermal Mass	3	inch	PU	Endress & Hauser	t-mass I 300, w/ flow conditioner plate		24VDC		2
31	MBR BLW	n/a	Other Valve	Manual Valves	Air Scour Blower Isolation Valves	Manual Butterfly	3	inch	DI, FKM, SS Disk	Bray	S30				4
	Clean-In-Place Equipment	**x**													
32	SMU CIP	n/a	Chemical Injection	Chemical Injection	SMU CIP System PVC pipes		1	inch	PVC	KUBOTA	Loose ship parts shown on xxx				1
33	SMU CIP	n/a	Flow Sensor	Flow Measurement	CIP solution Flow Meter	Electromagnetic	1	inch	PU				24 VDC		1
34	SMU CIP	n/a	Flow Sensor	Flow Measurement	CIP shelf chenical Flow Meter	Electromagnetic	3/8	inch	PU	Keyence	FD-Q10C		24VDC		1
35	SMU CIP	n/a	Auto Valve	Flow Control	CIP Flow Control Valve	ON/OFF Ball	1	inch	DI	ASAHI	S19-120VAC--1"-C20/S20		120VAC	0.18	1
36	SMU CIP	n/a	Other Valve	Manual Valves	Isolation Valves on CIP Station	Manual Ball	1, 0.5	inch	PVC	ASAHI	Type21 True Union				1
37	SMU CIP	n/a	Other Valve	Manual Valves	Pressure reducing valve	Pressure Reducing	1.5	inch	CI	Zurn	ZW209				1
	System Control Equipment	**x**													
38	CONTROL	n/a	Control Panel	Control Panel	Control Panel	OIT, PLC					NEMA 4/12, 72" x 72" x 18" floor mount enclosure (estimated size) , Allen Bradley 1756-L81E PLC (BABA-Version), FactoryTalk View SE		120VAC	TBD	1
39	D. SERVICE	n/a	D. Service	Direct Service	Direct Service						Design support, start-up, field service, remote service				1

Kubota will provide additional spare

SECTION 2

General Arrangement with BOM





PARTS LIST (PROVIDED BY KUBOTA, SHIP LOOSE TO SITE)

ITEM	QTY	MATERIAL	DESCRIPTION
1	1	PVC S80, FKM SEAL PC/PET, 304SS	ACTUATOR, ELECTRIC (ASAHI #S19-120VAC--1"-C20/S20 W/ SOC BALL VALVE)
2	2	PVC S80	UNION, 1/2", S X S
3	2	PVC S80	UNION, 1", S X S X S
4	2	PVC S80	BUSHING, REDUCING, 1" X 1/2", SPG X S
5	1	PVC S80	BUSHING, REDUCING, 1 1/2" X 1" SPG X S
6	5	PVC S80	ELBOW, 90 DEGREE, 1/2", S X S
7	3	PVC S80	ELBOW, 90 DEGREE, 1", S X S
8	2	PVC S80	FLANGE, VANSTONE, 1"
9	1	PVC S80	FLANGE, VANSTONE, 1 1/2"
10	4	PVC S80	TEE, 1", S X S X S
11	4	PVC S80	TEE, 1/2", S X S X S
12	2	PVC S80	TEE, REDUCING, 1" X 1" X 1/2", S X S X S
13	15 L.F.	PVC S80	PIPE, 1/2"
14	14 L.F.	PVC S80	PIPE, 1"
15	7	PVC S80, FKM SEAL	VALVE, BALL, 1/2", TRUE UNION, S X S, VENTED
16	3	PVC S80, FKM SEAL	VALVE, BALL, 1". TRUE UNION, S X S, VENTED
17	2	PVC S80, FKM SEAL	VALVE, BALL, CHECK, 1/2", TRUE UNION, S X S
18	1	PVC S80, FKM SEAL	VALVE, BALL, CHECK, 1", TRUE UNION, S X S
19	1	DUCTILE IRON	PRESSURE REDUCING VALVE, 1 1/2", (ZURN #ZW209)
20	1	COATED ALU, SS, PTFE	METER, FLOW, MAGNETIC, 1", FLG X FLG, WITH GROUNDING RINGS (E+H: PROMAG W400)
21	1	VARIES	SENSOR, FLOW, CLAMP-ON, 1/2" (KEYENCE FD-Q10C)
22	1	POLYPROPYLENE	VENTURI INJECTOR, 1", 1/2" SUCTION (MAZZEI #1078-03-PP)
23	2	316SS, SILICONE	GAUGE, PRESSURE, W/ ISOLATOR, 0-60 PSI (ASHCROFT #1279/#201)
24	2	EPDM	GASKET, 1", #150
25	2	EPDM	GASKET, 1 1/2", #150
26	3	304SS	FLANGE BOLT SET (4) 1/2" DIA. X 2-1/4" LG. BOLT W/ 1 NUT & 2 WASHERS EA

GENERAL NOTES:

1. DESIGN OF THIS CLEAN IN PLACE (CIP) STATION IS BASED ON THE ASSUMPTION THAT A REQUIRED BACKFLOW PREVENTER EXISTS IN THE PLANT WATER SUPPLY SYSTEM UPSTREAM OF CIP STATION. BACKFLOW PREVENTER NOT SUPPLIED BY KUBOTA MEMBRANE USA (KMU).
2. DRAIN PIPING & ALL PIPE SUPPORTS ARE NOT SUPPLIED BY KMU. LOCATION, TYPE, & QUANTITY OF PIPE SUPPORTS TO BE DETERMINED BY CONTRACTOR.
3. KMU SUPPLIED PRESSURE REDUCING VALVE, FLANGES, FASTENER ASSEMBLIES & GASKETS TO BE LOCATED BY CONTRACTOR IN HORIZONTAL OR VERTICAL RUN OF PIPE (FLOW UP) BETWEEN PLANT WATER SUPPLY CONNECTION & CIP STATION. ANY REQUIRED SUPPORTS ARE NOT SUPPLIED BY KMU.
4. ALL PARTS ARE SHIPPED LOOSE AND CIP STATION MUST BE FABRICATED AND INSTALLED BY CONTRACTOR PER THIS DOCUMENT. PIPE IS SHIPPED IN STANDARD LENGTHS AND MUST BE CUT BY CONTRACTOR.
5. ORIENTATION OF ALL PARTS & STATION CAN BE ALTERED TO SUIT SITE CONDITIONS BUT ALL PARTS MUST REMAIN IN THE SAME RESPECTIVE LOCATIONS AND CONFORM TO REQUIRED DIMENSIONS. MAJOR CHANGES TO BE APPROVED BY KMU.
6. PVC SOLVENT, PVC GLUE AND THREAD ANTI SEIZE COMPOUND NOT SUPPLIED BY KMU.
7. CONTRACTOR TO SUPPLY AND LOCATE AIR RELEASE VALVES AT ALL HIGH POINTS IN CIP PIPING SYSTEM. AIR RELEASE VALVES TO BE LOCATED AT POINT WHERE HIGH POINT PIPING TURNS DOWN.
8. **CIP SYSTEM SHOULD BE DRAINED ONLY FOR MAINTENANCE OR REPLACEMENT OF CIP EQUIPMENT. CLEAN WATER TO REMAIN IN SYSTEM BETWEEN CIP EVENTS.**
9. **WATER REPLACEMENT MUST BE PERFORMED AFTER EVERY CIP EVENT TO AVOID MIXING NaClO AND CITRIC ACID IN CIP STATION PIPING, CIP EQUIPMENT AND CIP TRANSFER PIPING.**

CIP PROCEDURE:

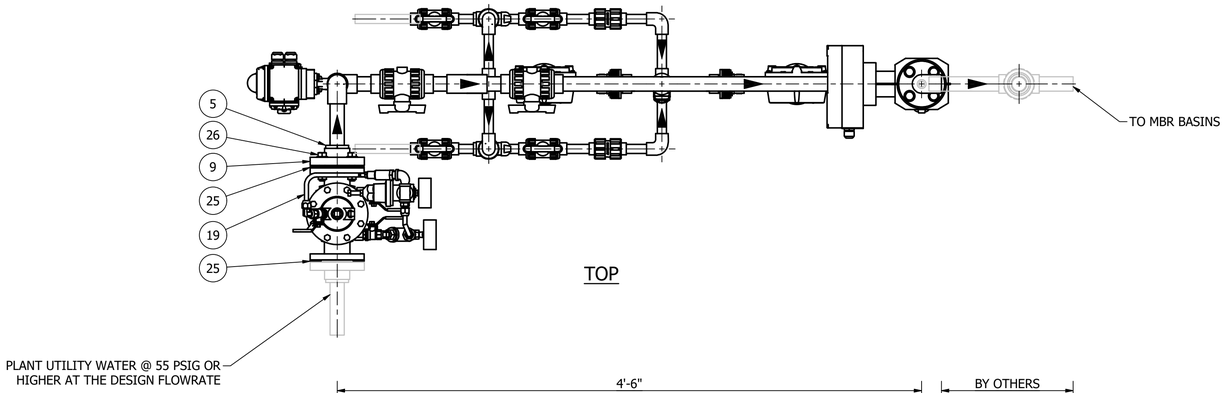
1. SET VALVE POSITIONS MANUALLY FOR EITHER NaClO INJECTION PROCEDURE OR CITRIC ACID INJECTION PROCEDURE.
2. PRESS "CIP INJECTION" BUTTON ON THE MBR OIT.
3. CIP INJECTION STOPS AUTOMATICALLY WHEN THE TOTAL GALLONS INJECTED REACHES THE TARGET AMOUNT.
4. SET VALVE POSITIONS FOR WATER REPLACEMENT PROCEDURE.
5. PRESS "WATER REPLACEMENT" BUTTON ON THE MBR OIT.
6. WATER REPLACEMENT STOPS AUTOMATICALLY WHEN THE INJECTION TIMER EXPIRES.
7. SET THE MANUAL VALVES TO THEIR ORIGINAL POSITIONS.
8. ALLOW 2 HOURS MEMBRANE SOAKING TIME FOR NaClO AND 1 HOUR FOR CITRIC ACID.

For Earth, For Life
Kubota

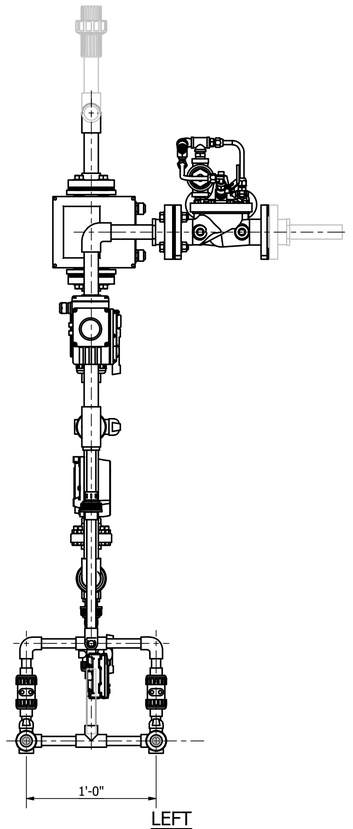
Kubota Membrane USA Corp. 11807 North Creek Parkway S. Suite B109
Bothell, WA 98011 USA Tel: +1 425 898 2853

		DATE	△	REVISION	DATE	BY	△	REVISION	DATE	BY
DRAWN BY:	ART	8/13/2025	0							
DESIGNED BY:	ART									
CHECKED BY:	JAT									
APPROVED BY:										

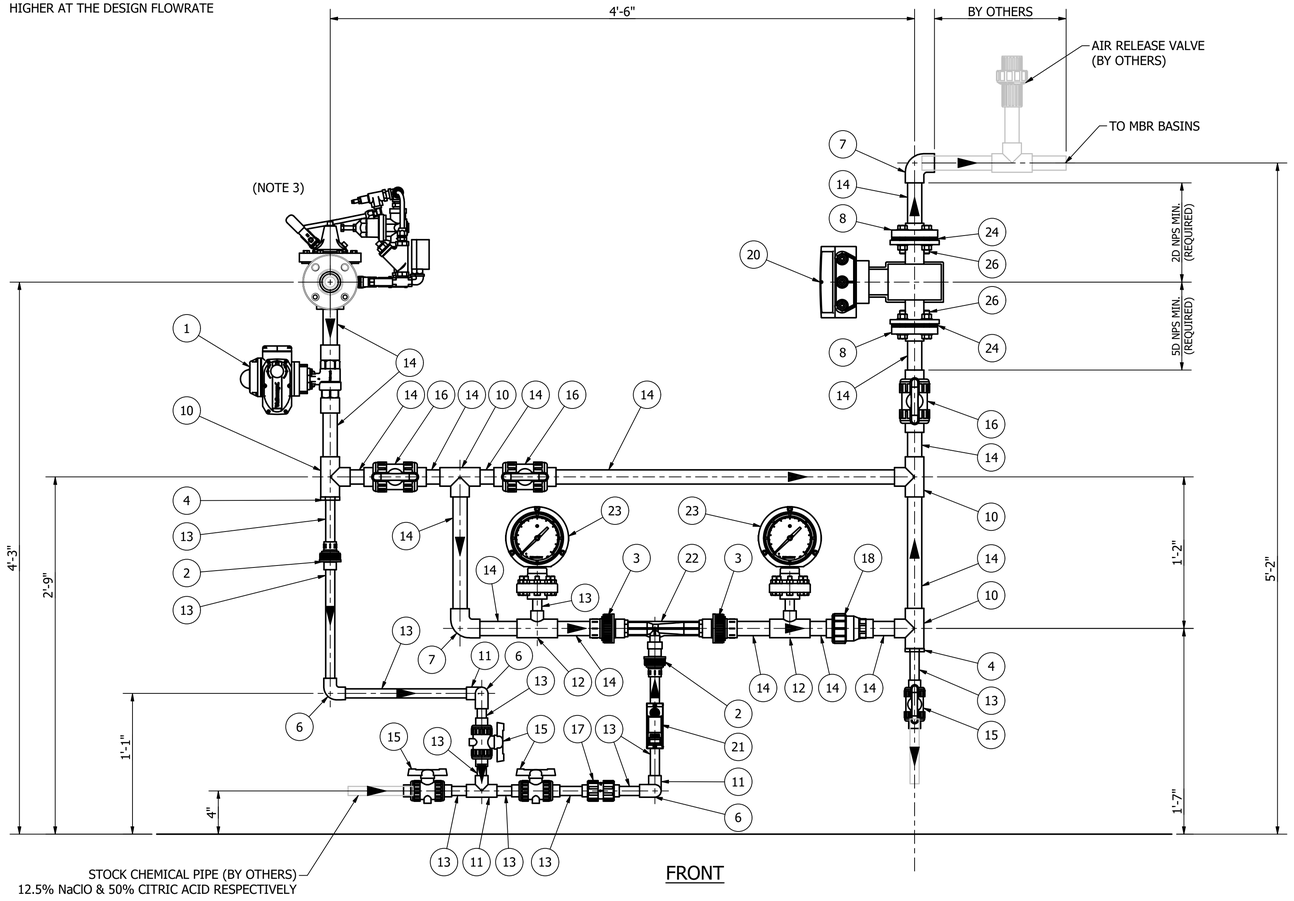
PROJECT NAME / NUMBER	KMU 1" CLEAN IN PLACE (CIP) STATION
SCALE	
SHEET	1 OF 3
DWG NO	TAYLOR BAY CIP
REV	0
TITLE	ISOMETRIC VIEWS & PARTS LIST



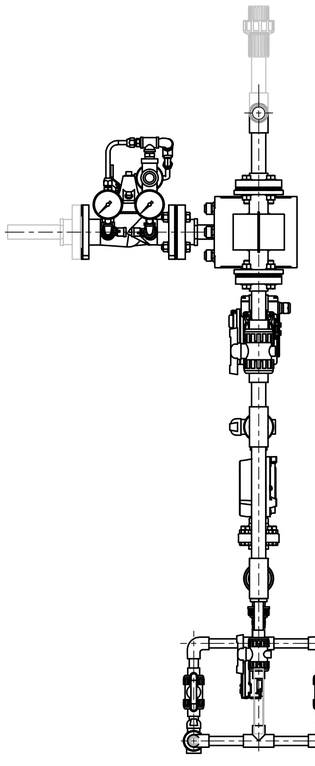
TOP



LEFT



FRONT



RIGHT

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Kubota

Kubota Membrane USA Corp., 11807 North Creek Parkway S. Suite B109
Bothell, WA 98011 USA Tel: +1 425 898 2853

		DATE		REVISION	DATE	BY		REVISION	DATE	BY
DRAWN BY:	ART	8/13/2025	0							
DESIGNED BY:	ART									
CHECKED BY:	JAT									
APPROVED BY:										

PROJECT NAME / NUMBER	KMU 1" CLEAN IN PLACE (CIP) STATION
SCALE	
SHEET	2 OF 3
DWG NO	TAYLOR BAY CIP
REV	0
TITLE	PLAN & ELEVATION VIEWS

DATA SHEET
Pressure Regulating Valve
Zurn #ZW209 - 1.5"FLG

Model ZW209

Pressure Reducing Valve

Application

The Zurn Wilkins Model ZW209 Pilot Operated Pressure Reducing Valve is designed for many applications where the reduction of high inlet pressures to safe and stable outlet pressure is required. The pilot assembly reacts to changes in downstream pressure allowing the main valve to modulate between the closed and open position ensuring a constant downstream set pressure. Once the downstream pressure reaches the pilot setting, the main valve will seal shut preventing damage downstream. Pressure regulation is not dependent upon flow rate, resulting in minimal pressure loss through the valve. In addition the Model ZW209 comes standard with epoxy coating internally and externally for corrosion protection, as well as isolation valves and pressures gauges for quick and easy maintenance or repair.

Standards Compliance:

- ANSI/AWWA C530
- Meets the requirements of NSF/ANSI/CAN 61*

*(0.25% MAX. WEIGHTED AVERAGE LEAD CONTENT)

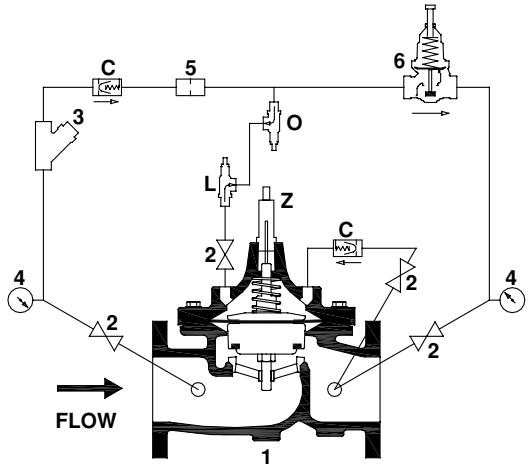
Materials

Main Valve Body	Ductile Iron ASTM A536
Main Valve Bonnet	Ductile Iron ASTM A536
Disc Guide	Stainless Steel
Seat	Stainless Steel
Disc	Buna-N Rubber
Diaphragm	Nylon Reinforced Buna-N
Stem	Stainless Steel
Spring	Stainless Steel

*The closing speed control (optional) on this valve should always be open at least three (3) turns off its seat.

Schematic Diagram

Item	Description of Standard Features
1	Main Valve
2	850XL Isolation Valve
3	SXL "Wye" Type Strainer
4	Pressure Gauge
5	Restriction Fitting
6	PRXL Pressure Reducing Control





DIRECTION OF FLOW

LEAD FREE

NSF/ANSI/CAN 61

BODY CONFIGURATIONS		GLOBE STYLE BODY		ANGLE STYLE BODY
END CONNECTION	PRESSURE RATING	FULL PORT	REDUCED PORT	
Threaded	400 psi max.	1 1/4"-3"	n/a	1 1/4"-3"
Flanged	ANSI Class 150, 250 psi max.	1 1/2"-16"	3"-10"	1 1/2"-10"
	ANSI Class 300, 400 psi max.			
Grooved	300 psi max.	1 1/2"-10"	n/a	1 1/2"-10"
MINIMUM INLET PRESSURE 10 PSI				

TEMPERATURE RATING: ☐ Water 33°F to 140°F
PILOT SPRING RANGE: ☐ 15-120 psi

Standard Features

- ☐ Epoxy Coated, FDA Approved
- ☐ Pilot Assembly
  - "Wye" Type Strainer
  - Opening Speed Control (sizes 1 1/4" - 4")
  - Isolation Valves
- ☐ Inlet and Outlet Pressure Gauges
- ☐ ANSI Class 150 Flanges
- ☐ Copper Tubing and Brass Fittings

Options (Add suffix letters to ZW209)

Function

- ☐ C - 40XL2 Hydraulic Check with Isolation Valve
- ☐ L - SC1 Closing Speed Control*
- ☐ O - SC1 Opening Speed Control (Standard 1 1/4" -4")

Body

- ☐ A - Angle Style Body
- ☐ R - Reduced Port Body

Connections

- ☐ G - IPS Grooved
- ☐ TH - NPT Threaded
- ☐ Y - ANSI Class 300 Flanges

Main Valve Options

- ☐ V - Viton Rubber Internals, rated 180°F (1-1/4"-6", only available with "LP" or "HP" Option)
- ☐ Z - ZPI Visual Position Indicator

Pilot System

- ☐ LP - 5-25 psi Low Pressure Range PV-PRD Pilot (replaces PRXL)
- ☐ HP - 30-300 psi High Pressure Range PV-PRD Pilot (replaces PRXL)
- ☐ SP - All Stainless Steel Pilotry (replaces all brass fittings, pilot valve and copper tubing. "GL" Option included)
- ☐ SH - Stainless Steel Braided Hoses (only replaces Copper Tubing)
- ☐ RV - Pilot on Reverse Side
- ☐ GL - Liquid Filled Gauge
- ☐ SO - Limit Switch Open Trip
- ☐ SC - Limit Switch Closed Trip
- ☐ SD - Limit Switch Dual Trip

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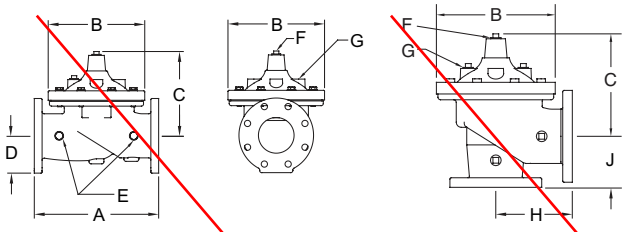
Rev. S
Date: 5/23
Document No. ACV-ZW209
Product No. Model ZW209
Patent zurn.com/patents

Globe and Angle Main Valve Dimensions

DIM	FULL PORT	VALVE SIZE INCHES (mm)											
		1 1/4 (32)	1 1/2(38)	2 (50)	2 1/2 (65)	3 (80)	4 (100)	6 (150)	8 (200)	10 (250)	12 (300)	14 (350)	16 (400)
A	Threaded	7 1/4	7 1/4	9 7/16	11	12 1/2							
	Class 150 Flange		8 1/2	9 3/8	11	12	15	20	25 3/8	29 3/4	34	39	41 3/8
	Class 300 Flange		9	10	11 5/8	13 1/4	15 5/8	21	26 7/16	31 1/8	35 1/2	40 1/2	43 1/2
	Grooved		8 1/2	9	11	12 1/2	15	20	25 3/8	29 3/4			
B	Diameter	5 5/8	5 5/8	6 3/4	8	9 3/16	11 11/16	15 3/4	20 1/8	23 11/16	27 1/2	31 3/4	34 1/2
C	Max.	5 3/4	5 3/4	6 3/16	7 3/8	8	10 3/16	12 5/16	15 9/16	17 5/8	20 3/16	22 13/16	25 7/8
D	Threaded/Grooved	1 3/8	1 3/8	1 3/4	2 1/8	2 9/16	3 7/16	5	5	5 13/16	6 3/4	8 7/8	8 13/16
	Class 150 Flange		2 1/2	3	3 1/2	3 3/4	4 1/2	5 1/2	6 3/4	8	9 1/2	10 1/2	11 3/4
	Class 300 Flange		3	3 1/4	3 3/4	4 1/8	5	6 1/4	7 1/2	8 3/4	10 1/4	11 1/2	12 3/4
E	NPT Body Tap	3/8	3/8	3/8	1/2	1/2	3/4	3/4	1	1	1	1	1
F	NPT Cvr. Plug Tap	1/2	1/2	1/2	1/2	1/2	3/4	3/4	1	1	1	1	1
G	NPT Cover Tap	3/8	3/8	3/8	1/2	1/2	3/4	3/4	1	1	1	1	1
H	Threaded	3 1/4	3 1/4	4 3/4	5 1/2	6 1/4							
	Class 150 Flange		4	4 3/4	5 1/2	6	7 1/2	10	12 11/16	14 7/8			
	Class 300 Flange		4 1/4	5	6	6 7/16	8	10 1/2	13 1/4	15 9/16			
	Grooved		4 7/16	4 3/4	5 1/2	6	7 1/2	10	12 11/16	14 7/8			
J	Threaded	1 15/16	1 15/16	3 1/4	4	4 1/2							
	Class 150 Flange		4	3 1/4	4	4	5	6	8	8 5/8			
	Class 300 Flange		4 1/4	3 1/2	4 5/16	4 7/16	5 5/16	6 1/2	8 1/2	9 5 /16			
	Grooved		3 3/16	3 1/4	4	4 1/4	5	6	8	8 5/8			
Valve Stem Internal Thread		10-32	10-32	10-32	10-32	1/4-20	1/4-20	1/4-20	3/8-16	3/8-16	3/8-16	3/8/16	3/8-16
Stem Travel (in)		7/16	7/16	3/4	7/8	1	1 3/16	1 3/4	2 3/8	2 13/16	3 7/16	3 13/16	4 5/16
Approx. Wt. (lbs)		22	26	36	55	70	130	240	440	720	820	1200	1550

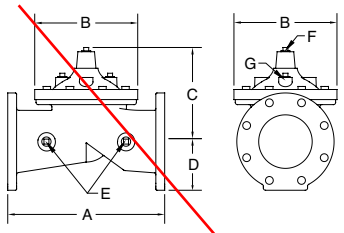
Reduced Port Main Valve Dimensions

DIM		VALVE SIZE INCHES (mm)				
		3" (80)	4" (100)	6" (150)	8" (200)	10" (250)
A	Class 150 Flange	10 1/4	14	17 3/4	21 7/16	26
	Class 300 Flange	11	14 1/2	18 11/16	22 7/16	27 7/16
B	Dia	6 3/4	9 3/16	11 11/16	15 3/4	20 1/8
C	Max	6 3/8	8 7/16	12 5/16	13 1/4	16 3/4
D	Class 150 Flange	3 3/4	4 1/2	5 1/2	6 3/4	8
	Class 300 Flange	4 1/8	5	6 1/4	7 1/2	8 3/4
E	NPT Body Tap	3/8	1/2	3/4	3/4	1
F	NPT Cvr. Plug Tap	3/8	1/2	3/4	3/4	1
G	NPT Cvr. Tap	3/8	1/2	3/4	3/4	1
Valve Stem Internal Thread		10-32	1/4-20	1/4-20	3/8-16	3/8-16
Stem Travel (in)		3/4	1	1 1/5	1 3/4	2 3/8
Approx. Wt. (Lbs)		35	80	140	275	480



Globe Style Body

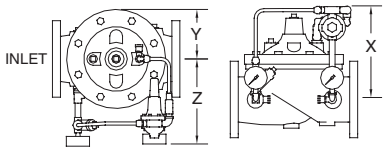
Angle Style Body



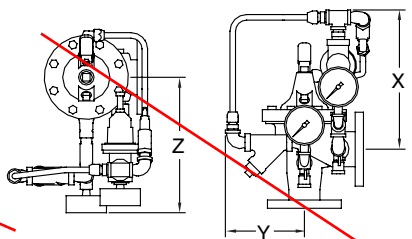
Reduced Port Body

Pilot System Dimensions

PILOT SYSTEM DIMENSIONS		VALVE SIZE INCHES (mm)											
	DIM	1-1/4 (32)	1-1/2 (40)	2" (50)	2-1/2" (65)	3" (80)	4" (100)	6" (150)	8" (200)	10" (250)	12" (300)	14" (350)	16" (400)
Full Port Body	X	8 1/2	8 1/2	8 1/2	8 1/2	9 1/2	12	13	14	17 1/2	20	23	26
	Y	4	4	3 1/2	4	4 1/2	6	8	10	12	14	16	17 1/2
	Z	8 1/2	8 1/2	9	9	9 1/2	10	11 1/2	13	14 1/2	17	19	20 1/2
Reduced Port Body	X					8 1/2	9 1/2	12	13	14			
	Y					3 1/2	4 1/2	6	8	10			
	Z					9	9 1/2	10	11 1/2	13			
Angle Body	X	9	9	9	9	10	12 1/2	13 1/2	14 1/2	18			
	Y	5	5	5	5	5	6	8	10	12			
	Z	9	9	9 1/2	9 1/2	10	10 1/2	12	13 1/2	15			



Globe Pilot System Dimensions



Angle Pilot System Dimensions

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Flow Characteristics

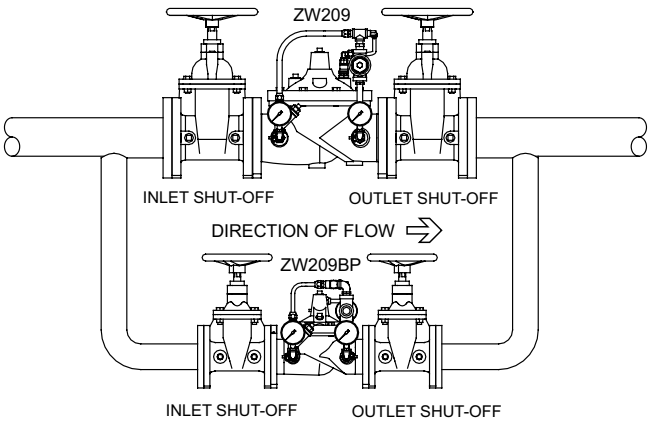
Full Port Globe and Angle Valve size	inches (mm)	1 1/4 (32)	1 1/2 (40)	2 (50)	2 1/2 (65)	3 (80)	4 (100)	6 (150)	8 (200)	10 (250)	12 (300)	14 (350)	16 (400)
Reduced Port Globe Valve Size	inches (mm)			3 (80)		4 (100)	6 (150)	8 (200)	10 (250)				
Suggested Flow (GPM)	Max. Continuous	93	125	210	300	460	800	1800	3100	4900	7000	8400	11000
	Max Intermittent	120	160	260	375	600	1000	2250	4000	6150	8700	10500	13800
	Min. Continuous	10	10	15	20	30	50	115	200	300	435	530	690
Suggested Flow (Liters/sec)	Max. Continuous	6	8	13	19	29	50	113	195	309	550	665	870
	Max. Intermittent	7.6	10	16.4	23	37	62	142	246	388	440	530	95
	Min. Continuous	.6	.6	0.9	1.3	1.9	3.2	7.2	13	19	28	33	43

Suggested flow calculations are based on flow through Schedule 40 Pipe. Maximum continuous flow is approx. 20 ft./sec (6.1 meters/sec) & maximum intermittent is approx. 25 ft./sec (7.6 meters/sec) and minimum continuous flow is approx. 1.25 ft./sec (0.4 meters/sec). Many factors should be considered in sizing pressure reducing valves including inlet pressure, outlet pressure and flow rates.

Notice:
In cases where design flow falls below the minimum continuous flow rate, a low flow by-pass shall be installed.

Operation
The Model ZW209 utilizes a pressure reducing pilot valve that installs on the discharge side of the control circuitry. The pilot is a direct acting, normally open, spring loaded, diaphragm actuated valve. The operation of the ZW209 begins with accurately sizing the valve, then fine tuning the control circuit by adjusting the pilot spring to the desired downstream pressure.
Inlet pressure is piped to the inlet port of the pressure reducing pilot. A sensing line runs internally from the discharge side of the pilot to its lower control chamber under the diaphragm. Thus, downstream pressure exceeding the preset acts to close the pilot while the adjustable spring seeks to keep it open. The result is a modulating action in the pilot that is transmitted to the bonnet of the main valve. This creates a mirror modulation of the diaphragm assembly in the main valve. Downstream pressure is maintained within narrow limits regardless of changing flow rates or varying inlet pressures.

Typical Installation



Caution: The recommended installation orientation for ACVs is horizontal, with the valve cover up. 6" and larger valves should only be installed horizontally, with the valve cover up, due to the difficulty of properly bleeding air out of the cover and performing maintenance on valves installed in the vertical orientation.

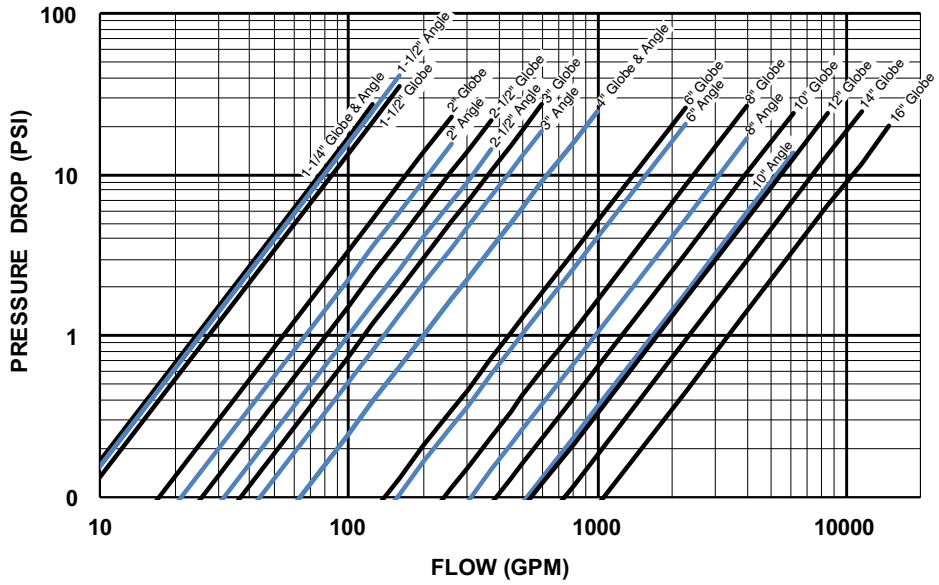
Specifications
The Pressure Reducing Valve shall be a diaphragm actuated, pilot controlled valve. The main valve body shall be ductile iron ASTM A 536. The stem of the basic valve shall be guided top and bottom. The diaphragm shall not be used as a seating surface. All internal and external ferrous surfaces shall be coated with a high quality, fusion epoxy coating. The pilot control shall be field adjustable from 15 psi to 120 psi. The valve shall be certified to NSF/ANSI/CAN Standard 61. The Pressure Reducing Valve shall be a ZURN WILKINS Model ZW209.

Job Name _____ **Contractor** _____

Job Location _____ **Engineer** _____

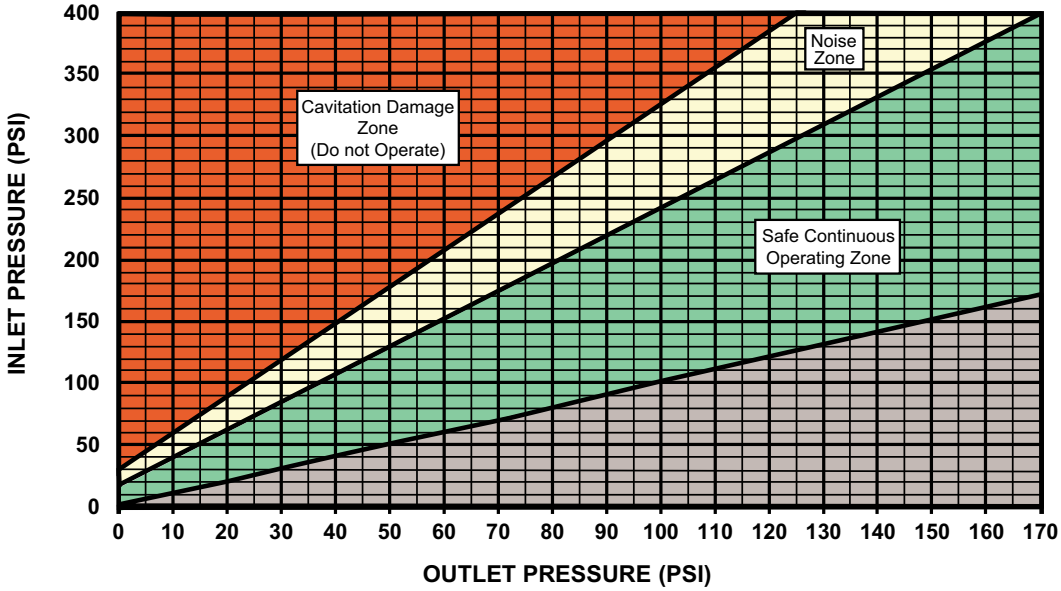
Flow Characteristics

BODY MINIMUM FRICTION LOSS



*** Notes for Body Minimum Friction Loss Chart:**
Minimum inlet pressure is 10 psi higher than set point or the additional body friction loss intended flow, whichever is higher. (friction loss may be important at flows above 20 ft/s)
Example: A 6" valve intended to flow 2000 GPM at 120 psi has a friction loss of 20 psi at 2000 GPM. The minimum inlet pressure would be 120 + 20 = 140 psi. When inlet pressure is below set point, the outlet pressure will be the pressure at the inlet minus the friction loss.

WATERWORKS PRESSURE REDUCTION LIMIT CHART



Notes for Pressure Reduction Limit Chart: Determine if the outlet reduced flowing pressure is within the safe operating zone for your Zurn Automatic Control Valve. First, find the system inlet pressure on the left axis and draw a horizontal line from that point across the chart. Then find the outlet reduced flowing pressure on the bottom axis and draw a vertical line up to where it meets the first line. The point where the lines intersect should be in the green “Safe Continuous Operating Zone” below and to the right of the yellow “Noise Zone”. If the operating point is in the area labeled “Noise Zone” or “Cavitation Damage Zone”, the valve seal ring, plunger, or body may be damaged. The lifespan of the valve will be reduced. Damage from cavitation to internal components may cause high pressure downstream and/or external leaks. To move out of the cavitation or noise zone you will need to place two valves in series in order to safely reduce pressure. Use the chart to pick an intermediate pressure in the green zone that you will set the first valve in series to. The intermediate pressure you pick will then become the inlet pressure for the 2nd valve and you can verify it will be in the green zone using the chart.

DATA SHEET
CIP on/off Valve with Electrical Actuator
ASAHI USA #S19-120VAC--1"-C20/S20

TYPE-21 AND TYPE-23 MULTIPORT® BALL VALVE WITH SERIES 19 COM PACK® ON/OFF ELECTRIC ACTUATOR



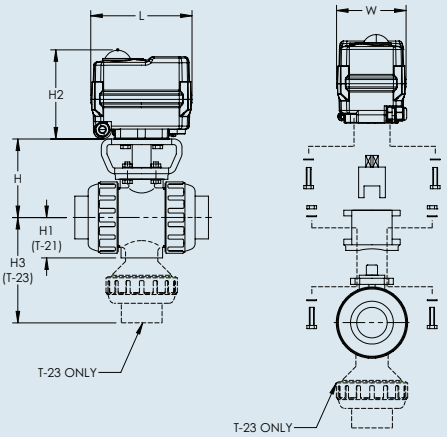
Specifications

Motor Type:	Reversing, brushless DC
Sizes:	C20 for 1/2" – 2" valves
Torque:	177 in-lbs
Voltage:	95 VAC to 265 VAC multi-voltage
Amp Draw:	0.18 Amp
Max Ambient Temp:	150° F
Enclosure:	NEMA 4X

Standard Features (Sizes 1/2" – 2")

- **Compact:** Compact and lightweight actuated valve package that is ideal for OEMs
- **Multi-voltage:** 95 VAC to 265 VAC or 24 VAC/VDC
- **Motor:** Reversing, brushless DC motor
- **Gear Train:** Permanently lubricated solid gears
- **Corrosion Resistant Enclosure:** NEMA 4X PC/PET enclosure with stainless steel trim
- **ISO** mounting configuration
- **Electrical Connection:** NEMA 4X cable gland with two-meter cable
- **Position Indication:** Highly visible dome position indicator
- **LED Position Indication:** RED closed, GREEN open
- **Manual Override:** Manually cycle valve via electroless nickel-plated hex key
- **Auxiliary Contacts:** Open and closed dry contacts rated 0.1 Amp @ 250 VAC, 0.5 Amp @ 30 VDC
- **Space Heater**: A two-watt heater is internally wired to limit condensation
- **QR Code:** Links to user manual; includes wiring schematic
- **CE Compliant:** All actuators are CE labeled
- **75% Duty Cycle:** Extended duty cycles are ideal for high cycling applications





Dimensions (inch)

Size	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
H	2.76	3.01	3.29	3.64	3.98	4.43
H1	1.14	1.38	1.54	1.85	2.17	2.60
H2	3.54	3.54	3.54	3.54	3.54	3.54
H3	3.08	3.56	4.32	N/A	5.71	6.66
L	4.01	4.01	4.01	4.01	4.01	4.01
W	2.76	2.76	2.76	2.76	2.76	2.76
Model	C20	C20	C20	C20	C20	C20

Weight (lbs)

Size	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
Weight	2.7	2.9	3.4	3.8	4.9	6.7

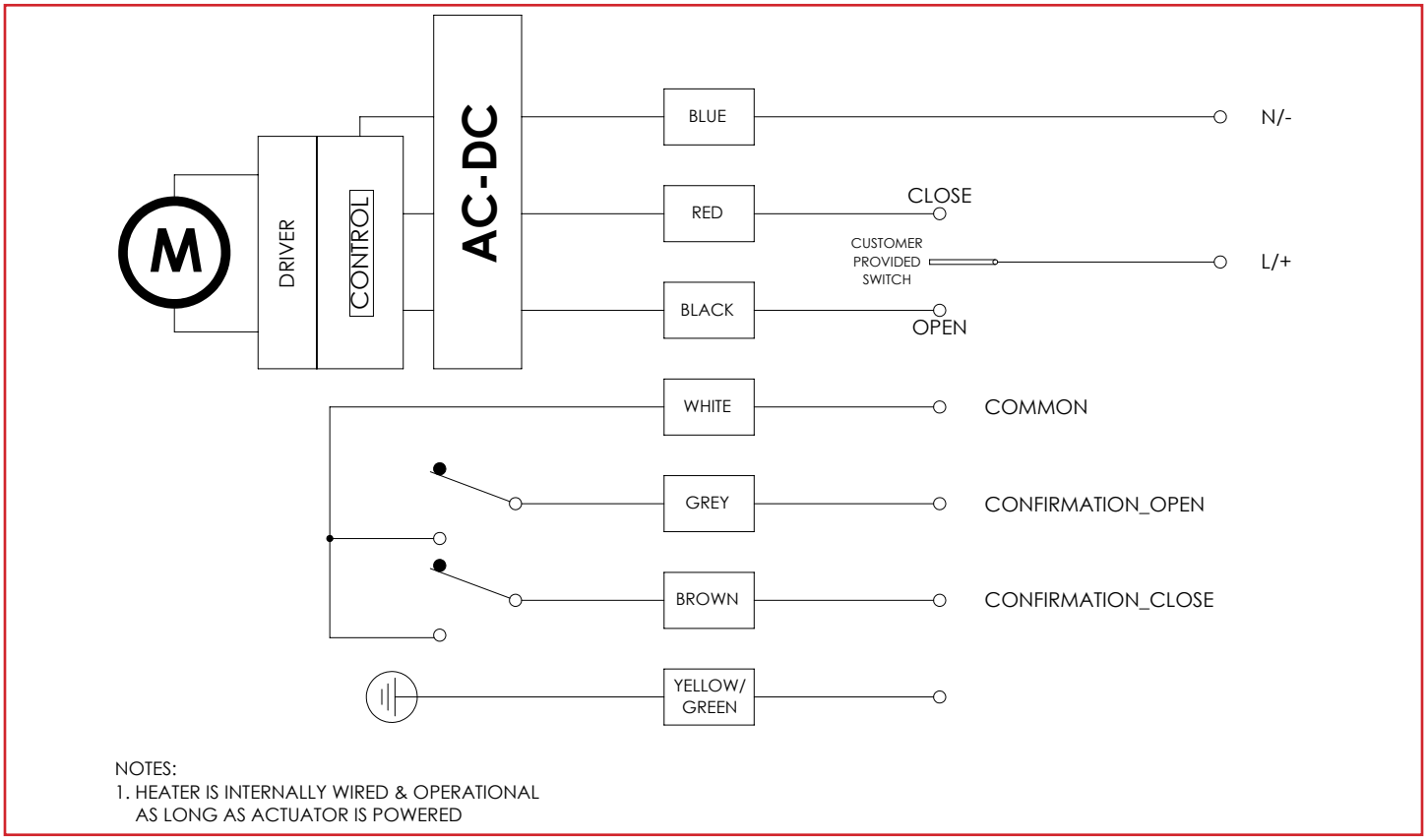
Engineering Data

Model	Torque (in-lbs)	95 - 265 VAC		24 VAC/VDC		Cycle time per 90 degrees (seconds)*
		Amp Draw	Duty Cycle	Amp Draw	Duty Cycle	
C20	177	0.18	75%	0.96	75%	10

Amp draw is considered locked rotor
*Cycle times are approximate
Duty cycle shown for ambient temp (73° F)

TYPE-21 AND TYPE-23 MULTIPORT® BALL VALVE WITH SERIES 19 COM PACK® ON/OFF ELECTRIC ACTUATOR

Wiring Diagram



Sample Specifications

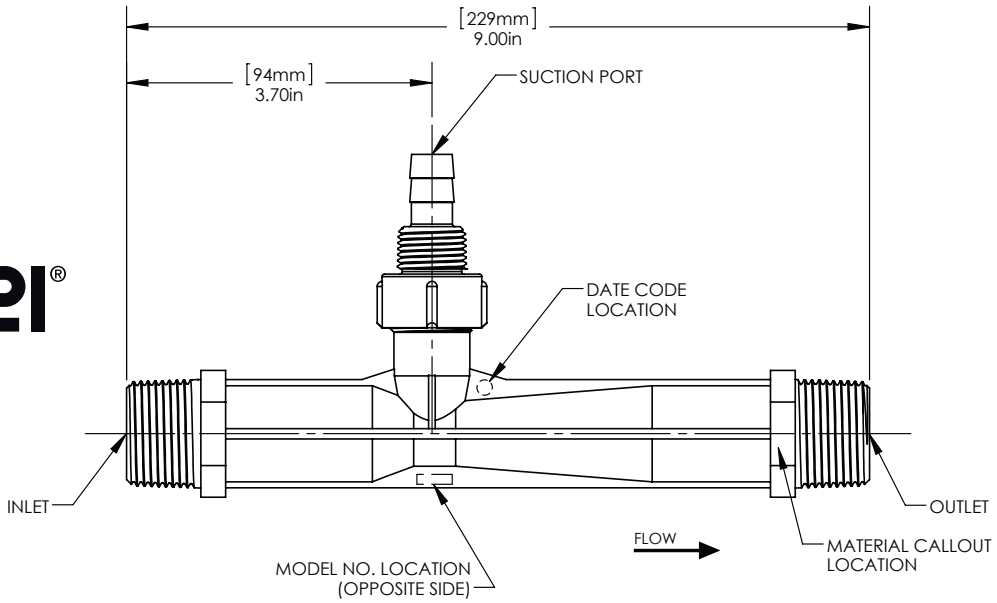
All Series 19 CAV on/off electric actuators shall have a brushless DC motor that accepts multiple voltages, permanently lubricated steel gears, NEMA 4X PC/PET enclosure with stainless steel trim, visual beacon indication, ISO 5211 valve mounting platform, manual override, and be CE compliant. Standard features shall include a heater, one set of dry contacts for PLC confirmation, an LED indicator, and a QR code that links to its user manual and wiring schematic.

Series 19 Actuator Selection Guide

Valve	Valve Size	C20	S20	S50	S110
Omni® Type-27 Ball Valves	3/8" - 2"	X			
Type-21/21a SST Ball Valves	1/2" - 2"	X	X		
	2-1/2" - 3"			X	
	4"				X
Type-23 Multiport® Valves	1/2" - 2"	X	X		
	3"			X	
	4"				X
Type-57P Butterfly Valves	1-1/2" - 2-1/2"		X		
	3" - 4"			X	
	5" - 6"				X



DATA SHEET
Venturi Injector
Mazzei #1078-03-PP



CONSTRUCTION

Available Material	Polypropylene (PP) - *BLACK*	Polyvinylidene Fluoride (PVDF) - *BLACK & NATURAL*
Unit Weight *(with box)*	0.35 lbs	0.51 lbs
Inlet & Outlet Connections	1" male NPT	
Suction Port Cap Connection - Default *(Inner Diameter)*	0.5" tubing barbs	
Suction Port Cap Connection - Alternate	0.5" male NPT	
Maximum Operating Temperature	212º F	
Maximum Operating Pressure *(at 68º F)*	120 psi	

ACCESSORIES

PART NUMBER	DESCRIPTION
K-183	Suction line kit
KR-183	Economy suction line kit
K181-A 02	Bypass kit *(includes suction line kit K-183)*
MV5-PP	PP metering valve with custom "V Port" seat control *(0.5" male NPT connections)*
MV5-N-PVDF	Natural PVDF metering valve with custom "V Port" seat control *(0.5" male NPT connections)*
S-50HB	Strainer *(0.5" barbed connection)*
S-84	Strainer without tubing adapter *(0.5" female NPT connection)*

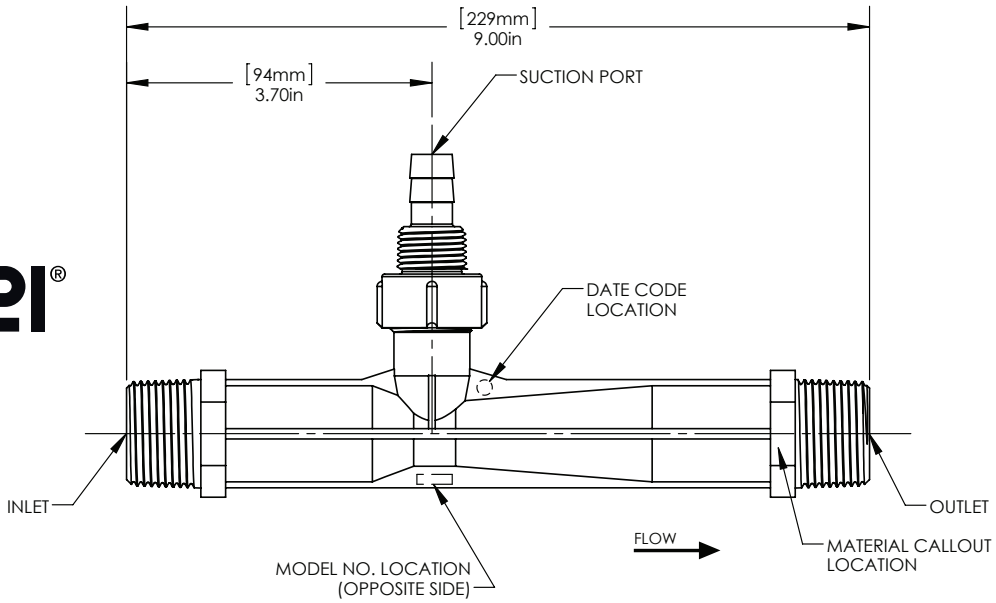
REPLACEMENT PARTS

INJECTOR MODEL	SUCTION PORT CAP	CHECK VALVE REPAIR KIT
1078 3 PP *BLACK*	CAP.75 PP	CR-4
1078 3 PVDF *BLACK*	CAP.75 PVDF	CR-4
1078 3 N-PVDF *NATURAL*	CAP.75 N-PVDF	CR-4



Model 1078

Mazzei®



CONSTRUCTION

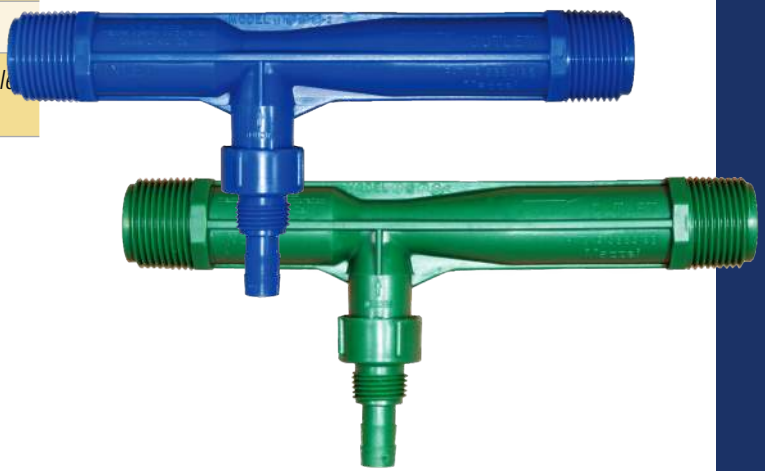
Available Material	Polypropylene (PP) - *GREEN*	Polyvinylidene Fluoride (PVDF) - *BLUE*
Unit Weight *(with box)*	0.16 kg	0.23 kg
Inlet & Outlet Connections	25 mm BSPT	
Suction Port Cap Connection - Default *(Inner Diameter)*	0.5" tubing barbs	
Suction Port Cap Connection - Alternate	0.5" male NPT	
Maximum Operating Temperature	100° C	
Maximum Operating Pressure *(at 20° C)*	8.44 bar	

ACCESSORIES

PART NUMBER	DESCRIPTION
MV5-PP	PP metering valve with custom "V Port" seat control *(0.5" male NPT connections)*
MV5-N-PVDF	Natural PVDF metering valve with custom "V Port" seat control *(0.5" male NPT connections)*
S-50HB	Strainer *(0.5" barbed connection)*
S-84	Strainer without tubing adapter *(0.5" female NPT connection)*

REPLACEMENT PARTS

INJECTOR MODEL	SUCTION PORT CAP	CHECK VALVE REPAIR KIT
ISO GRPP 1078-3 *GREEN*	ISO CAP .75 GRPP	CR-4
ISO 10783 PVDF *BLUE*	N/A	CR-4



Injector Data Sheet
ISO GRPP 1078-3 & ISO 10783 PVDF

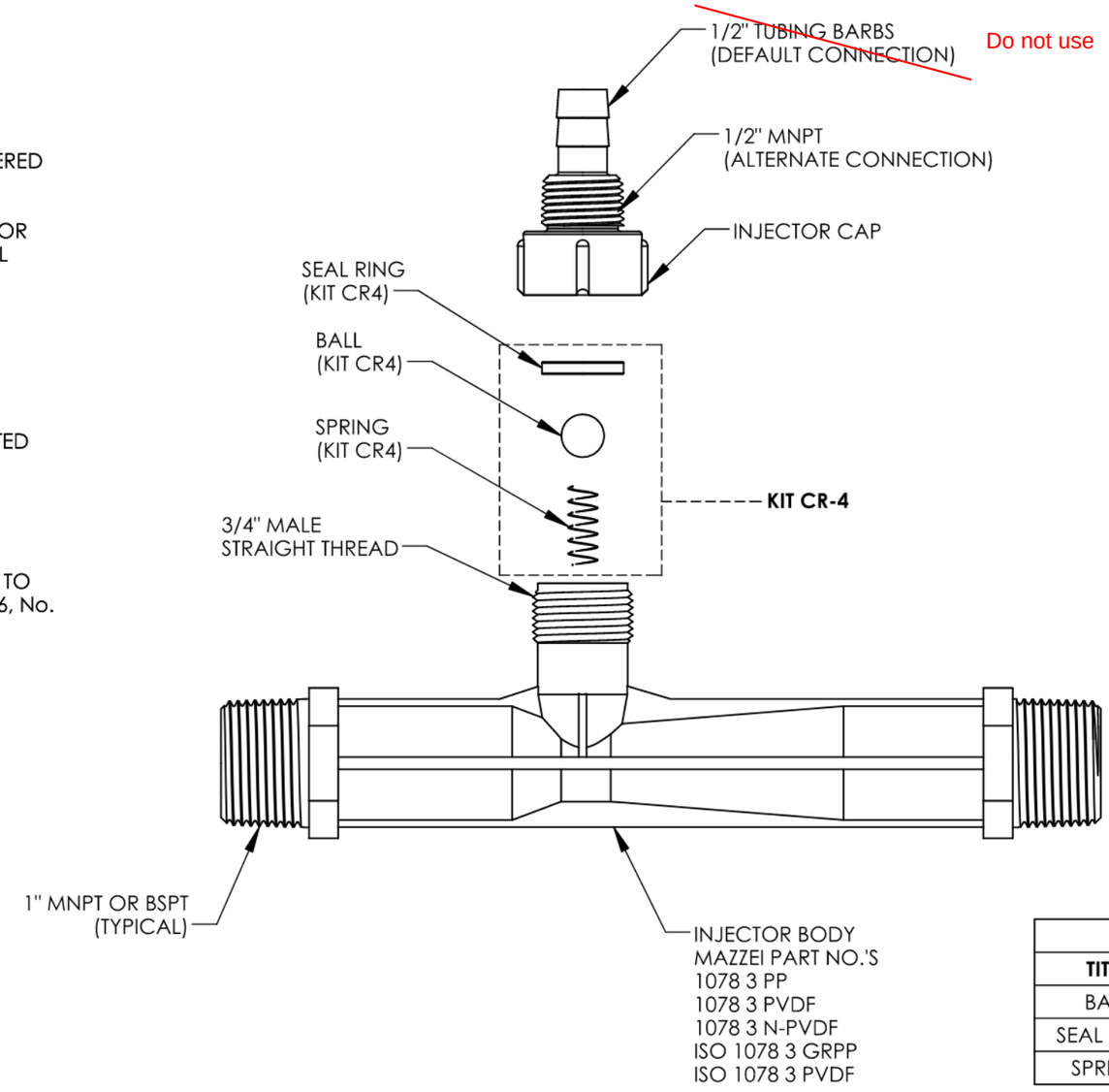
Model 1078

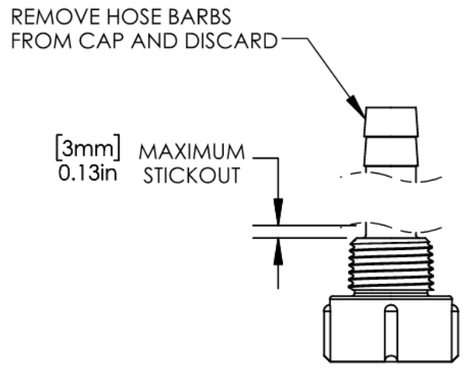
NOTES:

1. MADE IN THE U.S.A.
2. U.S. PATENT No. 5,863,128
3. U.S. No. 3,852,076 AND INTERNATIONAL REGISTERED TRADEMARKS
4. MATERIAL: GLASS FILLED POLYPROPYLENE (PP) OR POLYVINYLIDENE FLUORIDE (PVDF) OR NATURAL POLYVINYLIDENE FLUORIDE (N-PVDF)
5. INLET/OUTLET CONNECTION:
   1" MNPT OR BSPT
6. SUCTION PORT CONNECTION:

   DEFAULT - 1/2" I.D. TUBING BARB WITH INTEGRATED CHECK VALVE

   ALTERNATE - 1/2" MNPT - SEE ALTERNATE CAP MODIFICATION DETAIL
7. FOR INSTALLATION RECOMMENDATIONS REFER TO MAZZEI TECHNICAL BULLETINS No. 4, No. 5, No. 6, No. 10 AND No. 11, WHICH CAN BE FOUND AT WWW.MAZZEI.NET.
8. MAZZEI INJECTOR CO., LLC.
   500 ROOSTER DR.
   BAKERSFIELD, CA 93307
   TEL: 661.363.6500
   WEB: WWW.MAZZEI.NET

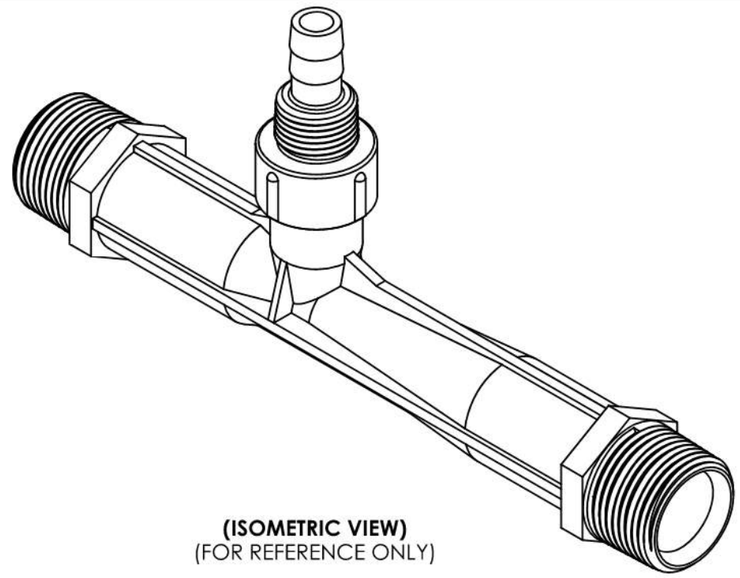




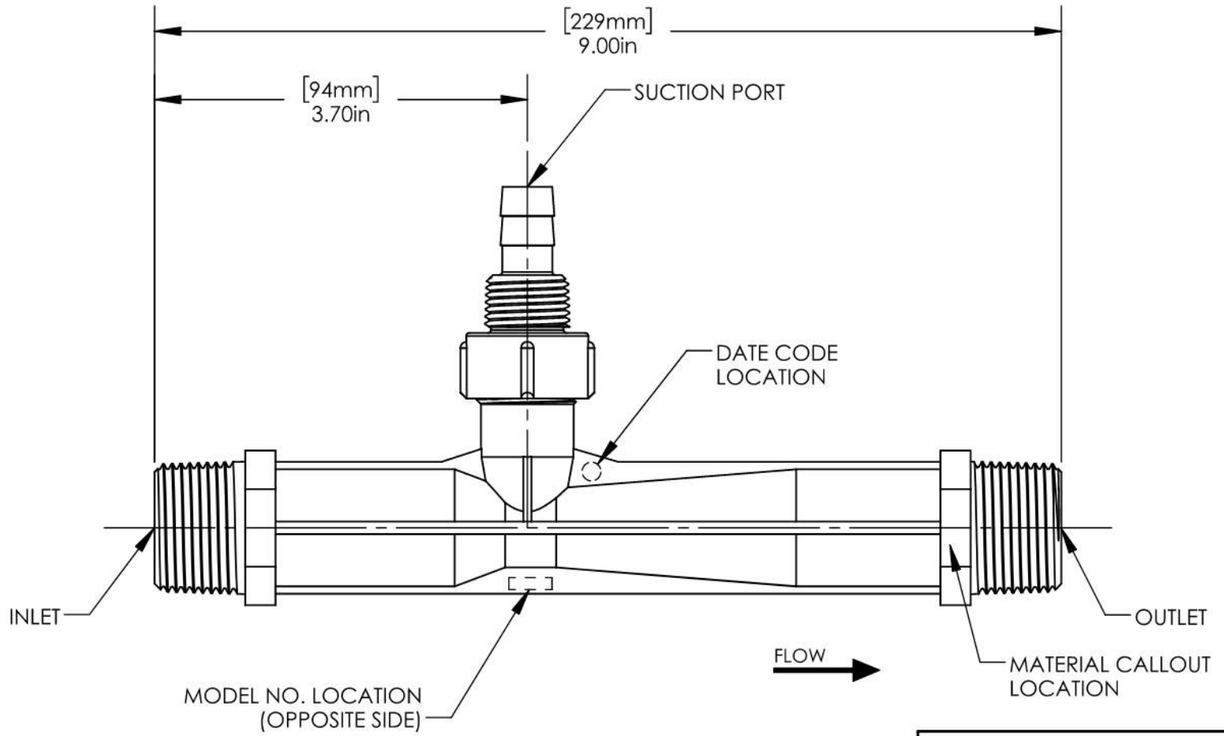
"CAP MODIFICATION DETAIL"
(ALTERNATE)

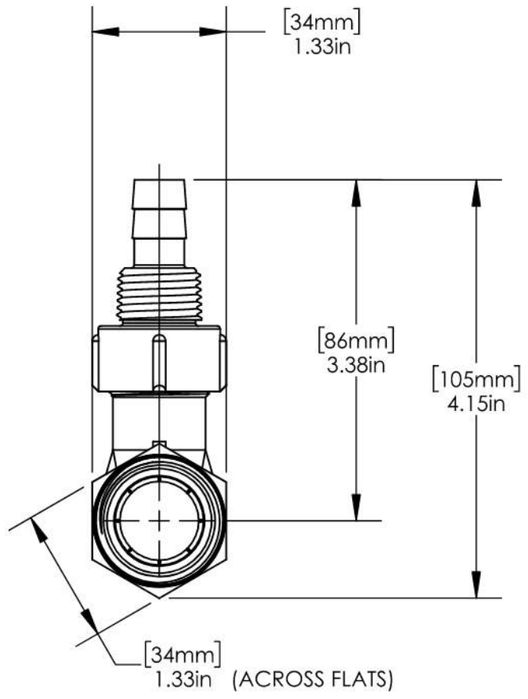
KIT CR-4	
TITLE	**MATERIAL**
BALL	TEFLON ® (PTFE)
SEAL RING	KEL-F ® (PCTFE)
SPRING	HASTELLOY C-22

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES		MAZZEI®	TITLE: 1" INJECTOR; MODEL 1078 3		
DRAWN:	T. JOHNS		DRAWING NO.: 1078 3		
DATE:	7/19/2013				
APPROVED:	P. BANKOWSKI	SIZE: A	WEIGHT: N/A	SCALE: 1:2	REV.: C	SHEET: 1 OF 2



(ISOMETRIC VIEW)
(FOR REFERENCE ONLY)





UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES		Mazzei®	TITLE: 1" INJECTOR; MODEL 1078 3			
DRAWN:	T. JOHNS		DRAWING NO.: 1078 3			
DATE:	7/19/2013					
APPROVED:	P. BANKOWSKI	SIZE: A	WEIGHT: N/A	SCALE: 1:2	REV.: C	SHEET: 2 OF 2

DATA SHEET
Pressure Gauge
Ashcroft #1279 with diaphragm seal

ASHCROFT®
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1279 Duragauge® Pressure Gauge

FEATURES

- Custom dial printing options
- Micrometer adjustable pointer
- ***PLUS!***™ Performance option dampens vibration, shock and pulsation effects
- Pressure range from vacuum to 30,000 psi
- NSF-61 Compliant

TYPICAL USES

- Refineries
- Chemical and petrochemical plants
- Offshore oil rigs
- Water and wastewater pressure control
- Pulp and water
- Mining and metals
- Equipment skids
- Specialized OEM equipment
- Cryogenics



1279
4½″ dial size

SPECIFICATIONS

Accuracy:	±0.5% of span (ASME B40.100 Grade 2A)		
Size:	4½″		
Range:	Vacuum, compound to 30,000 psi 60 psig		
Process Connection Location:	Lower, back, side, top		
Process Connection:	¼ NPT, ½ NPT, 9/16-18 UNF-2B Aminco® (high pressure connection)		
Case Style:	Solid front with pressure relief back		
Window:	Glass (STD.), acrylic, shatter proof glass, non-glare glass (OPT.)		
Movement:	Rotary, adjustable, 400 SS, Teflon™ coated		
Movement Materials:	400 SS, Teflon™ coated pinion gear and segment		
Dial:	Aluminum, white background, black scale		
Pointer:	Micrometer, adjustable, aluminum		
Weather Protection:	Case	IP Rating	Ordering Code
	Dry	Case not sealed, recommended for weather protected environment only	S
	Dry, field fillable	IP66	SH
	Liquid filled	IP66	SL
Dampening Options:	Liquid: glycerin, silicone, Halocarbon®, ***PLUS!***™ Performance		
Mounting:	Stem, surface, flush (STD.), pipe, remote (OPT.)		
Approvals:	CE, CRN, NSF-61		

WETTED COMPONENTS

Bourdon Tube	Process Connection	Joints
316L Stainless steel	316L Stainless steel	Welded
316L Stainless steel	Steel	Welded
K-Monel® 500	Monel® 400, Steel	Welded
C510 Pho. Bronze	Brass	Silver Brazed

KEY BENEFITS

- **Available with a wide variety of accessory and diaphragm seal assemblies**
- **Available with high process temperature dissipation siphons**

MIN/MAX TEMPERATURE LIMITS

Version	Ambient	Process	Storage
Dry	-20 °F to 200 °F (-29 °C to 93 °C)	-20 °F to 250 °F (-29 °C to 121 °C)	-40 °F to 250 °F (-40 °C to 121 °C)
PLUS!™	-40 °F to 150 °F (-40 °C to 66 °C)	-40 °F to 200 °F (-40 °C to 93 °C)	-40 °F to 150 °F (-40 °C to 66 °C)
Glycerin fill	20 °F to 150 °F (-7 °C to 66 °C)	20 °F to 150 °F (-7 °C to 66 °C)	0 °F to 150 °F (-18 °C to 66 °C)
Silicone fill	-40 °F to 150 °F (-40 °C to 66 °C)	-40 °F to 200 °F (-40 °C to 93 °C)	-40 °F to 150 °F (-40 °C to 66 °C)
Halocarbon® fill	-40 °F to 150 °F (-40 °C to 66°C)	-40 °F to 200 °F (-40 °C to 93 °C)	-40 °F to 150 °F (-40 °C to 66 °C)

NON-WETTED COMPONENTS

Case	Ring	Pressure Relief Back
Phenolic	Threaded, Polycarbonate (meets UL 94 V-0)	Polycarbonate (Meets UL 94 V-0)

Note: Other than discoloration of the dial and hardening of the gasketing that may occur as ambient or process temperatures exceeds 150 °F, non-liquid-filled gauges with standard glass windows, can withstand continuous operating temperatures up to 250 °F (121 °C). Liquid-filled gauges can withstand 200 °F (93 °C) but glycerin fill and acrylic window will tend to yellow. Accuracy at temperatures above or below the reference ambient temperature of 68 °F (20 °C) will be affected by approximately .4% per 25 °F. Gauges with welded joints will withstand 750 °F (400 °C), 450 °F (232 °C) with silver brazed joints for short times without rupture, although other parts of the gauge will be destroyed and calibration will be lost. For continuous use and for process or ambient temperatures above 250 °F (121 °C), a diaphragm seal or capillary or siphon is recommended.

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1279 Duragauge® Pressure Gauge

tag CIPPI1, CIPPI2

ORDERING CODE	Example:	451279	S	SL	04	L	XGV	NH	60#
		451279	**S**	**SH**	**04**	**L**	**XLL**		**15#**
Dial Size/Model Code									
451279 - 4½″ solid front		451279							
System (tube and process connection)									
A - Bronze tube, brass process connection, Max. pressure connection 1,000 psi									
P - K-Monel® 500 tube, Monel® 400 process connection, Max. pressure 30,000 psi									
R - 316L SS tube, steel process connection, Max. pressure 20,000 psi									
S - 316 SS tube, 316L SS process connection, Max. pressure 20,000 psi (NSF-61 Compliant)			S						
Case Design									
S - Solid front case, dry									
SH - Solid front case, dry (IP66 NEMA 4X)				SH					
SL - Solid front case, liquid filled (glycerin STD.)									
Process Connection Sizes									
02 - ¼ NPT Male, N/A for ranges over 20,000 psi									
04 - ½ NPT Male, N/A for ranges over 20,000 psi					04				
09 - 9/16 18 UNF-2B, Aminco® high pressure fitting, pressures over 20,000 psi (STD.)									
AM - AND 10050-4 (¼ tubing connection)									
RW - SAE 7/16 & 20 Straight thread									
Process Connection Location									
L - Lower						L			
B - Back									
D - Side (3 o'clock)									
E - Side connection (9 o'clock)									
T - Top connection									
Options (If choosing an option(s) must include a "X") (See Table 1 on page 3 for more options)							–X__		
GV - Silicone case fill									
GX - Halocarbon® case fill									
LL - ***PLUS!***™ Performance							LL		
ND - PLUS! Performance, silicone free (glycerin and silicone filled gauges)									
NZ - ***PLUS!***™ Performance, silicone free dry gauges									
X1P - IP65 dry case (case cannot by liquid filled)									
NH - SS tag wired to case									
PD - Acrylic window (STD. with liquid filled or hermetically sealed cases)									
SG - Safety Glass									
C4 - Traceable calibration certificate									
6B - Cleaned for oxygen service									
5G - Attach one accessory to gauge. Applicable to PL02 pressure limiting valve, V01,V02,V03 valves, 1098, 1100, 1198, 2198 siphons, 7001, 7004 needle valves, 1115 capillary, 1106 pulsation dampner, 1112, PD02 pressure snubbers, MDV swivel adapter, 2265 electric warning contact									
Range (coding examples only, see range table on page 3 for all standard ranges)									
Single Scales									
15# - 15 psi									15#
1BR - 1 bar									
1KSC - 1 kg/cm²									
100KP - 100 kPa									
Dual Scales									
15#/BR - 15 psi inner scale, 1 bar outer scale									
1BR/# - 1 bar inner scale, 15 psi outer scale									

When selecting a diaphragm seal or isolation ring, refer to the Min/Max Guide for compatibility with this gauge or scan the QR code to the right.

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1279 Duragauge® Pressure Gauge

TABLE 1

CODE	OPTION
AB	Gauges calibrated to compensate for absolute pressure
C3	Material Traceability Report per EN 10204 3.1 (S and P wetted parts only)
DA	Dial marking (text marking on the dial)
D3	DuraVis™ retroreflective dial
EP	Maximum pointer (adjustable, N/A with liquid filled or hermetically sealed cases)
HY	Hydrostatic/pneumatic testing. (System with ranges 15 -400 PSI pressurized to 150% of rated system pressure for 5 minutes. Ranges 600 PSI - 10,000 PSI pressurized to 130% system pressure for 5 minutes.)
MQ	Positive Material Identification
NG	Non-glare glass (N/A with liquid fill or hermetically sealed cases)
OS	Overload stop
SG	Safety glass
SH	Red set hand, stationary
TM	2″ Pipe mounting bracket
TS	Throttle screw (STD. with liquid filled, hermetically sealed or ***PLUS!***™ Performance)
VS	Underload stop
VY	Krytox Lubricated Movement (To be ordered with SH case design for low temperature use to -65 °F/-54 °C)
56	Flush mounting ring

STANDARD PRESSURE RANGES

	psi	bar	kPa	mPa	KG (kg/cm²)
Vacuum	30IMV	N1BR	N100KP	N1MP	N1KSC
	–	N1/0.6BR	N100/60KP	0.1/0.06MP	N1/0.6KSC
Compound	V/15#	–	–	–	–
	–	N1/1.5BR	N100/150KP	N0.1/0.15MP	N1/1.5KSC
	V/30#	–	–	–	–
	–	N1/3BR	N100/300KP	N0.1/0.3MP	N1/3KSC
	V/60#	–	–	–	–
	–	N1/5BR	N100/500KP	N0.1/0.5MP	N1/5KSC
	V/100#	–	–	–	–
	–	N1/9BR	N100/900KP	N0.1/0.9MP	N1/9KSC
Positive Pressure	15#	1BR	100KP	0.1MP	1KSC
	20#	–	–	–	–
	–	1.6BR	160KP	0.16MP	1.6KSC
	30#	–	–	–	–
	–	2.5BR	250KP	0.25MP	2.5KSC
	60#	4BR	400KP	0.4MP	4KSC
	–	6BR	600KP	0.6MP	6KSC
	100#	–	–	–	–
	120#	–	–	–	–
	–	10BR	1000KP	1MP	10KSC
	160#	–	–	–	–
	200#	–	–	–	–
	–	16BR	1600KP	1.6MP	16KSC
	300#	–	–	–	–
	–	25BR	2500KP	2.5MP	25KG
	400#	–	–	–	–
	500#	–	–	–	–
	600#	40BR	4000KP	4MP	40KSC
	800#	–	–	–	–
	–	60BR	6000KP	6MP	60KSC
	1000#	–	–	–	–
	1500#	100BR	10000KP	10MP	100KG
	2000#	–	–	–	–
	–	160BR	16000KP	16MP	160KSC
	3000#	–	–	–	–
	–	250BR	25000KP	25MP	250KSC
	4000#	–	–	–	–
	5000#	–	–	–	–
	6000#	400BR	40000KP	40MP	400KSC
	8000#	–	–	–	–
	–	600BR	60000KP	60MP	600KSC
	10000#	–	–	–	–
	15000#	1000BR	100000KP	100MP	1000KSC
	20000#	-	-	-	-
	-	1600BR	-	160MP	1600KSC
	30000#	-	-	-	-

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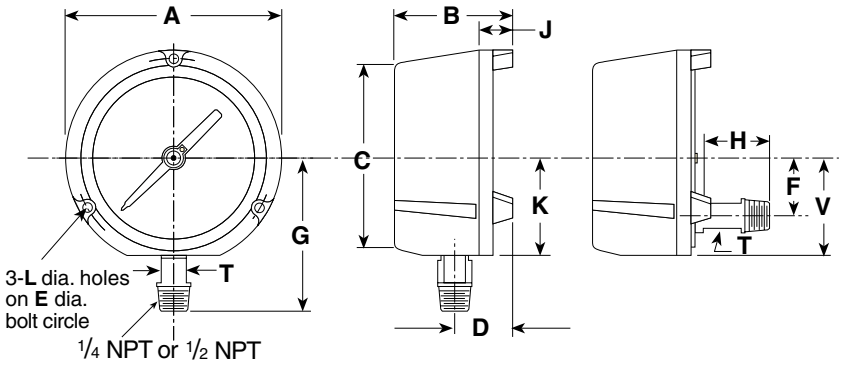
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1279 Duragauge® Pressure Gauge

DIMENSIONS in [ ] are millimeters

For reference only, consult Ashcroft for specific dimensional drawings

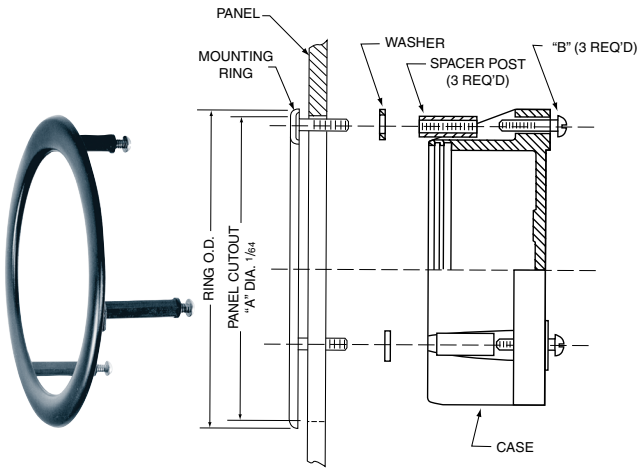
Dial Size Inches	A	B	C	D	E	F	G	H	J	K	L	T	V	Weight oz/kg
4½	5.81 [147.6]	3.36 [85.3]	5.07 [128.7]	1.60 [40.6]	5.375 [137]	1.62 [41.2]	3.92 [99.6]	0.73 [18.4]	0.94 [23.9]	2.62 [66.7]	0.218 [5.5]	0.62 [15.7]	2.62 [66.7]	2.5 (Dry) 3.5 (L.F.)



1278M Series Flush Mounting Ring

1278M Series Flush Mounting Ring. Used to flush mount gauge case 1279(*)S. Black finish (STD.); Polished SS finish (OPT.)

Gauge Size Inches	Ring O.D.	"A" DIA.	"B" Size of 3 Screws	"C" Size of Washers
4½	6 [152]	5.625 [148]	#10-24 x 1⅝	7/16 x 17/64 x 5/8



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ASHCROFT®
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100/101, 200/201, 300/301 Threaded Diaphragm Seal

FEATURES

- 316L Stainless steel top housing (standard)
- Available in wide range of wetted materials for process compatibility
- Flushing port (101, 201, 301) provides for easy cleaning of process
- Continuous duty design contains process if instrument is inadvertantly removed
- NSF-61 Compliant – 200 316L Stainless steel only

TYPICAL USES

- Oil and gas
- Refineries
- Chemical and petrochemical
- Water and wastewater
- NACE-compliant processes (sour gas separation)
- Biogas and biodiesel





Diaphragm Threaded To Top Housing - flexible design

Diaphragm Welded or Bonded To Top Housing

Diaphragm Clamped Between Upper & Lower Housing - flexible design for elastomeric diaphragms

SPECIFICATIONS

Connection Style:	100, 200, 300: Threaded 101, 201, 301: Threaded with flushing port
Process Connection:	¼ to ½ NPT Female, ¼ to 1 NPT Male
Instrument Connection:	¼ to ½ NPT
MAWP:	200 psi to 2500 psi (5000 psi optional) Refer to Seal Pressure & Temperature Guide
Fill Fluid:	See table 3 on page 3
Approvals:	CRN , NSF-61

TEMPERATURE RATINGS

Temperature Rating	Metallic Diaphragms	Non-Metallic Diaphragms
Threaded	450 °F/Refer to fill fluid temperature limit	Refer to diaphragm material and fill fluid temperature limits
Welded (XDU)	480 °F/Refer to fill fluid temperature limit	Refer to diaphragm material and fill fluid temperature limits

WETTED COMPONENTS

Diaphragm	Bottom Housing	Gasket (metalic diaphragm materials only)
See table 1 on page 2	See table 2 on page 2	PTFE (rated for -150 ºF to 480 ºF)

NON-WETTED COMPONENTS

Top Housing		Bolt/Clamp Rings	Nuts/Bolts
Standard	316L St. steel	Carbon steel	Zinc plated alloy steel
Optional	Monel® (XYM), Titanium (XHB)	316L (XSE)	316L (XSE)

KEY BENEFITS

- **Protects instrumentation from corrosive media**
- **Prevents pressure measuring instrument from clogging**
- **Dissipates elevated process temperature**

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ASHCROFT®
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100/101, 200/201, 300/301 Threaded Diaphragm Seal

		50	2	01	Y	S	04T	XDJ	
ORDERING CODE	**Example:**	**10**	**2**	**01**	**S**	**S**	**02T**	**XCK**	**NH**
Process Connection Size									
25 - ¼ NPT Female									
50 - ½ NPT Female									
75 - ¾ NPT Female									
10 - 1 NPT Female		10							
15 - 1½ NPT Female									
02 - ¼ NPT Male									
04 - ½ NPT Male									
06 - ¾ NPT Male									
08 - 1 NPT Male									
SA - ¼″ Socket weld									
SB - ½″ Socket weld									
SC - ¾″ Socket weld									
SD - 1″ Socket weld									
Diaphragm Type									
1 - 100 series capsule diaphragm threaded into top housing									
2 - 200 series diaphragm welded (metallic) or bonded (elastomeric) to top housing			2						
3 - 300 series elastomeric diaphragm clamped between top and lower housing									
Flushing Port									
00 - No flushing port									
01 - Flushing port in lower housing				01					
Diaphragm Materials (See Table 1 on page 2)									
~~S - 316L Stainless steel~~ Y-Viton per table 1					S				
Bottom Housing Materials (See Table 2 on page 2)									
S - 316L Stainless steel						S			
Instrument Connection Size									
02T - ¼ NPT Female instrument connection							02T		
04T - ½ NPT Female instrument connection									
Options (if choosing an option(s) must include an "X")								X__	
Fill Fluid (for seals attached to instruments) (See Table 3 on page 3 for more available fill fluids)									
CK - 50 cSt Silicone DJ - 10 cSt Silicone table 3								CK	
Optional Features (for more options, see table 4 on page 5)									
NH - Stainless steel instrument tag									NH

When selecting an instrument, refer to the Seal Pressure & Temperature Guide for compatibility with this diaphragm seal or scan the QR code to the right.

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ASHCROFT®
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100/101, 200/201, 300/301 Threaded Diaphragm Seal

TABLE 1 - DIAPHRAGM MATERIALS

Material	Letter Code	100 Series	200 Series	300 Series	Notes
316L Stainless steel	S	•	•		NSF-61 Compliant
304L Stainless steel	C	•	•		
904L Stainless steel	F		•		
Monel® 400	P	•	•		200-series must be ordered with XYM Monel® top housing option
Tantalum	U	•	•		
Hastelloy® C-276	H	•	•		
Hastelloy® B	G	•	•		
Hastelloy® C-22	J	•	•		
Carpenter 20®	D	•	•		
PTFE	T		•	•	Temp limits: -40 °F to 400 °F
Viton™	Y		•	•	Temp limits: -40 °F to 350 °F Max. pressure: 500 psi
Kalrez®	K		•	•	Temp limits: 30 °F to 212 °F Max. pressure: 500 psi
Nickel	N	•	•		
Titanium	Ti		•		Includes titanium top housing
Gold Plated 316L SS	W	•			

TABLE 2 - BOTTOM HOUSING MATERIALS

Material	Letter Code	Notes
316L Stainless steel	S	NSF-61 Compliant (200 only)
304L Stainless steel	C	
904L Stainless steel	F	
Carbon Steel	B	
Monel® 400	M	
Hastelloy® C-276	H	
Hastelloy® B	G	
Hastelloy® C-22	J	
Duplex 2205	Z	
Super Duplex 2507	A	Contact Ashcroft for availability
Carpenter 20®	D	
Inconel® 625	W	
Nickel	N	
Titanium	Ti	
PVDF	KY	Only offered in ½ NPT, ¼ NPT, and socket weld process connections. Not available with flushing connection. PVDF Temperature Limits: 200 psi - 74 °F, 125 psi - 125 °F, 80 psi - 150 °F
PVC	V	Only offered in ½ NPT, ¼ NPT, and socket weld process connections. Not available with flushing connection. PVC Temperature Limits: 200 psi - 74 °F, 125 psi - 125 °F, 80 psi - 150 °F

PRESSURE RATINGS

Diaphragm seal and lower housing material	MAWP	
	Standard	XHP
All-metallic construction	2500 psi	5000 psi
Viton™ or Kalrez® diaphragm	500 psi	N/A
PTFE diaphragm	2500 psi	N/A
PVC or PVDF lower housing	200 psi	N/A

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ASHCROFT®
Trust the shield.®

100/101, 200/201, 300/301 Threaded Diaphragm Seal

TABLE 3 - FILL FLUIDS

Fill Fluid	Temperature	Viscosity (cSt at 70ºF (21ºC))	Variation Code	Notes
Glycerin (food grade)	0 °F to 400 °F (-18 °C to 204 °C)	1,300	CG	Direct-mounting only. Not for use with vacuum service. Minimum span 15 psi.
50 cSt Silicone	-40 °F to 500 °F (-40 °C to 260 °C)	50	CK	
10 cSt Silicone	-40 °F to 500 °F (-40 °C to 260 °C)	10	DJ	
Halocarbon® 4.2	-70 °F to 300 °F (-57 °C to 199 °C)	4.2	CF	For use with oxygen/oxidizing process media
Slytherm® 800	-40 °F to 750 °F (-40 °C to 400 °C)	10	HA	High temperature applications
Syltherm® XLT	-150 °F to 500 °F (-100 °C to 260 °C)	1.4	CC	Low temperature applications
Calflo® AF	-20 °F to 600 °F (-29 °C to 316 °C)	60	KF	High temperature, silicone-free
Mineral Oil	10 °F to 400 °F (-12 °C to 204 °C)	75	MY	
Neobee® M-20 (food grade)	5 °F to 400° F (-15 °C to 204 °C)	9.5	NM	
Silicone (food grade)	-40 °F to 500 °F (-40 °C to 260 °C)	350	CZ	Minimum span 60 in. H_2O.
50/50 Glycerin/Water	15 °F to 200 °F (-9 °C to 93 °C)	30	GH	
Propylene Glycol	-50 °F to 325 °F (-46 °C to 163 °C)	54	CV	
Ethylene Glycol	20 °F to 325 °F (-7 °C to 163 °C)	14	FK	
50/50 Ethylene Glycol/Water	-25 °F to 190 °F (-32 °C to 88 °C)	2.9	CT	
80/20 Glycerin/Water	15 °F to 225 °F (-9 °C to 107 °C)	270	GR	
95/5 Water/Propylene Glycol	40 °F to 185 °F (4 °C to 85 °C)	1.0	PY	

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ASHCROFT®
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100/101, 200/201, 300/301 Threaded Diaphragm Seal

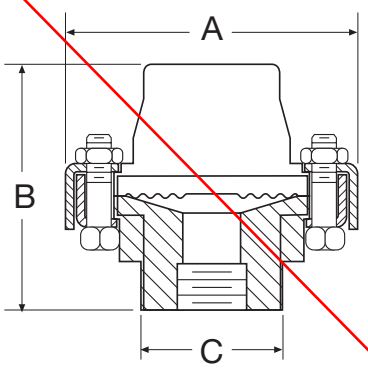
TABLE 4 - OPTIONS

Code	Option	Notes
Flushing Port		
AW	Single ½″ flushing connection	Process connection must be ¾ NPT or smaller
DB	Dual ½″ flushing connections	Process connection must be ¾ NPT or smaller
DK	Dual ¼″ flushing connections	
PU	Pipe plug for flushing connection	Plug will match bottom housing material. Seals with flushing connections only
Top Housing		
YM	Monel® 400 top housing	Must be ordered with Monel® or tantalum diaphragm
Assembly/Hardware		
SB	Stainless steel clamping bolts	
SE	Stainless steel rings and bolts	
HP	High-pressure clamping rings	Increases MAWP to 5,000 psi unless otherwise limited by material
LD	Stainless steel locking device	
NH	Stainless steel instrument tag	
NX	Teflon™-free diaphragm seal	200 psi maximum working pressure, 200 series only
DU	Instrument welded to top housing	Instrument socket must be like-material to top housing
Other		
MQ	Positive material identification	
NH	Stainless steel instrument tag	
6B	Cleaned for oxygen service	
CD-5	NACE compliance certificate	Stainless, Hastelloy®, or Monel® wetted materials Must be ordered as a separate line item

DIMENSIONS in [ ] are millimeters

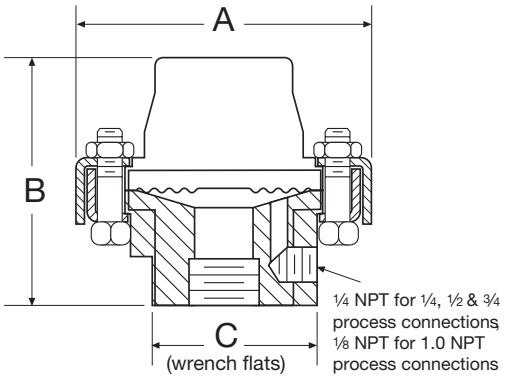
For reference only, consult Ashcroft for specific dimensional drawings

100, 200, 300 THREADED DIAPHRAGM SEAL



A	B	C
3¾ [95]	2⅞ [73]	1 13/16 [46]

101, 201, 301 THREADED DIAPHRAGM SEAL WITH FLUSHING PORT



A	B	C
3¾ [95]	2⅞ [73]	1 13/16 [46]

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DATA SHEET
Shelf Chemical Flow Meter
Keyence #FD-Q10C

KEYENCE

Clamp-on Flow Sensor
FD-Q Series

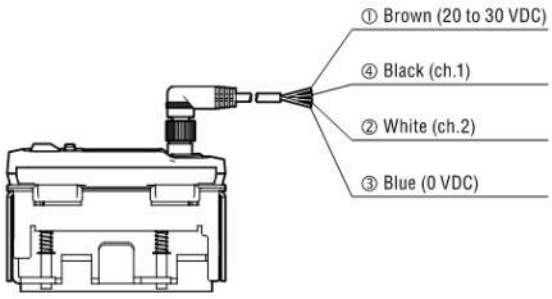


NO PIPE MODIFICATION NECESSARY



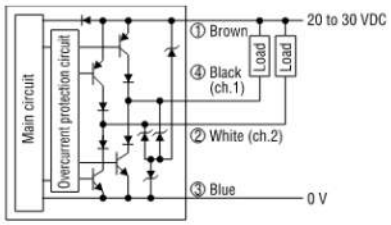
Multi-Sensor Controller
MU-N Series

When using the sensor without the controller

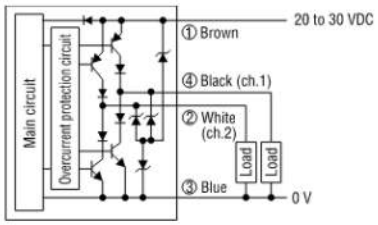


■ When "Control Output" is selected for ch.2*

When NPN is selected

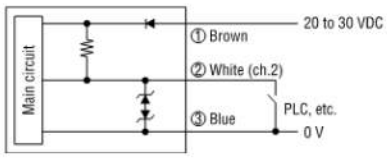


When PNP is selected

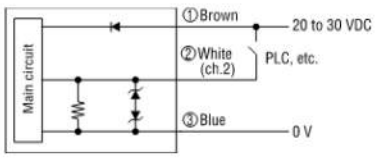


■ When "External Input" is selected for ch.2*

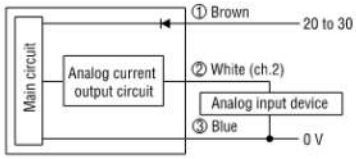
When NPN is selected



When PNP is selected



■ When "Analog Output" is selected for ch.2*

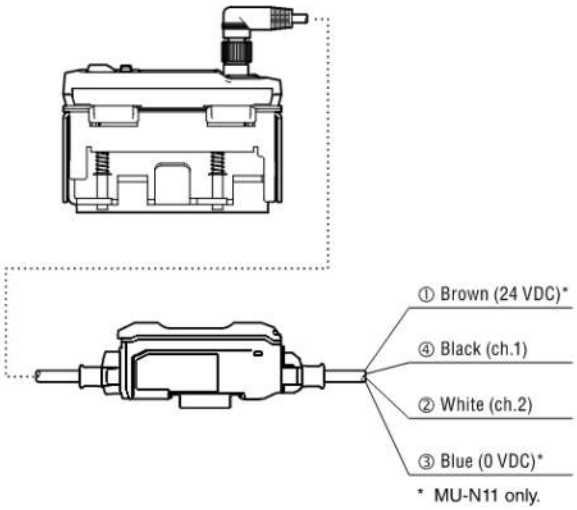


■ M12 Connector pin layout



*When "OFF" is selected for ch.2 (default), ② White will not be used.

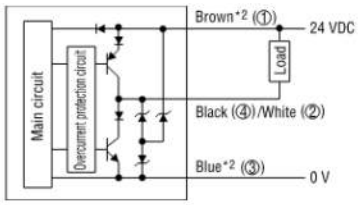
When using the sensor with the controller



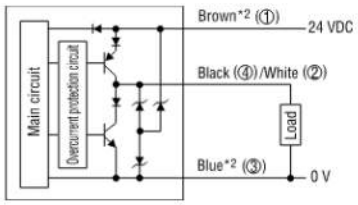
* MU-N11 only.

■ When "Control Output" is selected for ch.2*1

When NPN is selected

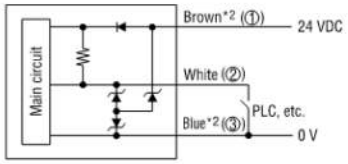


When PNP is selected

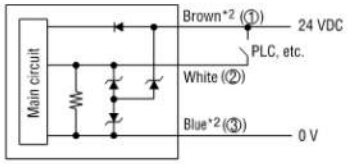


■ When "External Input" is selected for ch.2*1

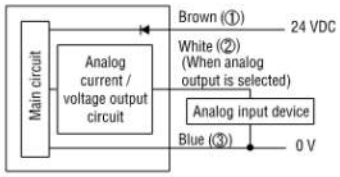
When NPN is selected



When PNP is selected



■ When "Analog Output" is selected for ch.2*1*2



■ Pin layout when the M12 connector (4-pin) cable is used



LINEUP

Sensor

Appearance	Model	Rated flow range	Connection Bore Diameter
	FD-Q10C	20 L/min 5.2 gal/min	1/4"(8 A) ø13 mm to ø16 mm
		30 L/min 7.9 gal/min	3/8"(10 A) ø16 mm to ø18 mm
	FD-Q20C	60 L/min 15.9 gal/min	1/2"(15 A) ø18 mm to ø23 mm
		100 L/min 26.4 gal/min	3/4"(20 A) ø23 mm to ø28 mm
	FD-Q32C	200 L/min 52.8 gal/min	1"(25 A) ø28 mm to ø37 mm
		300 L/min 79.3 gal/min	1 1/4"(32 A) ø37 mm to ø44 mm
	FD-Q50C	400 L/min 105.7 gal/min	1 1/2"(40 A) ø44 mm to ø52 mm
		500 L/min 132.1 gal/min	2"(50 A) ø52 mm to ø64 mm

Protection cover

Appearance	Model	Name	Material
	FD-QP1	Display Protection Cover	Polysulfone

When using the sensor without the controller: Select a suitable power supply cable from the table below.

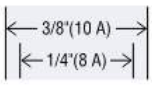
Power supply cable

Appearance	Model	Material	Connector type	Cable termination	Length
	OP-75722	PVC (Polyvinyl chloride)	M12 4 pins L-shape	Loose wire	2 m 6.6'
	OP-87274				10 m 32.8'
	OP-87640	PUR (Polyurethane) (Oil Resistant)	M12 4 pins L-shape	Loose wire	2 m 6.6'
	OP-87641				10 m 32.8'

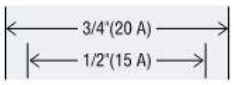
Bore Diameter Guide [The diagrams below display the applicable pipe widths]

(Each model contains a mounting bracket that can accommodate two different pipe sizes)

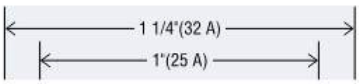
FD-Q10C



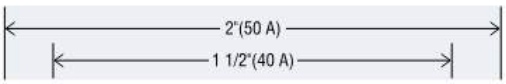
FD-Q20C



FD-Q32C



FD-Q50C



Sensor

Model		FD-Q10C		FD-Q20C		FD-Q32C		FD-Q50C	
Supported pipe diameter	Outer diameter of pipe (mm)	ø13 to ø16	ø16 to ø18	ø18 to ø23	ø23 to ø28	ø28 to ø37	ø37 to ø44	ø44 to ø52	ø52 to ø64
	NPS (Nominal Pipe Size)	1/4"	3/8"	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"
	DN (Diameter Nominal)	8 A	10 A	15 A	20 A	25 A	32 A	40 A	50 A
Supported pipe materials		Metal pipe/Resin pipe*1							
Supported fluids		Various liquid [i.e. water (including DI), oils, chemicals, etc.]*1							
Supported fluid temperature (Pipe surfacetemperature)		0 to 85°C 32 to 185°F (No freezing on the pipe surface)*2							
Maximum rated flow		20 L/min 5.2 gal/min	30 L/min 7.9 gal/min	60 L/min 15.9 gal/min	100 L/min 26.4 gal/min	200 L/min 52.8 gal/min	300 L/min 79.3 gal/min	400 L/min 105.7 gal/min	500 L/min 132.1 gal/min
Zero cut flow rate (Default) *3		1.0 L/min		2.5 L/min		5 L/min		25 L/min	
Display method		Status indicator, output indicator, dual row display with 4-digit, 7 segment LED, stability level indicator							
Display update cycle		Approx. 3 Hz							
Display resolution (L/min)		0.01/ 0.1/ 1 (Default: 0.1)		0.1/ 1 (Default:0.1)		0.1/ 1 (Default:1)			
Response time		0.5 s / 1.0 s / 2.5 s / 5 s / 10 s / 30 s / 60 s							
Repeatability /F.S.*4 (Specific to selected response time)		0.5 s:±2.0%, 1 s:±1.5%, 2.5 s:±1.0%, 5 s:±0.5%, 10 s:±0.35%, 30 s:±0.2%, 60 s:±0.15%							
Hysteresis		Variable							
Integrated flow unit display (L)		0.1/ 1/ 10/ 100/ 1000 (Default: 1)				1/ 10/ 100/ 1000/ 10000 (Default: 1)			
Integrated flow data storage cycle		Save to memory every 10 seconds							
Memory backup		EEPROM (Data storage length: 10 years or longer, Data read/write frequency: 1 million times or more)							
Power I/O connector		M12 4-pin connector							
Input/ Output (Selectable)*5	Output (ch.1/ch.2)	Control output/ Pulse output/ Error output (Selectable, Default: ch.1 control output/ ch.2 not used), NPN/PNP setting switchable,open collector output 30 V or less, max. 100 mA/ch., residual voltage 2.5 V or less							
	Analog output (ch.2)	4 to 20 mA / 0 to 20 mA (Selectable, Default: not used), load resistance 500 Ω or less							
	External input (ch.2)	Integrated flow reset input/ Flow rate zero input/ Origin adjustment input (Selectable, Default: not used), short-circuit current 1.5 mA or less, input time 20 ms or more							
Power source	Power supply voltage	20 to 30 VDC , ripple (P-P) 10% max, Class2/LPS							
	Current consumption	100 mA or less (Load current excluded)*6				130 mA or less (Load current excluded)*6			
Protection circuit		Power supply reverse connection protection, power supply surge protection, each output short-circuit protection, each output surge protection							
Environmental resistance	Enclosure rating	IP65/IP67 (IEC60529)							
	Ambient temperature	-10 to 60°C 14 to 140°F (No freezing)							
	Ambient humidity	35 to 85%RH (No condensation)							
	Vibration resistance	10 to 55 Hz, compound amplitude 1.5 mm 0.06", XYZ axes 2 hours for each axis							
	Shock resistance	100 m/s² 16 ms pulse X, Y, Z 1000 times for each axis							
Material	Sensor main unit	PPS/PES/PBT/SUS303/SUS304/SUSXM7							
	Sensor surface	Rubber							
	Mounting bracket	SUS304/PA/SUSXM7				SUS304/PA/POM/SUSXM7			
Weight (including mounting bracket)		Approx. 340 g		Approx. 400 g		Approx. 530 g		Approx. 640 g	

*1 Liquid must allow for the passage of an ultrasonic pulse, as well as not contain large air pockets or excessive bubbles. Detection may be unstable on certain non-standard pipes. (i.e. lined pipes)

*2 Contact KEYENCE when the temperature of the pipe is greater than 85°C 185°F.

*3 The zero cut flow rate can be changed in the settings. When using the unit with a low flow rate range, perform an origin adjustment when the fluid is not moving if you change the zero cut flow rate.

*4 This specification is valid when the flow velocity distribution is stable. This value does not take into account the effects of pulsation or fluctuations in flow velocity distribution due to facility factors. Convert the F.S. (full scale) listed in the table according to the rated flow range.

*5 IO-Link: Compatible with Specification v1.1 / COM2 (38.4 kbps) The setting file can be downloaded from the KEYENCE website. (http://www.keyence.com) If using the unit in the environment where downloading the file is not possible via internet, contact your nearest KEYENCE office. IO-Link is either registered trademarks or trademarks of PROFIBUS Nutzerorganisation e.V. (PNO)

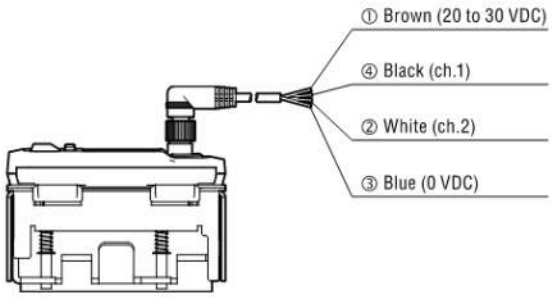
*6 When including the loads, please add 200 mA to this value.

Controller

Model			MU-N11	MU-N12
Type			Main unit	Expansion unit
Response time			0.5 s / 1.0 s / 2.5 s / 5 s / 10 s / 30 s / 60 s	
Power supply	Power voltage		24 VDC, ripple (P-P) 10% or less, Class 2 or LPS	
	Current consumption	with FD-Q10C/ Q20C	170 mA or less (without load)*1	155 mA or less (without load)*2
		with FD-Q32C/ Q50C	200 mA or less (without load)*1	185 mA or less (without load)*2
Input/Output (Selectable)	Output (ch.1/ch.2)		Control output/Pulse output/Error output (Selectable, Default : ch.1 control output/ch.2 not used), NPN/PNP setting switchable, open collector output 24 V or less, Main unit: max. 50 mA/ch*3., Expansion unit: 20 mA/ch., residual voltage 2 V or less	
	Analog output (ch.2)		4 to 20 mA, load resistance: 450 Ω or less/0 to 10 V External load resistance: 5 kΩ or more (Selectable, Default: not used)	—
	External input (ch.2)		Integrated flow reset input/Flow rate zero input/Origin adjustment input (Selectable, Default: not used), short-circuit current NPN: 1 mA or less/PNP: 2 mA or less	
Protection circuit			Protection against reverse power connection, power supply surge, output overcurrent, output surge, and reverse output connection	
Unit expansion			Up to 4 units per main unit*4	
Environmental resistance	Ambient temperature		-20 to +50°C -4 to 122 F (no freezing)	
	Ambient humidity		35 to 85%RH (no condensation)	
	Shock resistance		1000 m/s² in X, Y, Z axis directions respectively 6 times	
	Vibration resistance		10 to 55 Hz Double amplitude 1.5 mm 0.06" in the X, Y, Z axis directions respectively, 2 hours	
Material			Case and dust cover: Polycarbonate, Button: Polyacetal, Display panel: Acrylic	
Weight			Approx. 70 g	

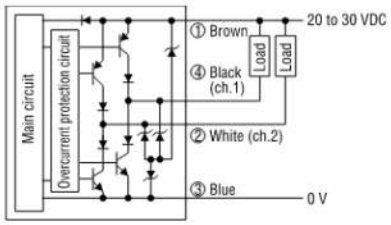
*1 When including the loads, please add 100 mA to this value.
*2 When including the loads, please add 40 mA to this value.
*3 20 mA/ch. or less when an expansion unit is connected.

When using the sensor without the controller

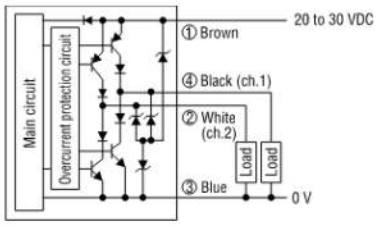


When "Control Output" is selected for ch.2*

When NPN is selected

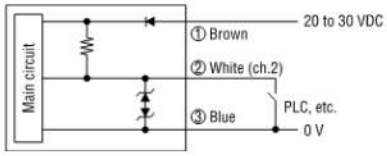


When PNP is selected

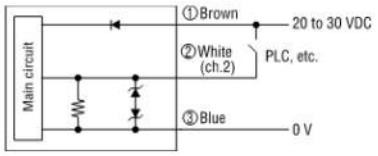


When "External Input" is selected for ch.2*

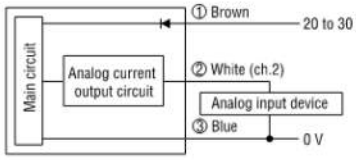
When NPN is selected



When PNP is selected



When "Analog Output" is selected for ch.2*

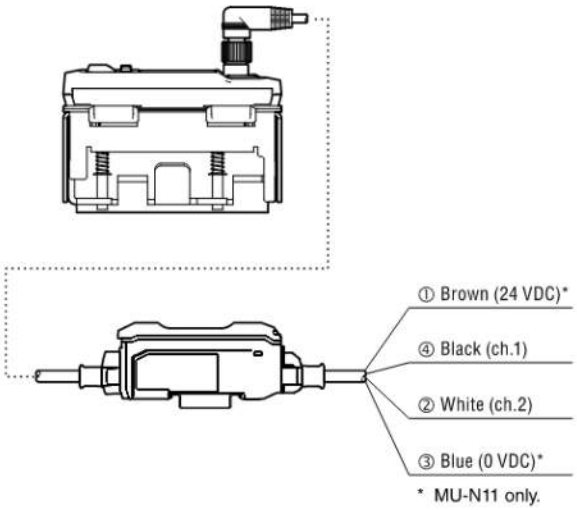


M12 Connector pin layout



*When "OFF" is selected for ch.2 (default), ② White will not be used.

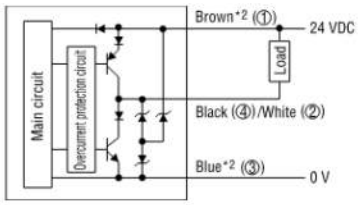
When using the sensor with the controller



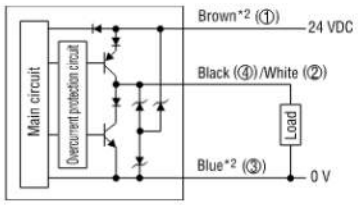
* MU-N11 only.

When "Control Output" is selected for ch.2*1

When NPN is selected

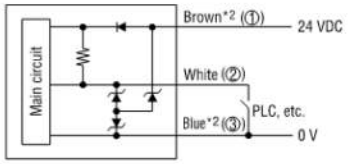


When PNP is selected

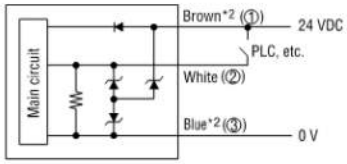


When "External Input" is selected for ch.2*1

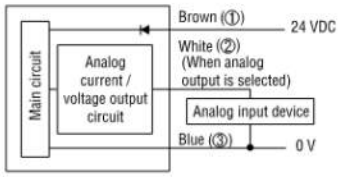
When NPN is selected



When PNP is selected



When "Analog Output" is selected for ch.2*1*2



Pin layout when the M12 connector (4-pin) cable is used



DATA SHEET
PVC Ball Valve
ASAHI USA #Type21-True Union



Type-21/21A Ball Valve

Specifications

Sizes: 1/2" – 6"
Models: PVC & CPVC: Socket, Threaded and Flanged (ANSI)
PP & PVDF: IPS and Metric (DIN) Socket, Threaded, Butt and Flanged (ANSI)
Bodies: PVC, CPVC, PP and PVDF
Seats: PTFE backed with EPDM or FKM
Seals: EPDM or FKM or AFLAS®‡

Sizes 1/2" - 4" PVC/EPDM/FKM Models
1/2"- 4" CPVC/EPDM/FKM Models
NSF-61 Certified

‡ Trademark of Asahi Glass Co., Ltd.

Standard Features (Sizes 1/2" – 6")

- Pressure rated up to 230psi (PVC, CPVC, PVDF)
- Double O-ring seals on stem for added protection
- Full bore, sizes 1/2" – 2"
- Full vacuum rated, all sizes
- Blocks in two directions, upstream and downstream, leaving full pressure on the opposite end of the valve
- Integrally molded ISO mounting pad for both manual and actuated operations
- Integrally molded base pad to mount valves securely or panel mounting
- PTFE seats with elastomeric backing cushions ensure bubble tight shut-off and a low fixed torque, while at the same time compensating for wear
- True union design for easier installation or repairs without expanding the pipe system
- Built-in spanner wrench on the handle for valve disassembly and assembly
- Two sets of end connectors (socket and threaded) included with all PVC and CPVC valves in sizes 1/2"– 2"
- CPVC threaded end connectors on sizes 1/2" – 1" come with stainless steel reinforcing rings
- New PTFE seat design – Facilitates easier field maintenance if required
- Tapered O-ring groove – Helps to keep the end connector O-rings on the valve body during installation
- Body flats – Flats have been added to either side of the valve body where a wrench can be applied to prevent the valve body from turning when the union nuts are tightened
- 1/2 - 2 " PVC and CPVC T-21A design

Options

- Pneumatic and electric actuators and accessories
- Stem extensions
- 2" square operating nut or "T" nut
- Locking handles
- Limit switches
- Vented ball

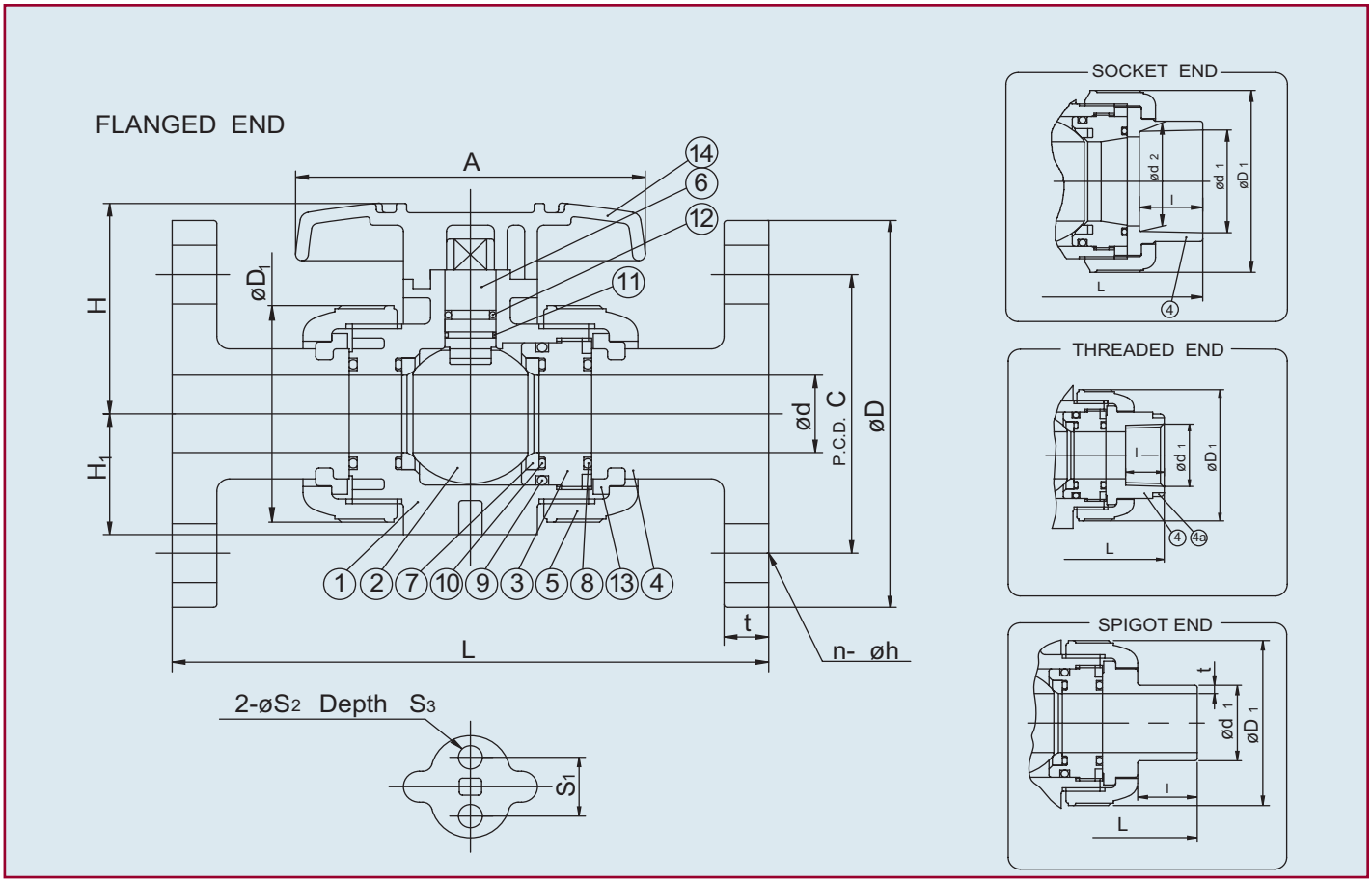
Parts List (Sizes 1/2" – 2")

PARTS			
NO.	DESCRIPTION	PCS.	MATERIAL
1	Body	1	PVC, CPVC, PP, PVDF
2	Ball	1	PVC, CPVC, PP, PVDF
3	Carrier	1	PVC, CPVC, PP, PVDF
4	End Connector	2	PVC, CPVC, PP, PVDF
5	Union Nut	2	PVC, CPVC, PP, PVDF
6	Stem	1	PVC, CPVC, PP, PVDF
7	Seat	2	PTFE
8	O-Ring (A)	2	EPDM FKM Others
9	O-Ring (B)	1	EPDM FKM Others
10	O-Ring (C)	2	EPDM FKM Others
11	O-Ring (D)	1	EPDM FKM Others
12	O-Ring (E)	1	EPDM FKM Others
13	Stop Ring*	2	PVDF
14	Handle	1	ABS
4a	Ring**	2	304 Stainless Steel

* Used for flanged end.
** Used for CPVC body, threaded end, 1/2"–1".



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Dimensions (Sizes 1/2" – 2") (in.)

NOMINAL SIZE			FLANGED						SOCKET										
			ANSI CLASS 150						PVC, CPVC				PP, PVDF (DIN)				PP, PVDF (IPS)		
									ASTM SCH 80				DIN 16962						
INCHES	mm	d	D	C	n	h	L	t	d1	d2	l	L	d1	d2	l	L	d1	l	L
1/2	15	0.59	3.50	2.38	4	0.62	5.63	0.47	0.848	0.836	0.875	4.45	0.768	0.760	0.57	3.90	0.83	0.87	4.45
3/4	20	0.79	3.88	2.75	4	0.62	6.77	0.55	1.058	1.046	1.000	5.08	0.965	0.957	0.63	4.45	1.03	1.00	5.08
1	25	0.98	4.25	3.12	4	0.62	7.36	0.55	1.325	1.310	1.125	5.75	1.240	1.232	0.71	4.84	1.30	1.13	5.75
1-1/4	32	1.26	4.62	3.50	4	0.62	7.48	0.63	1.670	1.655	1.250	6.46	1.553	1.543	0.81	5.47	1.65	1.25	6.46
1-1/2	40	1.57	5.00	3.88	4	0.62	8.35	0.63	1.912	1.894	1.375	7.24	1.947	1.937	0.93	5.87	1.89	1.37	7.24
2	50	2.01	6.00	4.75	4	0.75	9.21	0.63	2.387	2.369	1.500	8.23	2.461	2.445	1.08	6.93	2.36	1.50	8.23

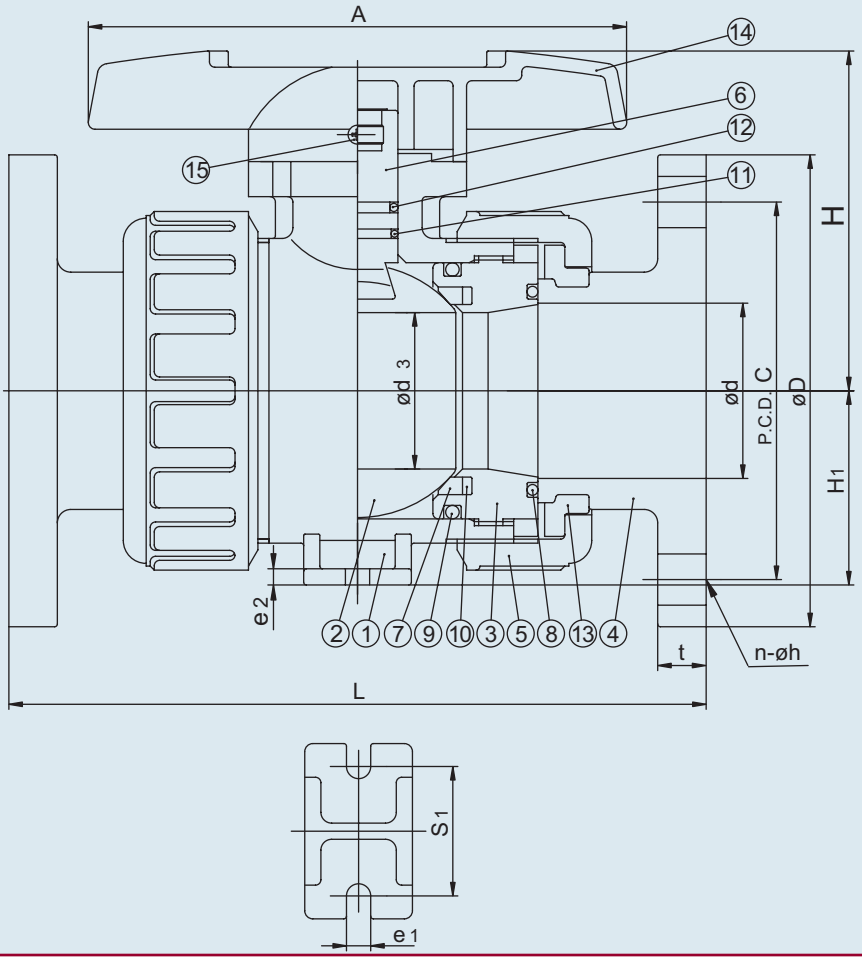
NOMINAL SIZE		THREADED			SPIGOT (BUTT END)											
					PP,PVDF											
					DIN 3442		PP	PVDF								
INCHES	mm	d1	l	L	d1	l	t	t	L	D1	H	H1	A	S1	S2	S3
1/2	15	1/2 - 14 NPT	0.59	4.02	0.787	0.728	0.098	0.075	4.882	1.89	2.03	1.14	3.62	0.75	0.29	0.43
3/4	20	3/4 - 14 NPT	0.67	4.72	0.984	0.866	0.106	0.075	5.669	2.36	2.34	1.38	3.94	0.75	0.29	0.43
1	25	1 - 11-1/2 NPT	0.79	5.16	1.260	0.886	0.118	0.094	6.063	2.76	2.68	1.54	4.33	0.75	0.29	0.43
1-1/4	32	1-1/4 - 11-1/2 NPT	0.87	5.91	1.575	1.024	0.146	0.094	6.850	3.23	3.17	1.85	4.76	1.18	0.35	0.59
1-1/2	40	1-1/2 - 11-1/2 NPT	0.98	6.42	1.968	1.260	0.181	0.118	7.638	3.94	3.50	2.17	5.16	1.18	0.35	0.59
2	50	2 - 11-1/2 NPT	1.10	7.76	2.480	1.417	0.228	0.118	8.819	4.96	4.04	2.60	6.26	1.18	0.35	0.59

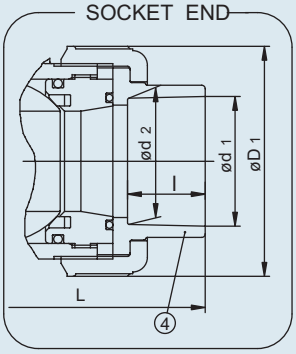
Note: The shape and appearance of assembly differ a little with nominal size compared to this drawing.

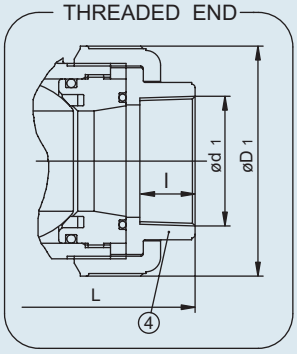
FLANGED END

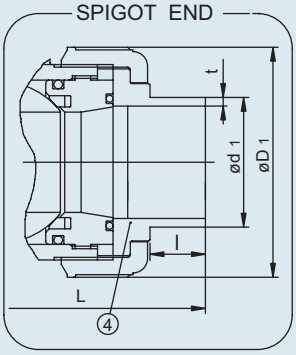
PARTS (Different Numbers from 1/2"-2")			
NO.	Description	PCS	MATERIAL
10	Cushion	2	EPDM, FKM, Others
15	Screw	1	304 Stainless Steel

NOTE: Quantity on Nos. 3 and 9 (see p. 6) is 2.









Dimensions (Sizes 2-1/2" – 4") (in.) For 6" size consult factory.

NOMINAL SIZE			FLANGED									SOCKET												
			ANSI CLASS 150									PVC, CPVC				PP, PVDF (DIN)					PP, PVDF (IPS)			
							L					ASTM SCH 80				DIN 16962			PP	PVDF			PP	PVDF
INCHES	mm	d	D	C	n	h	PVC CPVC	PP	PVDF	t	d1	d2	l	L	d1	d2	l	L	L	d1	l	L	L
2-1/2	65	2.56	7.0	5.5	4	0.75	10.20	10.12	10.08	0.71	2.889	2.868	1.750	9.45	2.923	2.911	1.22	8.07	8.03	2.88	1.752	9.37	9.33
3	80	3.07	7.5	6.0	4	0.75	12.05	12.07	11.89	0.71	3.516	3.492	1.875	11.14	3.512	3.498	1.40	9.92	9.80	3.48	1.874	11.10	10.28
4	100	3.94	9.0	7.5	8	0.75	14.72	14.72	14.53	0.71	4.518	4.491	2.000	13.89	4.293	4.278	1.63	12.28	12.09	4.48	2.252	14.37	14.13

NOMINAL SIZE		THREADED					SPIGOT (BUTT END)														
				L			PP,PVDF														
				PVC CPVC	PP	PVDF	DIN 3442		PP	PVDF	PP	PVDF									
INCHES	mm	d1	l				d1	l	t	t	L	L	d3	D1	H	H1	A	e1	e2	S1
2-1/2	65	2-1/2 - 8NPT	1.26	8.46	8.39	8.35	2.953	1.496	0.272	0.142	9.648	9.606	2.28	5,24	4.96	2.83	7.87	0.35	0.24	1.89
3	80	3 - 8NPT	1.38	10.43	10.39	10.28	3.543	1.496	0.323	0.169	11.654	11.535	2.70	5.98	5.51	3.35	9.45	0.43	0.28	2.17
4	100	4 - 8NPT	1.77	14.25	14.25	14.06	4.331	1.752	0.394	0.209	13.978	13.779	3.54	8.27	7.01	4.33	11.81	0.43	0.31	2.56

Note: The shape and appearance of assembly differ a little with nominal size compared to this drawing.

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Pressure vs. Temperature (psi, water, non-shock)

NOMINAL SIZE		PVC				CPVC						PP				PVDF				
INCHES	mm	30° F 70° F	71° F 105° F	106° F 120° F	121° F 140° F	30° F 70° F	71° F 105° F	106° F 120° F	121° F 140° F	141° F 175° F	176° F 195° F	- 5° F 85° F	86° F 120° F	121° F 140° F	141° F 175° F	- 5° F 70° F	71° F 105° F	106° F 140° F	141° F 175° F	176° F 210° F
1/2-2	15-50	230	170	150	30	230	170	150	120	75	55	150	110	90	55	230	185	150	115	85
2-1/2	65	230	170	150	NA	230	170	150	120	75	55	150	95	70	40	230	185	150	115	85
3	80	230	170	150	NA	230	170	150	85	55	40	150	95	70	40	230	185	150	100	70
4-6	100-150	150	150	150	NA	150	150	150	85	55	40	150	95	70	40	150	150	150	100	70

Sample Specification

All Type-21/21A ball valves, sizes 1/2" to 4", shall be of true union design with two-way blocking capability. All O-rings shall be EPDM or FKM with PTFE seats. PTFE seats shall have elastomeric backing cushion of the same material as the valve seals. Stem shall have double O-rings and be of blowout-proof design. The valve handle shall double as carrier removal and/or tightening tool. ISO mounting pad shall be integrally molded to valve body for actuation. PVC conforming to ASTM D1784 Cell Classification 12454A, CPVC conforming to ASTM D1784 Cell Classification 23567-A, PP conforming to ASTM D4101 Cell Classification PP0210B67272 and PVDF conforming to ASTM D3222 Cell Classification Type II. The ball valves, except PP, shall have a pressure rating of 230psi for sizes 1/2" to 3" and 150psi for 4" (150psi for PP, all sizes) at 70º F. Type-21/21A ball valves must carry a two year guarantee, as manufactured by Asahi/America, Inc.

Cv Values

NOMINAL SIZE		Cv
INCHES	mm	
1/2	15	14
3/4	20	29
1	25	47
1-1/4	32	72
1-1/2	40	155
2	50	190
2-1/2	65	365
3	80	410
4	100	680

Weight (lbs.)

NOMINAL SIZE		SOCKET	FLANGED
INCHES	mm	THREADED	
1/2	15	0.44	1.10
3/4	20	0.66	1.54
1	25	1.1	2.70
1-1/4	32	1.54	3.30
1-1/2	40	2.64	4.40
2	50	4.4	8.15
2-1/2	65	6.17	8.80
3	80	9.7	13.00
4	100	24.00	26.67

Caution

- Never remove valve from pipeline under pressure.
- Always wear protective gloves and goggles.
- Watch out for trapped fluid in valve. It is safe to close valve before removing it from the pipeline.

Caution

- Do not use ball valves where media has suspended particles. Use the following valves:
  - Butterfly valves – PVDF disc is most abrasion resistant. Make sure of chemical compatibility.
  - Diaphragm valves – Elastomeric diaphragm is designed for handling suspended particles.
- Volatile fluids such as sodium hypochlorite (NaClO) and hydrogen peroxide (H_2O_2) could be trapped and gasified within the valve. We can provide you with a Type-21 ball valve with a vented ball to relieve pressure build-up inside the valve.

Troubleshooting

What if the fluid still flows when valve is closed?

1. Carrier is not properly tightened. Tighten it.
2. PTFE seat is damaged or worn. Replace seat.
3. Foreign material is caught between ball and PTFE seat. Remove material and clean.
4. Ball is damaged or worn. Change ball.

What if fluid leaks outside of valve?

1. Union nut not properly tightened. Retighten.
2. Carrier is not properly tightened. Thread it in firmly.
3. Carrier or face O-ring is damaged, worn, or missing. Replace O-ring.

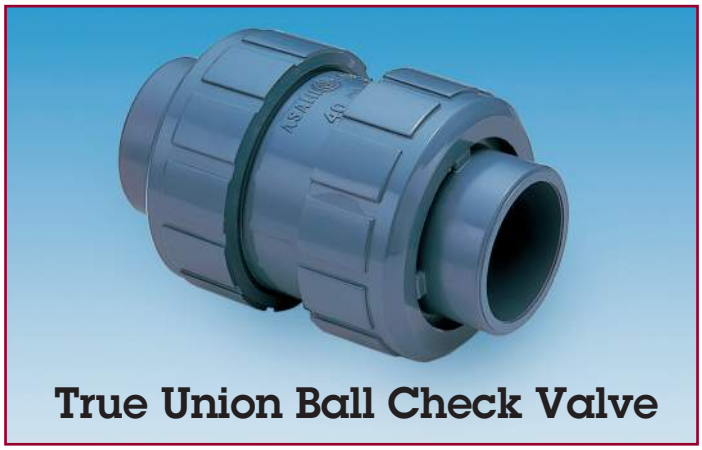
What if handle does not rotate smoothly?

1. Foreign material has formed on the ball or seat. Clean both.
2. Internal part(s) chemically attacked or swollen. Refer to Asahi/America Chemical Resistance Chart for compatibility. Replace part(s) as required.
3. Carrier overtightened. Retighten properly.

What if handle rotates too freely?

1. Stem is damaged. Replace stem.
2. Handle is not engaged with stem. Disassemble and reengage. Inspect.
3. Engaging part of stem and/or ball is damaged. Change stem and/or ball.

DATA SHEET
PVC Ball Check Valve
ASAHI USA #True Union



True Union Ball Check Valve

Specifications

Sizes: True Union : 1 /2" – 2"
Single Union: 3" – 4"
Models: Socket, Threaded, Flanged (ANSI), Butt End
Bodies: PVC, CPVC, PP and PVDF
Seats: EPDM, FKM, PTFE
Seals: EPDM, FKM, PTFE
Option: Foot Valve

Sizes 1/2" - 4" PVC/EPDM/FKM Models
1/2" - 4" CPVC/EPDM/FKM Models
NSF-61 Certified

Standard Features (Sizes 1/2" - 2")

- Uniseat/seal of EPDM or FKM
- Ball is the only moving part. It unseats to permit flow in one direction but seals against seat to prevent back flow
- May be used vertically or horizontally
- Minimum shut-off of 5psi
- All sizes rated for full vacuum service
- Solid thermoplastic ball

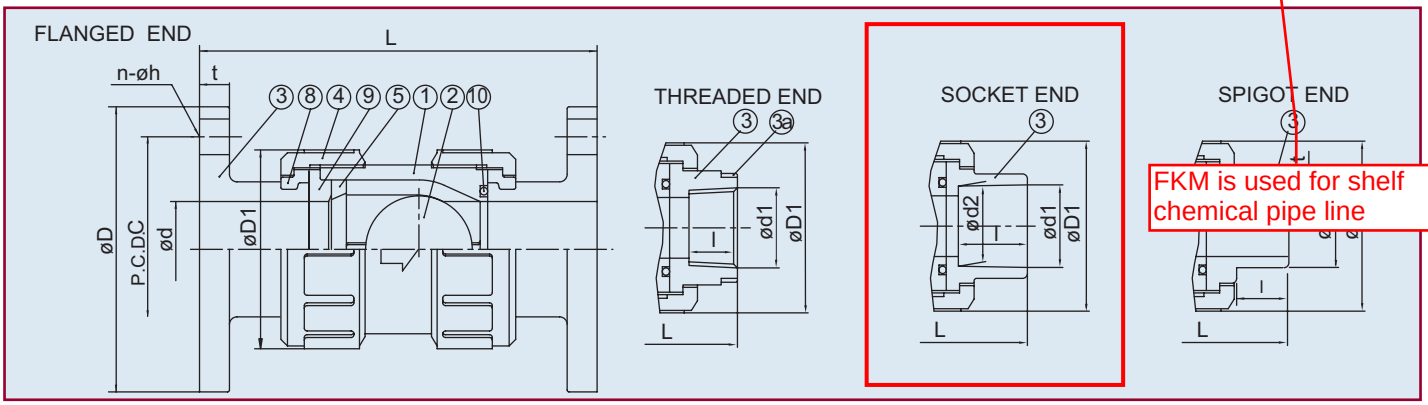
Options:

- PTFE coated FKM uniseat/seal
- Spring-loaded ball to assist ball in seating faster

Parts List – True Union (Sizes 1/2" - 2")

PARTS			
NO.	DESCRIPTION	PCS.	MATERIAL
1	Body	1	PVC, CPVC, PP, PVDF
2	Ball	1	PVC, CPVC, PP, PVDF
3	End Connector	2	PVC, CPVC, PP, PVDF
4	Union Nut	2	PVC, CPVC, PP, PVDF
5	Stop Ring (A)	1	PVC, CPVC, PP, PVDF
8	Stop Ring (B)*	1	PVDF
9	Seat	1	EPDM, FKM, PTFE
10	O-Ring	1	EPDM, FKM, PTFE
3a	Ring**	1	Stainless Steel 304

* Used for flanged end.
** Used for CPVC body, threaded end; 1/2" - 1".



Dimensions (Sizes 1/2" – 2") (in.)

NOMINAL SIZE		FLANGED						THREADED			SOCKET												SPIGOT (BUTT END)				
		ANSI CLASS 150									PVC, CPVC				PP, PVDF (DIN)				PP, PVDF (IPS)				PP, PVDF			
											ASTM SCH 80				DIN 16962								DIN 3442	PP	PVDF	
INCHES	mm	D	C	n	h	l	t	d1	l	l	d	D1	d1	d2	l	l	d1	d2	l	l	d1	l	l	d1	l	t	t	l
1/2	15	3.50	2.38	4	0.62	5.12	0.47	1/2 - 14NPT	0.59	3.39	0.59	1.89	0.848	0.836	0.688	3.43	0.768	0.760	0.57	3.19	0.83	0.87	3.31	0.787	0.728	0.098	0.075	4.00
3/4	20	3.88	2.75	4	0.62	6.10	0.55	3/4 - 14NPT	0.67	4.06	0.79	2.36	1.058	1.046	0.719	3.86	0.965	0.957	0.63	3.70	1.03	1.00	4.43	0.984	0.866	0.106	0.075	4.35
1	25	4.25	3.12	4	0.62	6.50	0.55	1 - 11-1/2NPT	0.79	4.45	0.98	2.76	1.325	1.310	0.875	4.37	1.240	1.232	0.71	4.13	1.30	1.13	4.35	1.260	0.866	0.118	0.094	4.75
1-1/4	32	-	-	-	-	-	-	1-1/4 - 11-1/2NPT	0.87	5.00	1.22	3.78	1.670	1.655	0.938	4.92	-	-	-	-	-	-	-	-	-	-	-	-
1-1/2	40	5.00	3.88	4	0.62	7.56	0.63	1-1/2 - 11-1/2NPT	0.98	5.94	1.57	3.78	1.912	1.894	1.094	5.94	1.947	1.937	0.93	5.62	1.89	1.37	5.57	1.969	1.260	0.181	0.118	5.75
2	50	6.00	4.75	4	0.75	8.43	0.63	2 - 11-1/2NPT	1.10	6.97	2.01	4.17	2.387	2.369	1.156	6.77	2.461	2.445	1.08	6.69	2.36	1.50	6.49	2.480	1.417	0.228	0.118	6.50

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DATA SHEET
CIP Flow Meter
E+H #Promag W 400, 5W4C25, DN25 1"
5W4C25-C6DLHP1DQA12GN+AABAJA

TI01046D/06/EN/10.21
71535814
2021-09-01

Technical Information
Proline Promag W 400

Electromagnetic flowmeter



Versatile standard flowmeter for the water and wastewater industry

Application

- The bidirectional measuring principle is virtually independent of pressure, density, temperature and viscosity
- Ideal for water measurement, e.g. drinking water, utility water and industrial/municipal wastewater

Device properties
- International drinking water approvals
- Degree of protection IP68 (Type 6P enclosure)
- Approved for custody transfer to MI-001/OIML R49
- Transmitter housing made of durable polycarbonate or aluminum
- WLAN access
- Integrated data logger: measured values monitoring

Your benefits

- Reliable measurement at constant accuracy with 0 x DN run without pressure loss
- Flexible engineering – sensors with fixed flanges or lap joint flanges
- Application suitability – corrosion protection according to EN ISO 12944 for buried or underwater installations
- Improved plant availability – sensor compliant with industry-specific requirements
- Safe operation – no need to open device
- Time-saving local operation without additional software and hardware – integrated web server
- Built-in verification and build-up detection – Heartbeat Technology

Endress+Hauser
People for Process Automation

Configuration summary

Mat. no.	Description Order code	Quantity	Unit
	25 25 1"		
71215557	Promag W 400, 5W4C80, DN80 3" 5W4C80-C6DLHP1DQA12GN+AABAJA 25	1	ST

010	Approval:	C6	CSA C/US NI Cl.I Div.2 Gr. ABCD
011	Design:	D	Lap joint flange
015	Power Supply:	L	AC 100...240V, AC/DC 24V
020	Output; Input:	H	4-20mA HART, pulse/freq., switch output
040	Housing:	P	Remote, alu, coated
045	Cable, Remote Version:	1	5m/15ft coil and signal cable
050	Electrical Connection:	D	Thread NPT1/2
060	Liner:	Q	PTFE 90oC
070	Process Connection:	A12	Cl.150, carbon steel, lap joint flange ASME B16.5
075	Electrodes:	G	1.4435/316L, bullet nose
080	Flow Calibration:	N	0.2%, 3-point
500	>Operation Language Display:	AA	English
505	>Display; Operation:	BA	WLAN
580	>>Test, Certificate:	JA	Inspection certificate 3.1, EN10204 (material certificate meas. tube+flange)

2 grounding rings are provided for each magmeter

Changed to Remote from Compact style to place transmitter for operator's convenient just in case

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About this document

Symbols

Electrical symbols

Symbol	Meaning
⎓	Direct current
~	Alternating current
⎓~	Direct current and alternating current
⏚	**Ground connection** A grounded terminal which, as far as the operator is concerned, is grounded via a grounding system.
⊜	**Protective Earth (PE)** A terminal which must be connected to ground prior to establishing any other connections. The ground terminals are situated inside and outside the device: ▪ Inner ground terminal: Connects the protectiv earth to the mains supply. ▪ Outer ground terminal: Connects the device to the plant grounding system.

Communication symbols

Symbol	Meaning
	Wireless Local Area Network (WLAN) Communication via a wireless, local network.
	Bluetooth Wireless data transmission between devices over a short distance.
	LED Light emitting diode is off.
	LED Light emitting diode is on.
	LED Light emitting diode is flashing.

Symbols for certain types of information

Symbol	Meaning
	Permitted Procedures, processes or actions that are permitted.
	Preferred Procedures, processes or actions that are preferred.
	Forbidden Procedures, processes or actions that are forbidden.
	Tip Indicates additional information.
	Reference to documentation
	Reference to page
	Reference to graphic
	Visual inspection

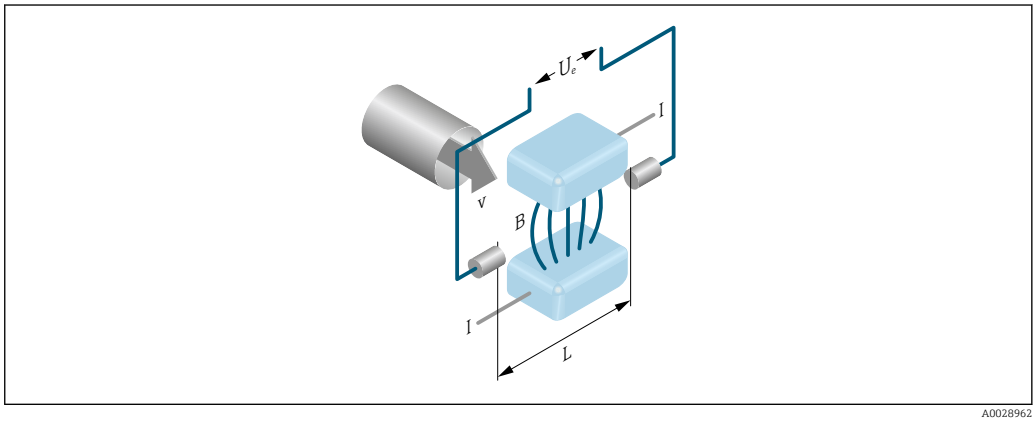
Symbols in graphics

Symbol	Meaning
1, 2, 3, ...	Item numbers
1., 2., 3., ...	Series of steps
A, B, C, ...	Views
A-A, B-B, C-C, ...	Sections
	Hazardous area
	Safe area (non-hazardous area)
	Flow direction

Function and system design

Measuring principle

Following *Faraday's law of magnetic induction*, a voltage is induced in a conductor moving through a magnetic field.



A0028962

Ue Induced voltage
B Magnetic induction (magnetic field)
L Electrode spacing
I Current
v Flow velocity

In the electromagnetic measuring principle, the flowing medium is the moving conductor. The voltage induced (U_e) is proportional to the flow velocity (v) and is supplied to the amplifier by means of two measuring electrodes. The flow volume (Q) is calculated via the pipe cross-section (A). The DC magnetic field is created through a switched direct current of alternating polarity.

Formulae for calculation

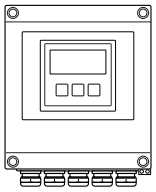
- Induced voltage $U_e = B \cdot L \cdot v$
- Volume flow $Q = A \cdot v$

Measuring system

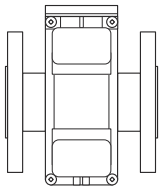
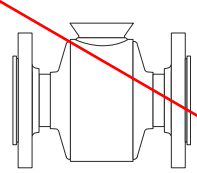
The device consists of a transmitter and a sensor.

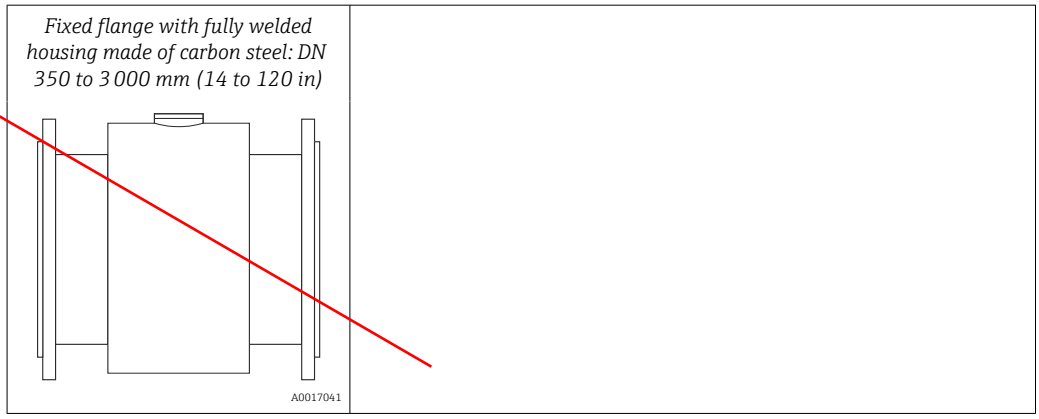
Two device versions are available:
- Compact version - transmitter and sensor form a mechanical unit.
- Remote version - transmitter and sensor are mounted in separate locations.

Transmitter

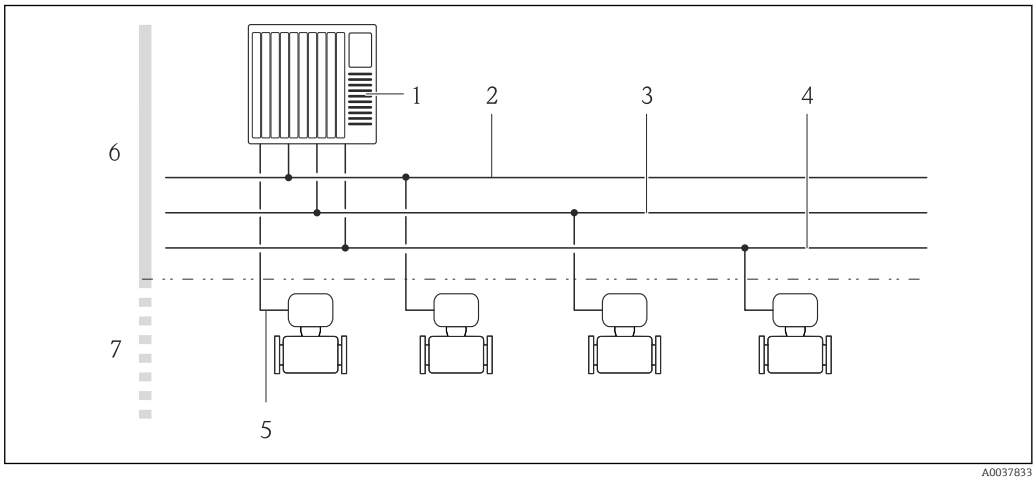
Proline 400

A0045222
	Device versions and materials:
	- Compact version: compact housing
	  - Polycarbonate plastic
	  - Aluminum, AlSi10Mg, coated
	- Remote version: wall-mount housing
	  - Polycarbonate plastic
	  - Aluminum, AlSi10Mg, coated
	Configuration:
	- External operation via four-line, illuminated local display with touch control and guided menus ("Make-it-run" wizards) for applications
	- Via operating tools (e.g. FieldCare)
	- Via Web browser (e.g. Microsoft Internet Explorer)
	- Also for device version with EtherNet/IP output:
	  - Via Add-on Profile Level 3 for automation system from Rockwell Automation
	  - Via Electronic Data Sheet (EDS)
	- Also for device version with PROFIBUS DP output:
	Via PDM driver for Siemens automation system

Sensor

Promag W *Lap joint flange, lap joint flange, stamped plate or fixed flange with aluminum half-shell housing: DN 25 to 300 mm (1 to 12 in)*  A0017040	- Nominal diameter range: DN 25 to 3 000 mm (1 to 120 in) - Materials → 91
Fixed flange with fully welded housing made of carbon steel: DN 25 to 300 mm (1 to 12 in)  A0022673	



Equipment architecture



1 *Possibilities for integrating measuring devices into a system*

1 *Control system (e.g. PLC)*
2 *EtherNet/IP*
3 *PROFIBUS DP*
4 *Modbus RS485*
5 *4 to 20 mA HART, pulse/frequency/switch output*
6 *Non-hazardous area*
7 *Non-hazardous area and Zone 2/Div. 2*

Safety

IT security

Our warranty is valid only if the device is installed and used as described in the Operating Instructions. The device is equipped with security mechanisms to protect it against any inadvertent changes to the settings.

IT security measures, which provide additional protection for the device and associated data transfer, must be implemented by the operators themselves in line with their security standards.

Device-specific IT security

The device offers a range of specific functions to support protective measures on the operator's side. These functions can be configured by the user and guarantee greater in-operation safety if used correctly. An overview of the most important functions is provided in the following section.

Protecting access via a password

Different passwords are available to protect write access to the device parameters or access to the device via the WLAN interface.

- User-specific access code
  Protect write access to the device parameters via the local display, Web browser or operating tool (e.g. FieldCare, DeviceCare). Access authorization is clearly regulated through the use of a user-specific access code.
- WLAN passphrase
  The network key protects a connection between an operating unit (e.g. notebook or tablet) and the device via the WLAN interface which can be ordered as an option.

User-specific access code

Write access to the device parameters via the local display or operating tool (e.g. FieldCare, DeviceCare) can be protected by the modifiable, user-specific access code.

WLAN passphrase: Operation as WLAN access point

A connection between an operating unit (e.g. notebook or tablet) and the device via the WLAN interface, which can be ordered as an optional extra, is protected by the network key. The WLAN authentication of the network key complies with the IEEE 802.11 standard.

When the device is delivered, the network key is pre-defined depending on the device. It can be changed via the **WLAN settings** submenu in the **WLAN passphrase** parameter.

General notes on the use of passwords

- The access code and network key supplied with the device should be changed during commissioning.
- Follow the general rules for generating a secure password when defining and managing the access code or network key.
- The user is responsible for the management and careful handling of the access code and network key.

Access via Web server

The device can be operated and configured via a Web browser with the integrated Web server. The connection is via the service interface (CDI-RJ45) or the WLAN interface. For device versions with the EtherNet/IP and PROFINET communication protocols, the connection can also be established via the terminal connection for signal transmission with EtherNet/IP or PROFINET (RJ45 plug).

The Web server is enabled when the device is delivered. The Web server can be disabled if necessary (e.g. after commissioning) via the **Web server functionality** parameter.

The device and status information can be hidden on the login page. This prevents unauthorized access to the information.

For detailed information on device parameters, see:
The "Description of Device Parameters" document → 106

Input

Measured variable

Direct measured variables

- Volume flow (proportional to induced voltage)
- Electrical conductivity

In custody transfer: only volume flow

Calculated measured variables

Mass flow

Measuring range

Typically v = 0.01 to 10 m/s (0.03 to 33 ft/s) with the specified accuracy

Electrical conductivity: ≥ 5 µS/cm for liquids in general

Flow characteristic values in SI units: DN 25 to 125 mm (1 to 4 in)

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.3...10 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 2 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.04 m/s)
[mm]	[in]	[dm³/min]	[dm³/min]	[dm³]	[dm³/min]
25	1	9 to 300	75	0.5	1
32	–	15 to 500	125	1	2

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.3...10 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 2 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.04 m/s)
[mm]	[in]	[dm³/min]	[dm³/min]	[dm³]	[dm³/min]
40	1 ½	25 to 700	200	1.5	3
50	2	35 to 1 100	300	2.5	5
65	–	60 to 2 000	500	5	8
80	3	90 to 3 000	750	5	12
100	4	145 to 4 700	1 200	10	20
125	–	220 to 7 500	1 850	15	30

Flow characteristic values in SI units: DN 150 to 3 000 mm (6 to 120 in)

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.3...10 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 2 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.04 m/s)
[mm]	[in]	[m³/h]	[m³/h]	[m³]	[m³/h]
150	6	20 to 600	150	0.025	2.5
200	8	35 to 1 100	300	0.05	5
250	10	55 to 1 700	500	0.05	7.5
300	12	80 to 2 400	750	0.1	10
350	14	110 to 3 300	1 000	0.1	15
375	15	140 to 4 200	1 200	0.15	20
400	16	140 to 4 200	1 200	0.15	20
450	18	180 to 5 400	1 500	0.25	25
500	20	220 to 6 600	2 000	0.25	30
600	24	310 to 9 600	2 500	0.3	40
700	28	420 to 13 500	3 500	0.5	50
750	30	480 to 15 000	4 000	0.5	60
800	32	550 to 18 000	4 500	0.75	75
900	36	690 to 22 500	6 000	0.75	100
1000	40	850 to 28 000	7 000	1	125
–	42	950 to 30 000	8 000	1	125
1200	48	1 250 to 40 000	10 000	1.5	150
–	54	1 550 to 50 000	13 000	1.5	200
1400	–	1 700 to 55 000	14 000	2	225
–	60	1 950 to 60 000	16 000	2	250
1600	–	2 200 to 70 000	18 000	2.5	300
–	66	2 500 to 80 000	20 500	2.5	325
1800	72	2 800 to 90 000	23 000	3	350
–	78	3 300 to 100 000	28 500	3.5	450
2000	–	3 400 to 110 000	28 500	3.5	450

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.3...10 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 2 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.04 m/s)
[mm]	[in]	[m³/h]	[m³/h]	[m³]	[m³/h]
–	84	3700 to 125000	31000	4.5	500
2200	–	4100 to 136000	34000	4.5	540
–	90	4300 to 143000	36000	5	570
2400	–	4800 to 162000	40000	5.5	650
–	96	5000 to 168000	42000	6	675
–	102	5700 to 190000	47500	7	750
2600	–	5700 to 191000	48000	7	775
–	108	6500 to 210000	55000	7	850
2800	–	6700 to 222000	55500	8	875
–	114	7100 to 237000	59500	8	950
3000	–	7600 to 254000	63500	9	1025
–	120	7900 to 263000	65500	9	1050

Flow characteristic values in SI units: DN 50 to 200 mm (2 to 8 in) for order code for "Design", option C "Fixed flange, constricted measuring tube, 0 x DN inlet/outlet runs"

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.12...5 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 4 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.01 m/s)
[mm]	[in]	[dm³/min]	[dm³/min]	[dm³]	[dm³/min]
50	2	15 to 600	300	1.25	1.25
65	–	25 to 1000	500	2	2
80	3	35 to 1500	750	3	3.25
100	4	60 to 2400	1200	5	4.75
125	–	90 to 3700	1850	8	7.5
150	6	145 to 5400	2500	10	11
200	8	220 to 9400	5000	20	19

Flow characteristic values in SI units: DN 250 to 300 mm (10 to 12 in) for order code for "Design", option C "Fixed flange, constricted measuring tube, 0 x DN inlet/outlet runs"

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.12...5 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 4 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.01 m/s)
[mm]	[in]	[m³/h]	[m³/h]	[m³]	[m³/h]
250	10	20 to 850	500	0.03	1.75
300	12	35 to 1300	750	0.05	2.75

Flow characteristic values in US units: DN 1 to 48 in (25 to 1200 mm)

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.3...10 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 2 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.04 m/s)
[in]	[mm]	[gal/min]	[gal/min]	[gal]	[gal/min]
1	25	2.5 to 80	18	0.2	0.25
–	32	4 to 130	30	0.2	0.5
1 ½	40	7 to 185	50	0.5	0.75
2	50	10 to 300	75	0.5	1.25
–	65	16 to 500	130	1	2
3	80	24 to 800	200	2	2.5
4	100	40 to 1250	300	2	4
–	125	60 to 1950	450	5	7
6	150	90 to 2650	600	5	12
8	200	155 to 4850	1200	10	15
10	250	250 to 7500	1500	15	30
12	300	350 to 10600	2400	25	45
14	350	500 to 15000	3600	30	60
15	375	600 to 19000	4800	50	60
16	400	600 to 19000	4800	50	60
18	450	800 to 24000	6000	50	90
20	500	1000 to 30000	7500	75	120
24	600	1400 to 44000	10500	100	180
28	700	1900 to 60000	13500	125	210
30	750	2150 to 67000	16500	150	270
32	800	2450 to 80000	19500	200	300
36	900	3100 to 100000	24000	225	360
40	1000	3800 to 125000	30000	250	480
42	–	4200 to 135000	33000	250	600
48	1200	5500 to 175000	42000	400	600

Flow characteristic values in US units: DN 54 to 120 in (1400 to 3000 mm)

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.3...10 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 2 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.04 m/s)
[in]	[mm]	[Mgal/d]	[Mgal/d]	[Mgal]	[Mgal/d]
54	–	9 to 300	75	0.0005	1.3
–	1400	10 to 340	85	0.0005	1.3
60	–	12 to 380	95	0.0005	1.3
–	1600	13 to 450	110	0.0008	1.7
66	–	14 to 500	120	0.0008	2.2
72	1800	16 to 570	140	0.0008	2.6

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.3...10 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 2 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.04 m/s)
[in]	[mm]	[Mgal/d]	[Mgal/d]	[Mgal]	[Mgal/d]
78	–	18 to 650	175	0.0010	3.0
–	2000	20 to 700	175	0.0010	2.9
84	–	24 to 800	190	0.0011	3.2
–	2200	26 to 870	210	0.0012	3.4
90	–	27 to 910	220	0.0013	3.6
–	2400	31 to 1030	245	0.0014	4.0
96	–	32 to 1066	265	0.0015	4.0
102	–	34 to 1203	300	0.0017	5.0
–	2600	34 to 1212	305	0.0018	5.0
108	–	35 to 1300	340	0.0020	5.0
–	2800	42 to 1405	350	0.0020	6.0
114	–	45 to 1503	375	0.0022	6.0
–	3000	48 to 1613	405	0.0023	6.0
120	–	50 to 1665	415	0.0024	7.0

Flow characteristic values in US units: DN 2 to 12 in (50 to 300 mm) for order code for "Design", option C "Fixed flange, constricted measuring tube, 0 x DN inlet/outlet runs"

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.12...5 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 4 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.01 m/s)
[in]	[mm]	[gal/min]	[gal/min]	[gal]	[gal/min]
2	50	4 to 160	75	0.3	0.35
–	65	7 to 260	130	0.5	0.6
3	80	10 to 400	200	0.8	0.8
4	100	16 to 650	300	1.2	1.25
–	125	24 to 1000	450	1.8	2
6	150	40 to 1400	600	2.5	3
8	200	60 to 2500	1200	5	5
10	250	90 to 3700	1500	6	8
12	300	155 to 5700	2400	9	12

Recommended measuring range

Flow limit → 52

For custody transfer, the applicable approval determines the permitted measuring range, the pulse value and the low flow cut off.

Operable flow range

Over 1000 : 1

For custody transfer, the operable flow range is 100 : 1 to 630 : 1, depending on the nominal diameter. Further details are specified by the applicable approval.

Input signal

External measured values

Various pressure transmitters and temperature measuring devices can be ordered from Endress +Hauser: see "Accessories" section → 105

It is recommended to read in external measured values to calculate the following measured variables: Mass flow

HART protocol

The measured values are written from the automation system to the measuring device via the HART protocol. The pressure transmitter must support the following protocol-specific functions:
- HART protocol
- Burst mode

Digital communication

The measured values can be written from the automation system to the measuring via:
- PROFIBUS DP
- Modbus RS485
- EtherNet/IP

Status input

Maximum input values	▪ DC 30 V ▪ 6 mA
Response time	Configurable: 5 to 200 ms
Input signal level	▪ Low signal (low): DC −3 to +5 V ▪ High signal (high): DC 12 to 30 V
Assignable functions	▪ Off ▪ Reset totalizers 1-3 separately ▪ Reset all totalizers ▪ Flow override

Output

Output signal

Current output

Current output	Can be set as: ▪ 4 to 20 mA NAMUR ▪ 4 to 20 mA US ▪ 4 to 20 mA HART ▪ 0 to 20 mA
Maximum output values	▪ DC 24 V (no flow) ▪ 22.5 mA
Load	0 to 700 Ω
Resolution	0.5 µA

Damping	Configurable: 0.07 to 999 s
Assignable measured variables	▪ Volume flow ▪ Mass flow ▪ Corrected volume flow ▪ Flow velocity ▪ Conductivity [1)] ▪ Corrected conductivity [1)] ▪ Temperature [1)] ▪ Electronics temperature ▪ Reference electrode potential [1)] ▪ Coil current rise time [1)] ▪ Noise [1)] ▪ Build-up measured value [1)] ▪ Test points 1-3

1) Visible depending on order options or device settings

Pulse/frequency/switch output

Function	▪ With the order code for "Output; Input", option **H**: output 2 can be set as a pulse or frequency output ▪ With the order code for "Output; Input", option **I**: output 2 and 3 can be set as a pulse, frequency or switch output ▪ With the order code for "Output; Input", option **J**: output 2 firmly assigned as certified pulse output
Version	Passive, open collector
Maximum input values	▪ DC 30 V ▪ 250 mA
Voltage drop	At 25 mA: ≤ DC 2 V
Pulse output	
Pulse width	Configurable: 0.05 to 2 000 ms
Maximum pulse rate	10 000 Impulse/s
Pulse value	Configurable
Assignable measured variables	▪ Volume flow ▪ Mass flow ▪ Corrected volume flow
Frequency output	
Output frequency	Configurable: 0 to 12 500 Hz
Damping	Configurable: 0 to 999 s
Pulse/pause ratio	1:1
Assignable measured variables	▪ Volume flow ▪ Mass flow ▪ Corrected volume flow ▪ Flow velocity ▪ Conductivity [1)] ▪ Corrected conductivity [1)] ▪ Temperature [1)] ▪ Electronics temperature ▪ Noise [1)] ▪ Coil current rise time [1)] ▪ Reference electrode potential [1)] ▪ Build-up measured value [1)] ▪ Test points 1-3
Switch output	
Switching behavior	Binary, conductive or non-conductive
Switching delay	Configurable: 0 to 100 s

Number of switching cycles	Unlimited

Assignable functions	▪ Off
	▪ On
	▪ Diagnostic behavior
	▪ Limit value:
	  ▪ Off
	  ▪ Volume flow
	  ▪ Corrected volume flow
	  ▪ Mass flow
	  ▪ Flow velocity
	  ▪ Conductivity [1]
	  ▪ Corrected conductivity [1]
	  ▪ Totalizer 1-3
	  ▪ Temperature [1]
	  ▪ Electronics temperature
	▪ Flow direction monitoring
	▪ Status:
	  ▪ Empty pipe detection
	  ▪ Low flow cut off
	  ▪ Build-up limit value [1]

1) Visible depending on order options or device settings

PROFIBUS DP

Signal encoding	NRZ code
Data transmission	9.6 kBaud...12 MBaud

Modbus RS485

Physical interface	In accordance with EIA/TIA-485-A standard
Terminating resistor	Integrated, can be activated via DIP switch on the transmitter electronics module

EtherNet/IP

Standards	In accordance with IEEE 802.3

Signal on alarm

Depending on the interface, failure information is displayed as follows:

Current output 4 to 20 mA

4 to 20 mA

Failure mode	Choose from: ▪ 4 to 20 mA in accordance with NAMUR recommendation NE 43 ▪ 4 to 20 mA in accordance with US ▪ Min. value: 3.59 mA ▪ Max. value: 22.5 mA ▪ Freely definable value between: 3.59 to 22.5 mA ▪ Actual value ▪ Last valid value

0 to 20 mA

Failure mode	Choose from: ▪ Maximum alarm: 22 mA ▪ Freely definable value between: 0 to 22.5 mA

HART current output

Device diagnostics	Device condition can be read out via HART Command 48

Pulse/frequency/switch output

Pulse output	
Failure mode	Choose from: ▪ Actual value ▪ No pulses
Frequency output	
Failure mode	Choose from: ▪ Actual value ▪ 0 Hz ▪ Defined value: 0 to 12 500 Hz
Switch output	
Failure mode	Choose from: ▪ Current status ▪ Open ▪ Closed

PROFIBUS DP

Status and alarm messages	Diagnostics in accordance with PROFIBUS PA Profile 3.02

Modbus RS485

Failure mode	Choose from: ▪ NaN value instead of current value ▪ Last valid value

EtherNet/IP

Device diagnostics	Device condition can be read out in Input Assembly

Local display

Plain text display	With information on cause and remedial measures
Backlight	Red backlighting indicates a device error.

Status signal as per NAMUR recommendation NE 107

Interface/protocol

- Via digital communication:
  - HART protocol
  - ~~PROFIBUS DP~~
  - ~~Modbus RS485~~
  - ~~EtherNet/IP~~
- Via service interface
  - CDI-RJ45 service interface
  - WLAN interface

Plain text display	With information on cause and remedial measures

Additional information on remote operation → 95

Web browser

Plain text display	With information on cause and remedial measures

Light emitting diodes (LED)

Status information	Status indicated by various light emitting diodes The following information is displayed depending on the device version: ▪ Supply voltage active ▪ Data transmission active ▪ Device alarm/error has occurred ▪ EtherNet/IP network available ▪ EtherNet/IP connection established

Low flow cut off

The switch points for low flow cut off are user-selectable.

Galvanic isolation

The following connections are galvanically isolated from each other:
- Inputs
- Outputs
- Power supply

Protocol-specific data

HART

Manufacturer ID	0x11
Device type ID	0x1169
HART protocol revision	7
Device description files (DTM, DD)	Information and files under: www.endress.com
HART load	Min. 250 Ω
Dynamic variables PV, SV, TV, QV	▪ Read out the dynamic variables via HART command 3 ▪ The measured variables can be freely assigned to the dynamic variables
Device variables	▪ Read out the device variables via HART command 9 ▪ The measured variables can be freely assigned ▪ A maximum of 8 device variables can be transmitted
System integration	Operating Instructions for the device → 106

PROFIBUS DP

Manufacturer ID	0x11
Ident number	0x1562
Profile version	3.02
Device description files (GSD, DTM, DD)	Information and files under: ▪ www.endress.com ▪ www.profibus.org
Output values	Output values (from the measuring device to the automation system) ▪ 4 Analog input ▪ 2 Digital input ▪ 3 Totalizer

Input values	Input values (from the automation system to the measuring device) ▪ 2 Analog output (fixed assignment) ▪ 2 Digital output (fixed assignment) ▪ 3 Totalizer
Device address configuration options	Configuration of the device address ▪ Hardware: DIP switches on the I/O electronics module ▪ Software: Via operating tools (e.g. FieldCare)
Supported functions	▪ Identification & Maintenance: Simplest device identification on the part of the control system and nameplate ▪ PROFIBUS upload/download: Reading and writing parameters is up to ten times faster with PROFIBUS upload/download ▪ Condensed status: Simplest and self-explanatory diagnostic information by categorizing diagnostic messages that occur
System integration	Operating Instructions for the device → 🖹 106

Modbus RS485

Protocol	Modbus Applications Protocol Specification V1.1
Device type	Slave
Slave address range	1 to 247
Broadcast address range	0
Function codes	▪ 03: Read holding register ▪ 04: Read input register ▪ 06: Write single registers ▪ 08: Diagnostics ▪ 16: Write multiple registers ▪ 23: Read/write multiple registers
Broadcast messages	Supported by the following function codes: ▪ 06: Write single registers ▪ 16: Write multiple registers ▪ 23: Read/write multiple registers
Supported baud rate	▪ 1200 BAUD ▪ 2400 BAUD ▪ 4800 BAUD ▪ 9600 BAUD ▪ 19200 BAUD ▪ 38400 BAUD ▪ 57600 BAUD ▪ 115200 BAUD
Modus data transmission	▪ ASCII ▪ RTU
Data access	Each device parameter can be accessed via Modbus RS485. For detailed information on the "Modbus RS485 register information", see the Description of Device Parameters → 🖹 106
System integration	Operating Instructions for the device → 🖹 106

EtherNet/IP

Protocol	▪ The CIP Networks Library Volume 1: Common Industrial Protocol ▪ The CIP Networks Library Volume 2: EtherNet/IP Adaptation of CIP
Communication type	▪ 10Base-T ▪ 100Base-TX
Device profile	Generic device (product type: 0x2B)
Manufacturer ID	0x49E

Device type ID	0x1069
Baud rates	Automatic 10/100 Mbit with half-duplex and full-duplex detection
Polarity	Auto-polarity for automatic correction of crossed TxD and RxD pairs
Supported CIP connections	Max. 3 connections
Explicit connections	Max. 5 connections
I/O connections	Max. 6 connections (scanner)
Configuration options for measuring device	Configuration options for measuring device ▪ DIP switches on the electronics module for IP addressing ▪ Manufacturer-specific software (FieldCare) ▪ Custom Add-on Profile for Rockwell Automation control systems ▪ Web browser ▪ Electronic Data Sheet (EDS) integrated in the measuring device
EtherNet interface configuration options	Configuration of the EtherNet interface ▪ Speed: 10 MBit, 100 MBit, auto (factory setting) ▪ Duplex: half-duplex, full-duplex, auto (factory setting)
Device address configuration options	Configuration of the device address ▪ DIP switches on the electronics module for IP addressing (last octet) ▪ DHCP ▪ Manufacturer-specific software (FieldCare) ▪ Custom Add-on Profile for Rockwell Automation control systems ▪ Web browser ▪ EtherNet/IP tools, e.g. RSLinx (Rockwell Automation)
Device Level Ring (DLR)	No
Assembly	▪ Legacy Input Assembly Fix (Assem 100) ▪ Legacy Input Assembly Configurable (Assem 101) ▪ Legacy Output Assembly Fix (Assem 102) ▪ Legacy Configuration Assembly (Assem 104) ▪ Input Assembly Fix (Assem 120) ▪ Input Assembly Configurable (Assem 121) ▪ Output Assembly Fix (Assem 122) ▪ Configuration Assembly (Assem 124) ▪ Volume Flow Extended Fix Input (Assem 126) ▪ Volume Flow Universal Fix Input (Assem 127) ▪ Dummy Output Assembly Fix (Assem 199)
Requested Packet Interval (RPI)	5 ms to 10 s (factory setting: 20 ms)
System integration	Operating Instructions for the device → 106

Power supply

Terminal assignment

Transmitter: 0 to 20 mA/4 to 20 mA HART

The sensor can be ordered with terminals.

Connection methods available		Possible options for order code "Electrical connection"
Outputs	**Power supply**	
Terminals	Terminals	▪ Option **A**: coupling M20x1 ▪ Option **B**: thread M20x1 ▪ Option **C**: thread G ½" ▪ Option **D**: thread NPT ½"

Supply voltage

Order code "Power supply"	Terminal numbers	terminal voltage		Frequency range
Option **L** (wide range power unit)	1 (L+/L), 2 (L-/N)	DC 24 V	±25%	–
		AC 24 V	±25%	50/60 Hz, ±4 Hz
		AC 100 to 240 V	−15 to +10%	50/60 Hz, ±4 Hz

Signal transmission with current output 0 to 20 mA/4 to 20 mA HART and other outputs and inputs

Order code for "Output" and "Input"	Terminal numbers							
	Output 1		Output 2		Output 3		Input	
	26 (+)	27 (-)	24 (+)	25 (-)	22 (+)	23 (-)	20 (+)	21 (-)
Option **H**	Current output ▪ 4 to 20 mA HART (active) ▪ 0 to 20 mA (active)		Pulse/frequency output (passive)		Switch output (passive)		-	
Option **I**	Current output ▪ 4 to 20 mA HART (active) ▪ 0 to 20 mA (active)		Pulse/frequency/ switch output (passive)		Pulse/frequency/ switch output (passive)		Status input	
Option **J**	Current output ▪ 4 to 20 mA HART (active) ▪ 0 to 20 mA (active)		Fixed assignment: Certified pulse output (passive)		Switch output		Status input	

Transmitter: PROFIBUS DP

The sensor can be ordered with terminals.

Connection methods available		Possible options for order code "Electrical connection"
Outputs	Power supply	
Terminals	Terminals	▪ Option **A**: coupling M20x1 ▪ Option **B**: thread M20x1 ▪ Option **C**: thread G ½" ▪ Option **D**: thread NPT ½"

Supply voltage

Order code "Power supply"	Terminal numbers	terminal voltage		Frequency range
Option **L** (wide range power unit)	1 (L+/L), 2 (L-/N)	DC 24 V	±25%	–
		AC 24 V	±25%	50/60 Hz, ±4 Hz
		AC 100 to 240 V	−15 to +10%	50/60 Hz, ±4 Hz

PROFIBUS DP signal transmission

Order code for "Output" and "Input"	Terminal numbers	
	26 (RxD/TxD-P)	27 (RxD/TxD-N)
Option **L**	B	A
Order code for "Output": Option L: PROFIBUS DP, for use in non-hazardous areas and Zone 2/Div. 2		

Transmitter: Modbus RS485

The sensor can be ordered with terminals.

Connection methods available		Possible options for order code "Electrical connection"
Outputs	**Power supply**	
Terminals	Terminals	▪ Option **A**: coupling M20x1 ▪ Option **B**: thread M20x1 ▪ Option **C**: thread G ½" ▪ Option **D**: thread NPT ½"

Supply voltage

Order code "Power supply"	Terminal numbers	terminal voltage		Frequency range
Option **L** (wide range power unit)	1 (L+/L), 2 (L-/N)	DC 24 V	±25%	–
		AC 24 V	±25%	50/60 Hz, ±4 Hz
		AC 100 to 240 V	–15 to +10%	50/60 Hz, ±4 Hz

Signal transmission with Modbus RS485 and other outputs

Order code for "Output" and "Input"	Terminal numbers							
	26 (+)	27 (-)	24 (+)	25 (-)	22 (+)	23 (-)	20 (+)	21 (-)
Option **M**	Modbus B	Modbus A	-		-		-	
Option **O**	Current output 4 to 20 mA (active)		Pulse/frequency/ switch output (passive)		Pulse/frequency/ switch output (passive)		Modbus B	Modbus A
Option **P**	Current output 4 to 20 mA (active)		Pulse output certified (passive)		Pulse/frequency/ switch output (passive)		Modbus B	Modbus A

Transmitter: EtherNet/IP

The transmitter can be ordered with terminals or a device plug.

Connection methods available		Possible options for order code "Electrical connection"
Outputs	**Power supply**	
EtherNet/IP (RJ45 plug)	Terminals	Option **D**: thread NPT ½"
Device plug → 🖹 22	Terminals	▪ Option **L**: plug M12x1 + thread NPT ½" ▪ Option **N**: plug M12x1 + coupling M20 ▪ Option **P**: plug M12x1 + thread G ½" ▪ Option **U**: plug M12x1 + thread M20

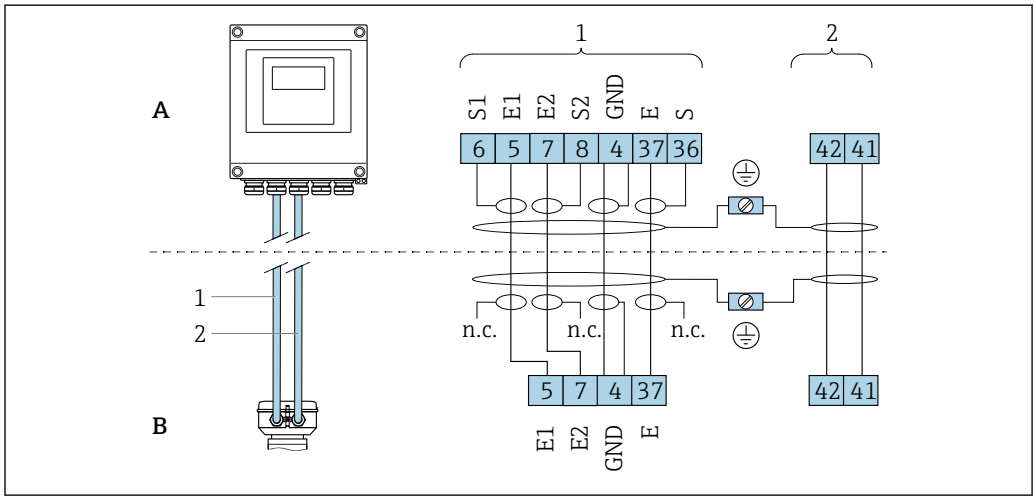
Supply voltage

Order code "Power supply"	Terminal numbers	terminal voltage		Frequency range
Option **L** (wide range power unit)	1 (L+/L), 2 (L-/N)	DC 24 V	±25%	–
		AC 24 V	±25%	50/60 Hz, ±4 Hz
		AC 100 to 240 V	–15 to +10%	50/60 Hz, ±4 Hz

EtherNet/IP signal transmission

Order code for "Output"	Connection via
Option **N**	EtherNet/IP: RJ45 or M12 plug

Remote version



2 *Remote version terminal assignment*

A Transmitter wall-mount housing
B Sensor connection housing
1 Electrode cable
2 Coil current cable
n.c. Not connected, insulated cable shields

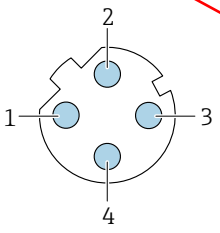
Terminal No. and cable colors: 6/5 = brown; 7/8 = white; 4 = green; 36/37 = yellow

Pin assignment, device plug

Order codes for the M12x1 plugs, see the "Order code for electrical connection" column: EtherNet/IP → 21

EtherNet/IP

Device plug for signal transmission (device side)



Pin		Assignment	Coding	Plug/socket
1	+	Tx	D	Socket
2	+	Rx		
3	-	Tx		
4	-	Rx		

Recommended plug:
- Binder, series 763, part no. 99 3729 810 04
- Phoenix, part no. 1543223 SACC-M12MSD-4Q
- The device plug is not permitted in the hazardous area, Class I Division 2. The device plug may only be used in the non-hazardous area (General Purpose).

Supply voltage

Transmitter

Order code for "Power supply"	terminal voltage		Frequency range
Option **L**	DC 24 V	±25%	–
	AC 24 V	±25%	50/60 Hz, ±4 Hz
	AC 100 to 240 V	−15 to +10%	50/60 Hz, ±4 Hz

Power consumption

Order code for "Output"	Maximum power consumption
Option **H**: 4-20mA HART, pulse/frequency output, switch output	30 VA/8 W
Option **I**: 4-20mA HART, 2 x pulse/frequency/switch output, status input	30 VA/8 W
Option **J**: 4-20mA HART, certified pulse output, switch output, status input	30 VA/8 W
Option **L**: PROFIBUS DP	30 VA/8 W
Option **M**: Modbus RS485	30 VA/8 W
Option **O**: Modbus RS485, 4-20mA, 2 x pulse/ frequency/switch output	30 VA/8 W
Option **P**: Modbus RS485, 4-20mA, certified pulse output, pulse/frequency/switch output	30 VA/8 W
Option **N**: EtherNet/IP	30 VA/8 W

Current consumption

Transmitter

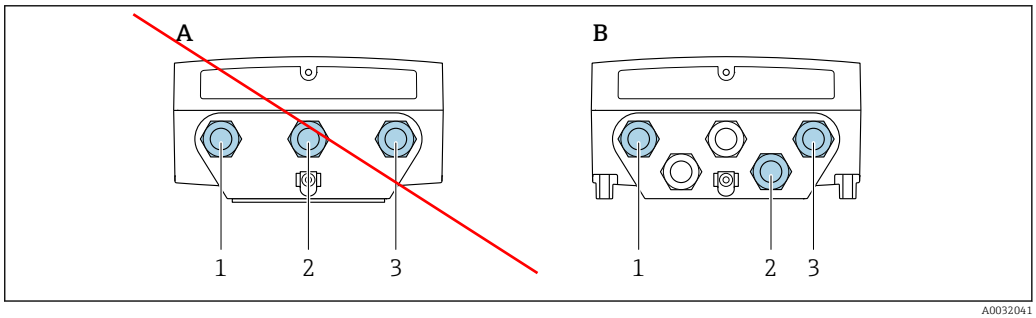
Order code for "Power supply"	Maximum Current consumption	Maximum switch-on current
Option **L**: AC 100 to 240 V	145 mA	25 A (< 5 ms)
Option **L**: AC/DC 24 V	350 mA	27 A (< 5 ms)

Power supply failure

- Totalizers stop at the last value measured.
- Depending on the device version, the configuration is retained in the device memoryor in the pluggable data memory (HistoROM DAT).
- Error messages (incl. total operated hours) are stored.

Electrical connection

Connecting the transmitter

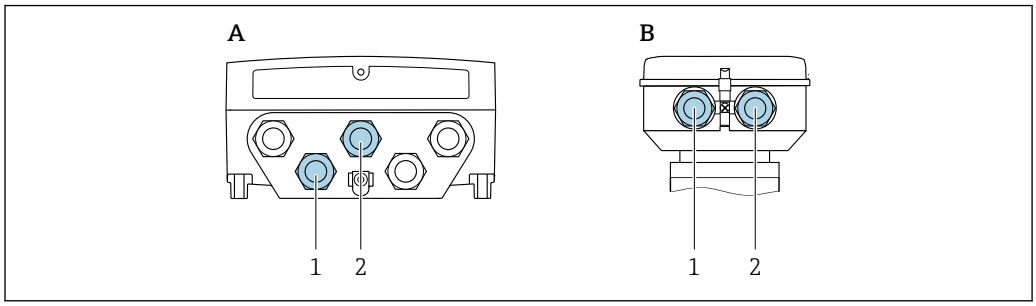


3 *Supply voltage and signal transmission connection*

A Compact version
B Remote version wall-mount housing
1 Cable entry for supply voltage
2 Cable entry for signal transmission
3 Cable entry for signal transmission

Remote version connection

Connecting cable



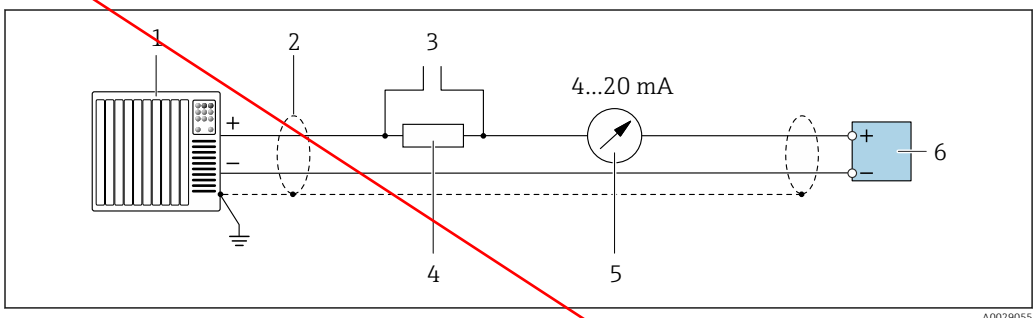
4 *Connecting cable connection: electrode and coil current cable*

A Transmitter wall-mount housing
B Sensor connection housing
1 Electrode cable
2 Coil current cable

- Fix the cable run or route it in an armored conduit.
  Cable movements can influence the measuring signal especially in the case of low fluid conductivities.
- Route the cable well clear of electrical machines and switching elements.
- Ensure potential equalization between the sensor and transmitter → 27.

Connection examples

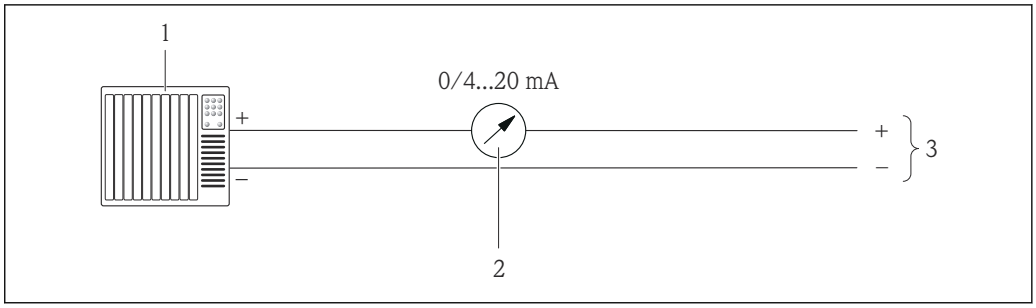
Current output 4 to 20 mA HART



5 *Connection example for 4 to 20 mA HART current output (active)*

1 Automation system with current input (e.g. PLC)
2 Cable shield provided at one end. The cable shield must be grounded at both ends to comply with EMC requirements; observe cable specifications → 31
3 Connection for HART operating devices → 95
4 Resistor for HART communication (≥ 250 Ω): observe maximum load → 13
5 Analog display unit: observe maximum load → 13
6 Transmitter

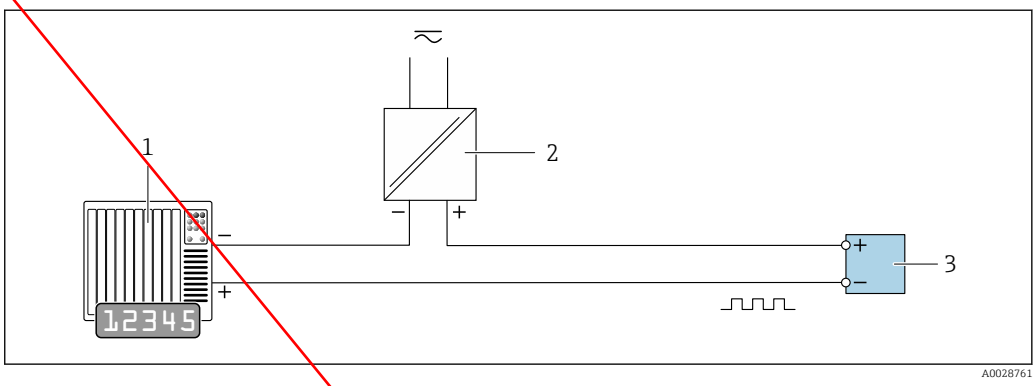
Current output 4 to 20 mA



6 *Connection example for 0 to 20 mA (active) and 4 to 20 mA (active) current output*

1 *Automation system with current input (e.g. PLC)*
2 *Analog display unit: observe maximum load*
3 *Transmitter*

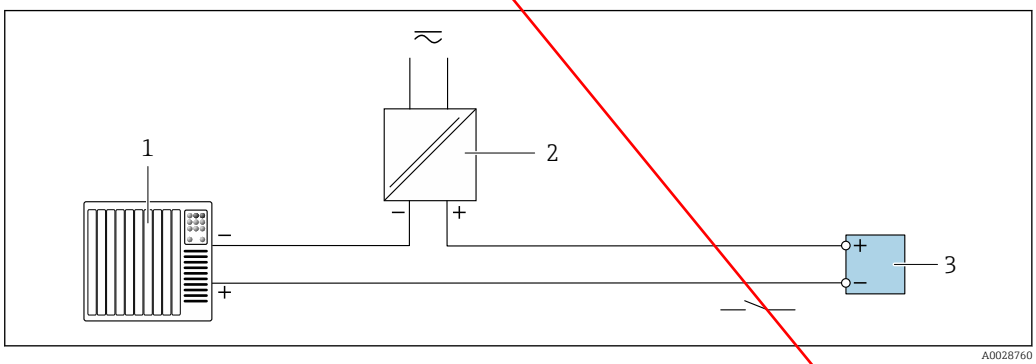
Pulse/frequency output



7 *Connection example for pulse/frequency output (passive)*

1 *Automation system with pulse/frequency input (e.g. PLC)*
2 *Power supply*
3 *Transmitter: Observe input values → 14*

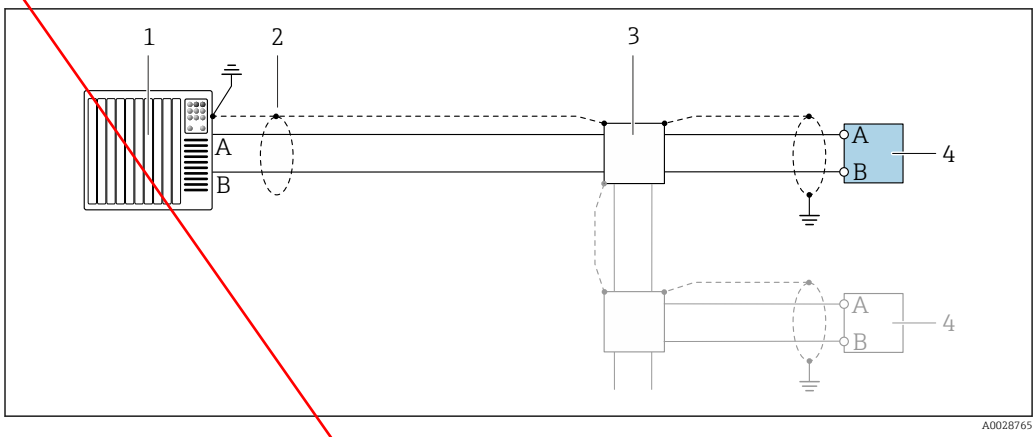
Switch output



8 *Connection example for switch output (passive)*

1 *Automation system with switch input (e.g. PLC)*
2 *Power supply*
3 *Transmitter: Observe input values → 14*

PROFIBUS DP

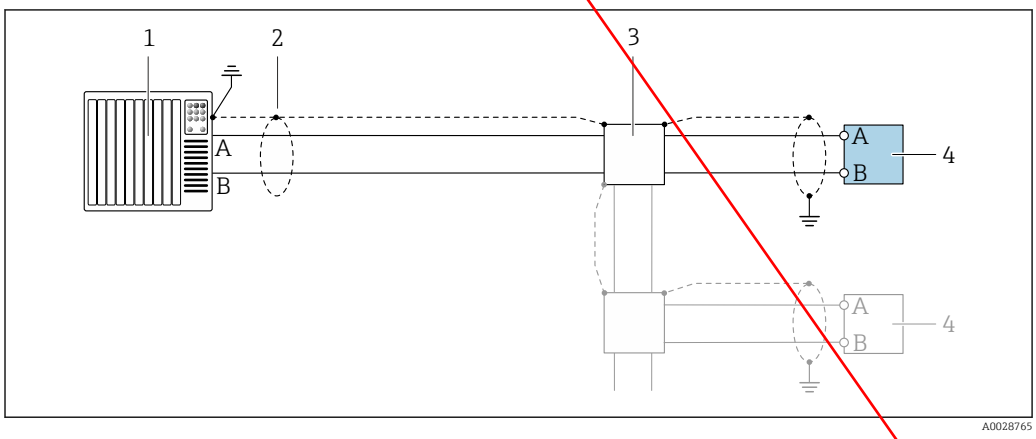


9 Connection example for PROFIBUS DP, non-hazardous area and Zone 2/Div. 2

1 Control system (e.g. PLC)
2 Cable shield provided at one end. The cable shield must be grounded at both ends to comply with EMC requirements; observe cable specifications
3 Distribution box
4 Transmitter

If baud rates > 1.5 MBaud an EMC cable entry must be used and the cable shield must continue as far as the terminal wherever possible.

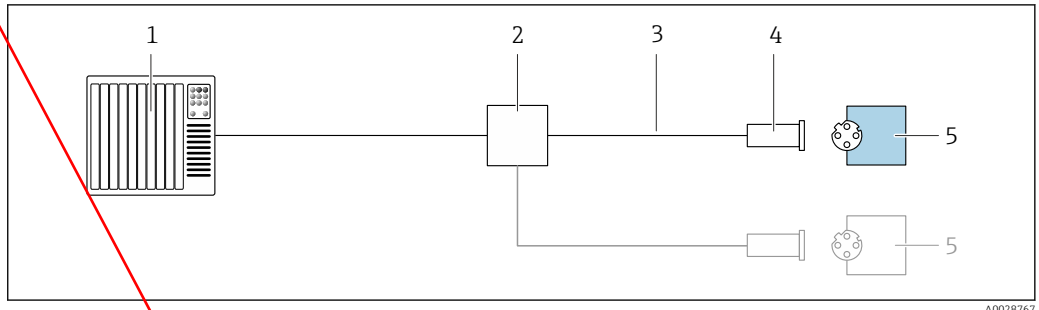
Modbus RS485



10 Connection example for Modbus RS485, non-hazardous area and Zone 2/Div. 2

1 Control system (e.g. PLC)
2 Cable shield provided at one end. The cable shield must be grounded at both ends to comply with EMC requirements; observe cable specifications
3 Distribution box
4 Transmitter

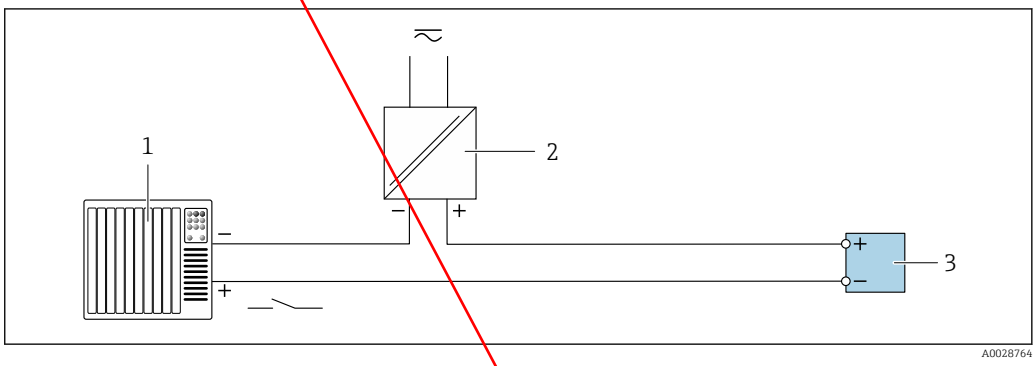
EtherNet/IP



11 Connection example for EtherNet/IP

1 Control system (e.g. PLC)
2 Ethernet switch
3 Observe cable specifications
4 Device plug
5 Transmitter

Status input



12 Connection example for status input

1 Automation system with status output (e.g. PLC)
2 Power supply
3 Transmitter

Potential equalization

Introduction

Correct potential equalization (equipotential bonding) is a prerequisite for stable and reliable flow measurement. Inadequate or incorrect potential equalization can result in device failure and present a safety hazard.

The following requirements must be observed to ensure correct, trouble-free measurement:
- The principle that the medium, the sensor and the transmitter must be at the same electrical potential applies.
- Take in-company grounding guidelines, materials and the grounding conditions and potential conditions of the pipe into consideration.
- Any necessary potential equalization connections must be established by ground cables with a minimum cross-section of 6 mm^2 (0.0093 in^2).
- For remote device versions, the ground terminal in the example always refers to the sensor and not to the transmitter.

You can order accessories like ground cables and ground disks from Endress+Hauser → 103

For devices intended for use in hazardous locations, observe the instructions in the Ex documentation (XA).

Abbreviations used

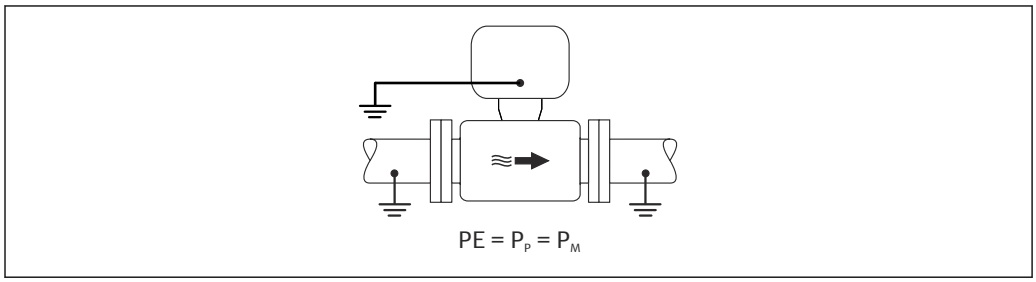
- PE (Protective Earth): potential at the protective earth terminals of the device
- P_P (Potential Pipe): potential of the pipe, measured at the flanges
- P_M (Potential Medium): potential of the medium

Connection examples for standard situations

Unlined and grounded metal pipe

- Potential equalization is via the measuring pipe.
- The medium is set to ground potential.

Starting conditions:
- Pipes are correctly grounded on both sides.
- Pipes are conductive and at the same electrical potential as the medium



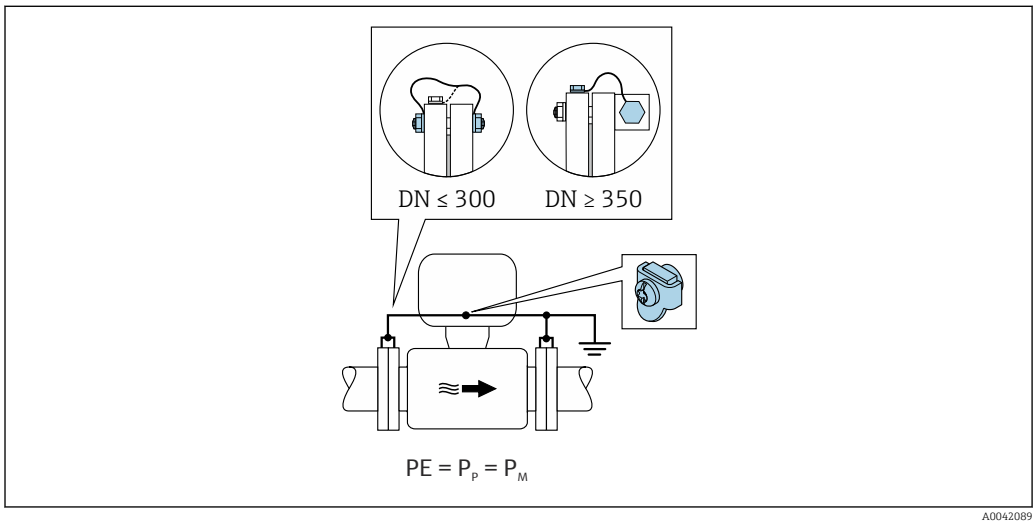
A0044854

▶ Connect the connection housing of the transmitter or sensor to ground potential by means of the ground terminal provided for this purpose.

Unlined metal pipe

- Potential equalization is via the ground terminal and pipe flanges.
- The medium is set to ground potential.

Starting conditions:
- Pipes are not sufficiently grounded.
- Pipes are conductive and at the same electrical potential as the medium



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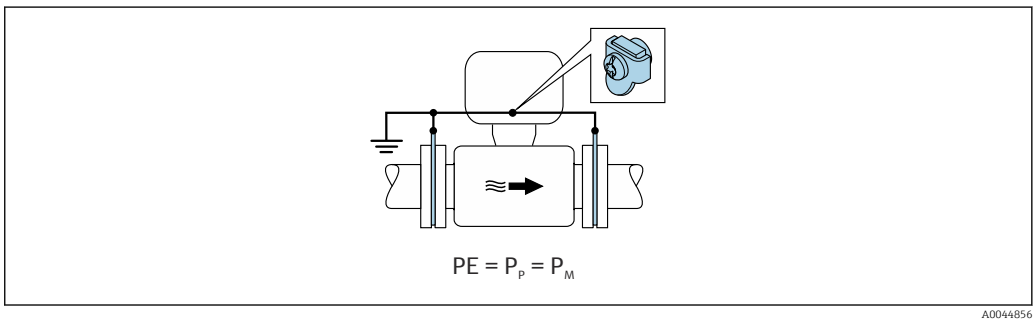
1. Connect both sensor flanges to the pipe flange via a ground cable and ground them.
2. Connect the connection housing of the transmitter or sensor to ground potential by means of the ground terminal provided for this purpose.

- For DN ≤ 300 (12"): Mount the ground cable directly on the conductive flange coating of the sensor with the flange screws.
- For DN ≥ 350 (14"): Mount the ground cable directly on the metal transport bracket. Observe screw tightening torques: see the Brief Operating Instructions for the sensor.

Plastic pipe or pipe with insulating liner

- Potential equalization is via the ground terminal and ground disks.
- The medium is set to ground potential.

Starting conditions:
- The pipe has an insulating effect.
- Low-impedance medium grounding close to the sensor is not guaranteed.
- Equalizing currents through the medium cannot be ruled out.



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1. Connect the ground disks to the ground terminal of the connection housing of the transmitter or sensor via the ground cable.
2. Connect the connection to ground potential.

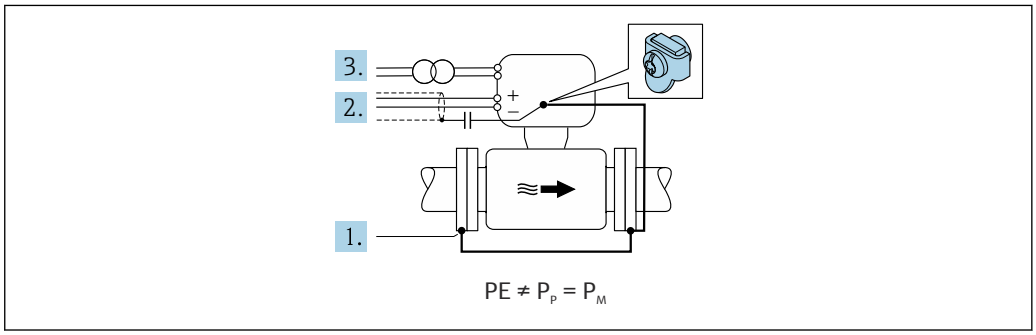
Connection example with the potential of the medium not equal to the protective ground

In these cases, the medium potential can differ from the potential of the device.

Metal, ungrounded pipe

The sensor and transmitter are installed in a way that provides electrical insulation from PE, e.g. applications for electrolytic processes or systems with cathodic protection.

Starting conditions:
- Unlined metal pipe
- Pipes with an electrically conductive liner



A0042253

1. Connect the pipe flanges and transmitter via the ground cable.
2. Route the shielding of the signal lines via a capacitor (recommended value 1.5µF/50V).
3. Device connected to power supply such that it is floating in relation to the protective earth (isolation transformer). This measure is not required in the case of 24V DC supply voltage without PE (= SELV power unit).

Connection examples with the potential of medium not equal to protective earth with the "Measurement isolated from ground" option

In these cases, the medium potential can differ from the potential of the device.

Introduction

The "Measurement isolated from ground" option enables the galvanic isolation of the measuring system from the device potential. This minimizes harmful equalizing currents caused by differences

in potential between the medium and the device. The "Measurement isolated from ground" option is optionally available: order code for "Sensor option", option CV

Operating conditions for the use of the "Measurement isolated from ground" option

Device version	Compact version and remote version (length of connecting cable ≤ 10 m)
Differences in voltage between medium potential and device potential	As small as possible, usually in the mV range
Alternating voltage frequencies in the medium or at ground potential (PE)	Below typical power line frequency in the country

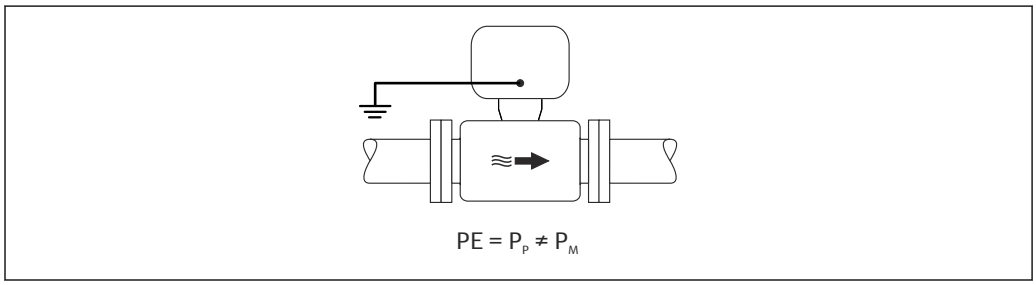
To achieve the specified conductivity measuring accuracy, a conductivity calibration is recommended when the device is installed.

A full pipe adjustment is recommended when the device is installed.

Plastic pipe

Sensor and transmitter are correctly grounded. A difference in potential can occur between the medium and protective earth. Potential equalization between P_M and PE via the reference electrode is minimized with the "Measurement isolated from ground" option.

Starting conditions:
- The pipe has an insulating effect.
- Equalizing currents through the medium cannot be ruled out.



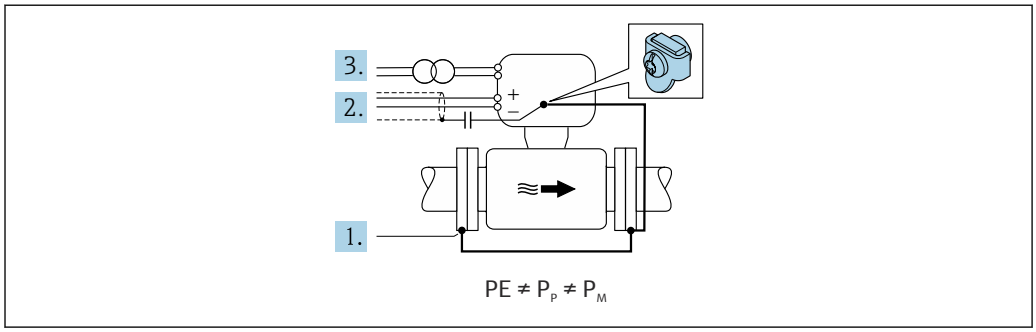
A0044855

1. Use the "Measurement isolated from ground" option, while observing the operating conditions for measurement isolated from ground.
2. Connect the connection housing of the transmitter or sensor to ground potential by means of the ground terminal provided for this purpose.

Metal, ungrounded pipe with insulating liner

The sensor and transmitter are installed in a way that provides electrical insulation from PE. The medium and pipe have different potentials. The "Measurement isolated from ground" option minimizes harmful equalizing currents between P_M and P_P via the reference electrode.

Starting conditions:
- Metal pipe with insulating liner
- Equalizing currents through the medium cannot be ruled out.



A0044857

1. Connect the pipe flanges and transmitter via the ground cable.
2. Route the shielding of the signal cables via a capacitor (recommended value 1.5µF/50V).
3. Device connected to power supply such that it is floating in relation to the protective earth (isolation transformer). This measure is not required in the case of 24V DC supply voltage without PE (= SELV power unit).
4. Use the "Measurement isolated from ground" option, while observing the operating conditions for measurement isolated from ground.

Terminals

Transmitter
- Supply voltage cable: plug-in spring terminals for wire cross-sections 0.5 to 2.5 mm² (20 to 14 AWG)
- Signal cable: plug-in spring terminals for wire cross-sections 0.5 to 2.5 mm² (20 to 14 AWG)
- Electrode cable: spring terminals for wire cross-sections 0.5 to 2.5 mm² (20 to 14 AWG)
- Coil current cable: spring terminals for wire cross-sections 0.5 to 2.5 mm² (20 to 14 AWG)

Sensor connection housing
Spring terminals for wire cross-sections 0.5 to 2.5 mm² (20 to 14 AWG)

Cable entries

Cable entry thread
- M20 x 1.5
- Via adapter:
  - NPT ½"
  - G ½"

Cable gland
- For standard cable: M20 × 1.5 with cable Φ 6 to 12 mm (0.24 to 0.47 in)
- For armored cable: M20 × 1.5 with cable Φ 9.5 to 16 mm (0.37 to 0.63 in)

If metal cable entries are used, use a grounding plate.

Cable specification

Permitted temperature range
- The installation guidelines that apply in the country of installation must be observed.
- The cables must be suitable for the minimum and maximum temperatures to be expected.

Power supply cable (incl. conductor for the inner ground terminal)

Standard installation cable is sufficient.

Signal cable

Current output 0/4 to 20 mA

Standard installation cable is sufficient.

Current output 4 to 20 mA HART

A shielded cable is recommended. Observe grounding concept of the plant.

Pulse/frequency/switch output

Standard installation cable is sufficient.

Status input

Standard installation cable is sufficient.

PROFIBUS DP

The IEC 61158 standard specifies two types of cable (A and B) for the bus line which can be used for every transmission rate. Cable type A is recommended.

Cable type	A
Characteristic impedance	135 to 165 Ω at a measuring frequency of 3 to 20 MHz
Cable capacitance	< 30 pF/m
Wire cross-section	> 0.34 mm² (22 AWG)

Cable type	Twisted pairs
Loop resistance	≤110 Ω/km
Signal damping	Max. 9 dB over the entire length of the cable cross-section
Shield	Copper braided shielding or braided shielding with foil shield. When grounding the cable shield, observe the grounding concept of the plant.

For further information on planning and installing PROFIBUS networks see:
Operating Instructions "PROFIBUS DP/PA: Guidelines for planning and commissioning" (BA00034S)

Modbus RS485

The EIA/TIA-485 standard specifies two types of cable (A and B) for the bus line which can be used for every transmission rate. Cable type A is recommended.

Cable type	A
Characteristic impedance	135 to 165 Ω at a measuring frequency of 3 to 20 MHz
Cable capacitance	< 30 pF/m
Wire cross-section	> 0.34 mm² (22 AWG)
Cable type	Twisted pairs
Loop resistance	≤110 Ω/km
Signal damping	Max. 9 dB over the entire length of the cable cross-section
Shield	Copper braided shielding or braided shielding with foil shield. When grounding the cable shield, observe the grounding concept of the plant.

EtherNet/IP

The standard ANSI/TIA/EIA-568-B.2 Annex specifies CAT 5 as the minimum category for a cable used for EtherNet/IP. CAT 5e and CAT 6 are recommended.

For more information on planning and installing EtherNet/IP networks, please refer to the "Media Planning and Installation Manual. EtherNet/IP" of ODVA Organization

Connecting cable for remote version

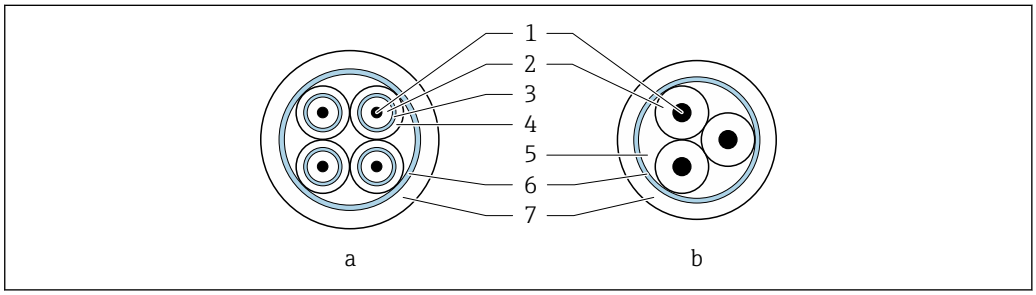
Electrode cable

Standard cable	3 ×0.38 mm² (20 AWG) with common, braided copper shield (ϕ ~9.5 mm (0.37 in)) and individual shielded cores
Cable for empty pipe detection (EPD)	4 ×0.38 mm² (20 AWG) with common, braided copper shield (ϕ ~9.5 mm (0.37 in)) and individual shielded cores
Conductor resistance	≤50 Ω/km (0.015 Ω/ft)
Capacitance: core/shield	≤420 pF/m (128 pF/ft)
Operating temperature	–20 to +80 °C (–4 to +176 °F)

Coil current cable

Standard cable	3 ×0.75 mm² (18 AWG) with common, braided copper shield (ϕ ~9 mm (0.35 in))
Conductor resistance	≤37 Ω/km (0.011 Ω/ft)
Capacitance: core/core, shield grounded	≤120 pF/m (37 pF/ft)

Operating temperature	–20 to +80 °C (–4 to +176 °F)
Test voltage for cable insulation	≤ AC 1433 V rms 50/60 Hz or ≥ DC 2026 V



13 *Cable cross-section*

a Electrode cable
b Coil current cable
1 Core
2 Core insulation
3 Core shield
4 Core jacket
5 Core reinforcement
6 Cable shield
7 Outer jacket

A connecting cable can be ordered from Endress+Hauser for IP68:
- Pre-terminated cables that are already connected to the sensor
- Pre-terminated cables, where the cables are connected by the customer onsite (incl. tools for sealing the connection compartment)

Armored connecting cable

Armored connecting cables with an additional, reinforcing metal braid should be used:
- When laying the cable directly in the ground
- Where there is a risk of damage from rodents
- Use as per IP68 degree of protection

Armored connecting cables with an additional, reinforcing metal braid can be ordered from Endress+Hauser → 103.

Operation in environments with strong electrical interference

The measuring system meets the general safety requirements → 102 and EMC specifications → 48.

Grounding is by means of the ground terminal provided for the purpose inside the connection housing. The stripped and twisted lengths of cable shield to the ground terminal must be as short as possible.

Performance characteristics

Reference operating conditions

- Error limits following DIN EN 29104, in future ISO 20456
- Water, typically +15 to +45 °C (+59 to +113 °F); 0.5 to 7 bar (73 to 101 psi)
- Data as indicated in the calibration protocol
- Accuracy based on accredited calibration rigs according to ISO 17025

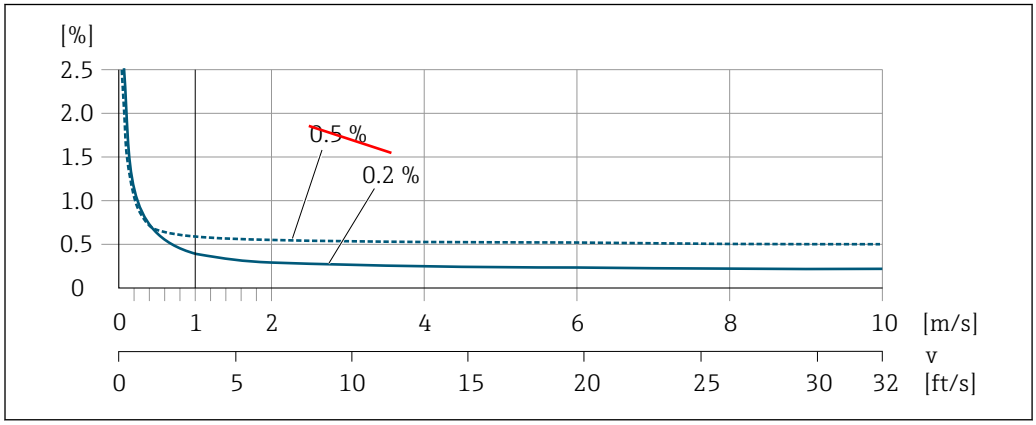
Maximum measured error

Error limits under reference operating conditions

Volume flow

- ±0.5 % o.r. ± 1 mm/s (0.04 in/s)
- Optional: ±0.2 % o.r. ± 2 mm/s (0.08 in/s)

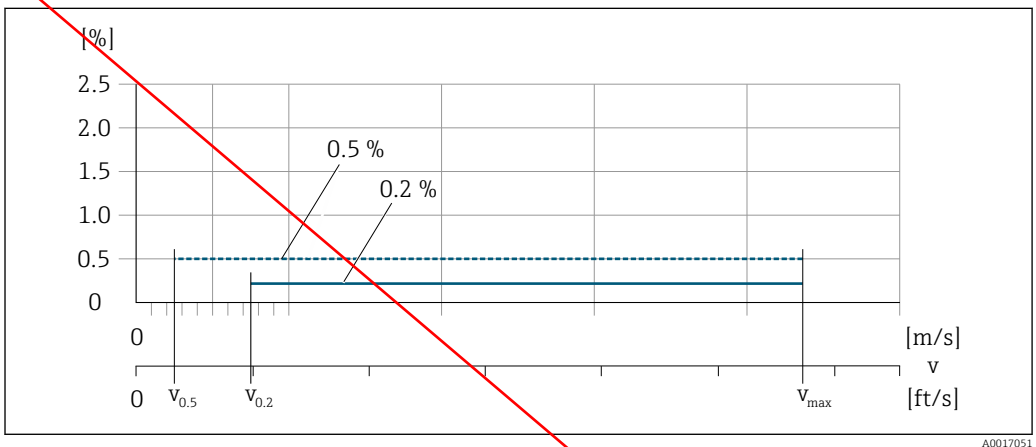
Fluctuations in the supply voltage do not have any effect within the specified range.



14 *Maximum measured error in % o.r.*

Flat Spec

For Flat Spec in the range $v_{0.5}$ ($v_{0.2}$) up to v_{max} the measured error is constant.



15 *Flat Spec in % o.r.*

Flat Spec flow values 0.5 %

Nominal diameter		$v_{0.5}$		v_{max}	
[mm]	[in]	[m/s]	[ft/s]	[m/s]	[ft/s]
25 to 600	1 to 24	0.5	1.64	10	32
50 to 300 [1)]	2 to 12	0.25	0.82	5	16

1) Order code for "Design", option C

Flat Spec flow values 0.2 %

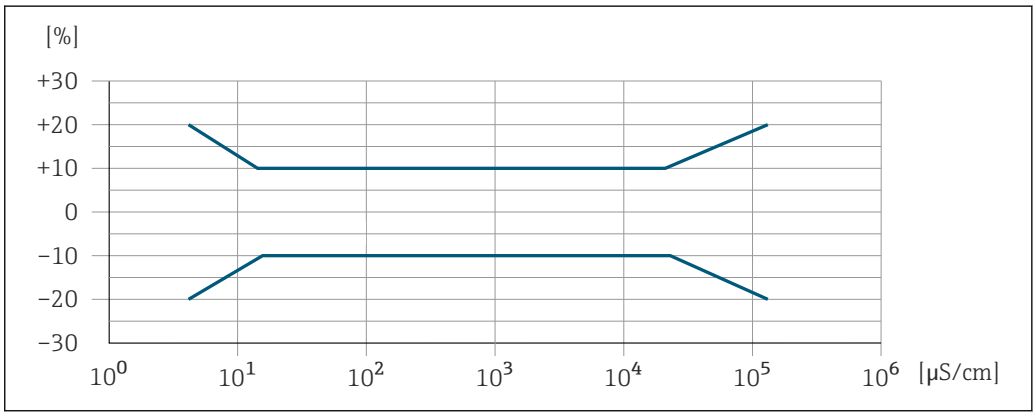
Nominal diameter		$v_{0.2}$		v_{max}	
[mm]	[in]	[m/s]	[ft/s]	[m/s]	[ft/s]
25 to 600	1 to 24	1.5	4.92	10	32
50 to 300 [1)]	2 to 12	0.6	1.97	4	13

1) Order code for "Design", option C

Electrical conductivity

The values apply for:
- Measurements at a reference temperature of 25 °C (77 °F)
  At different temperatures, attention must be paid to the temperature coefficient of the medium (typically 2.1 %/K)
- Device version: compact version - transmitter and sensor form a mechanical unit
- Devices installed in a metal pipe or in a non-metal pipe with ground disks
- Devices whose potential equalization was performed according to the instructions in the associated Operating Instructions

Conductivity [µS/cm]	Measured error [%] o. r.
5 to 20	± 20%
20 to 20 000	± 10%
20 000 to 100 000	± 20%



16 *Measured error*

Accuracy of outputs

The outputs have the following base accuracy specifications.

Current output

Accuracy	Max. ±5 µA

Pulse/frequency output

o.r. = of reading

Accuracy	Max. ±50 ppm o.r. (over the entire ambient temperature range)

Repeatability

o.r. = of reading

Volume flow
max. ±0.1 % o.r. ± 0.5 mm/s (0.02 in/s)

Electrical conductivity
Max. ±5 % o.r.

Influence of ambient temperature

Current output

o.r. = of reading

Temperature coefficient	Max. ±0.005 % o.r./°C

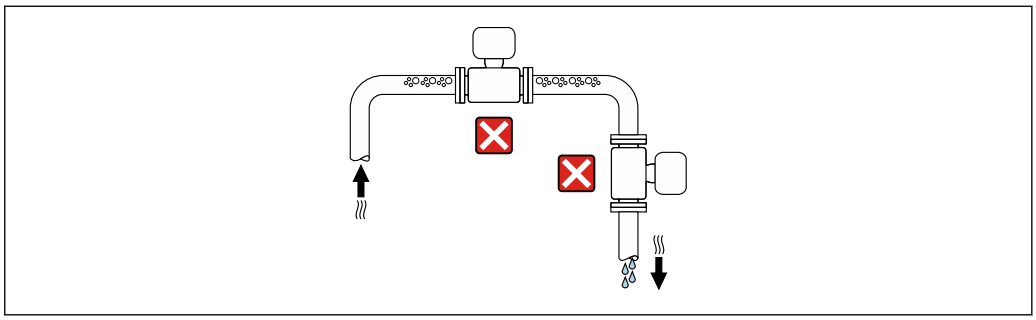
Pulse/frequency output

Temperature coefficient	No additional effect. Included in accuracy.

Installation

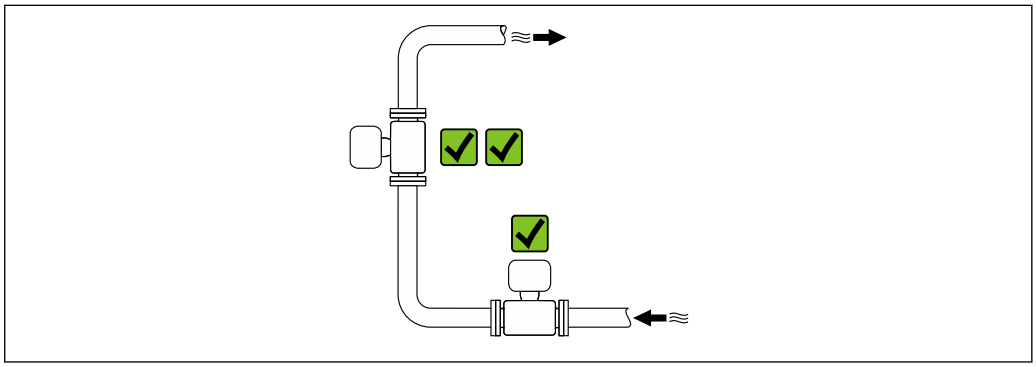
Mounting location

- Do not install the device at the highest point of the pipe.
- Do not install the device upstream from a free pipe outlet in a down pipe.



A0042131

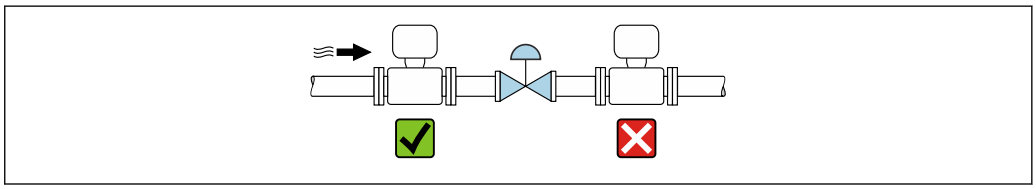
The device should ideally be installed in an ascending pipe.



A0042317

Installation near valves

Install the device in the direction of flow upstream from the valve.



A0041091

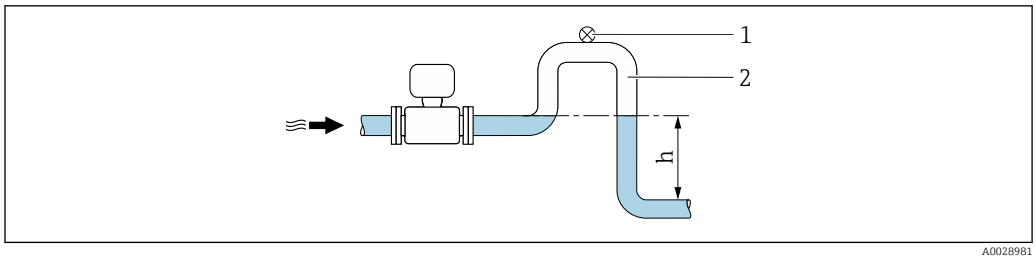
Installation upstream from a down pipe

NOTICE

Negative pressure in the measuring pipe can damage the liner!

▶ If installing upstream from down pipes with a length h ≥ 5 m (16.4 ft), install a siphon with a vent valve downstream from the device.

This arrangement prevents the stoppage of liquid flow and the formation of air pockets.

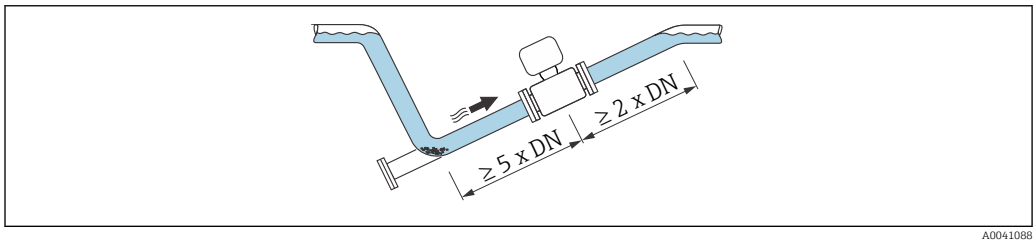


A0028981

1 Vent valve
2 Pipe siphon
h Length of down pipe

Installation with partially filled pipes

- Partially filled pipes with a gradient require a drain-type configuration.
- The installation of a cleaning valve is recommended.



A0041088

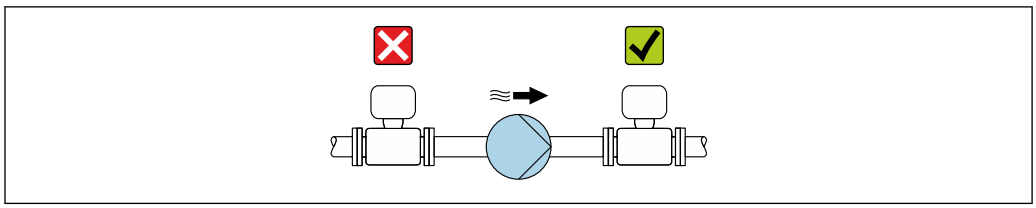
No inlet and outlet runs for devices with the order code for "Design": Option C, H, I, J or K.

Installation near pumps

NOTICE

Negative pressure in the measuring pipe can damage the liner!

- ▶ In order to maintain the system pressure, install the device in the flow direction downstream from the pump.
- ▶ Install pulsation dampers if reciprocating, diaphragm or peristaltic pumps are used.



A0041083

- Information on the liner's resistance to partial vacuum → 51
- Information on the measuring system's resistance to vibration and shock → 47

Installation of very heavy devices

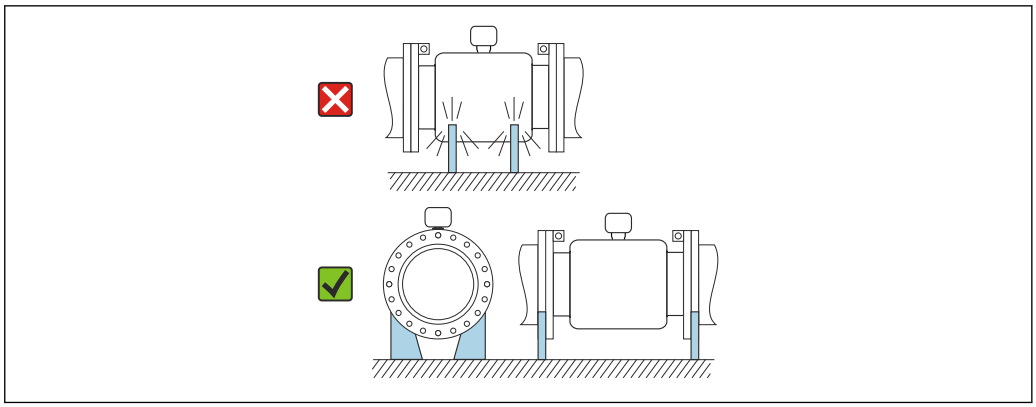
Support required for nominal diameters of DN ≥ 350 mm (14 in).

NOTICE

Damage to the device!

If incorrect support is provided, the sensor housing could buckle and the internal magnetic coils could be damaged.

- ▶ Only provide supports at the pipe flanges.



A0041087

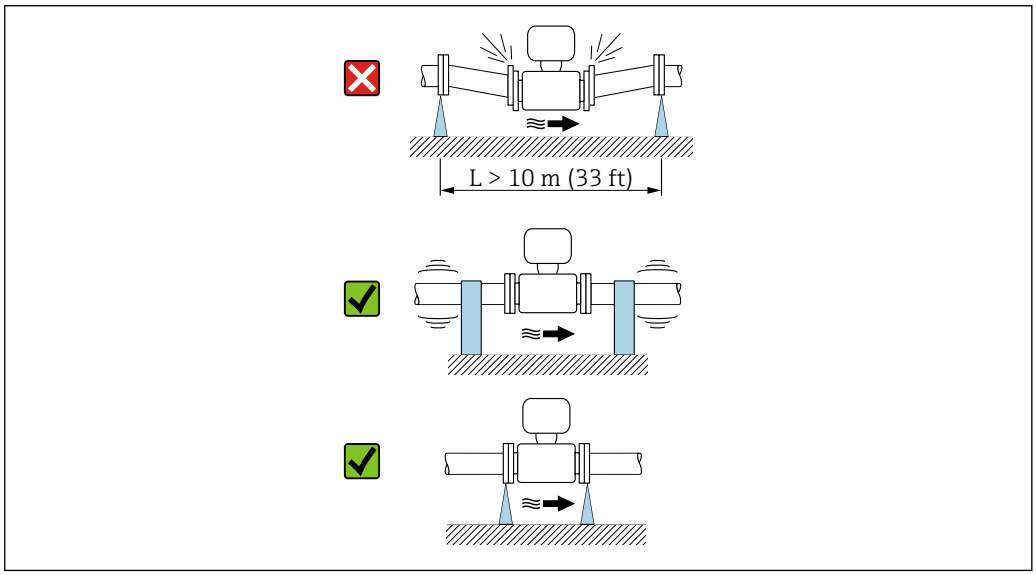
Installation in event of pipe vibrations

A remote version is recommended in the event of strong pipe vibrations.

NOTICE

Pipe vibrations can damage the device!

- Do not expose the device to strong vibrations.
- Support the pipe and fix it in place.
- Support the device and fix it in place.
- Mount the sensor and transmitter separately.

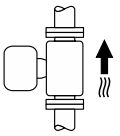
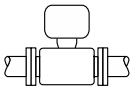
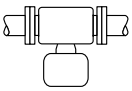
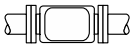


A0041092

Information on the measuring system's resistance to vibration and shock → 47

Orientation

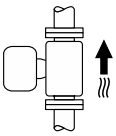
The direction of the arrow on the sensor nameplate helps you to install the sensor according to the flow direction (direction of medium flow through the piping).

Orientation		Recommendation
Vertical orientation	 A0015591	✓✓
Horizontal orientation, transmitter at top	 A0015589	✓✓ 1)
Horizontal orientation, transmitter at bottom	 A0015590	✓✓ 2) 3) ✗ 4)
Horizontal orientation, transmitter at side	 A0015592	✗

1) Applications with low process temperatures may decrease the ambient temperature. To maintain the minimum ambient temperature for the transmitter, this orientation is recommended.
2) Applications with high process temperatures may increase the ambient temperature. To maintain the maximum ambient temperature for the transmitter, this orientation is recommended.
3) To prevent the electronics module from overheating in the case of a sharp rise in temperature (e.g. CIP or SIP processes), install the device with the transmitter component pointing downwards.
4) With the empty pipe detection function switched on: empty pipe detection only works if the transmitter housing is pointing upwards.

Vertical

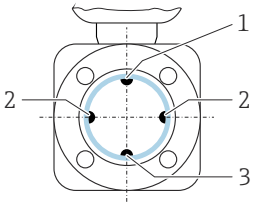
Optimum for self-emptying pipe systems and for use in conjunction with empty pipe detection.



A0015591

Horizontal

- Ideally, the measuring electrode plane should be horizontal. This prevents brief insulation of the measuring electrodes by entrained air bubbles.
- Empty pipe detection only works if the transmitter housing is pointing upwards as otherwise there is no guarantee that the empty pipe detection function will actually respond to a partially filled or empty measuring tube.



A0029344

1 EPD electrode for empty pipe detection
2 Measuring electrodes for signal detection
3 Reference electrode for potential equalization

Inlet and outlet runs

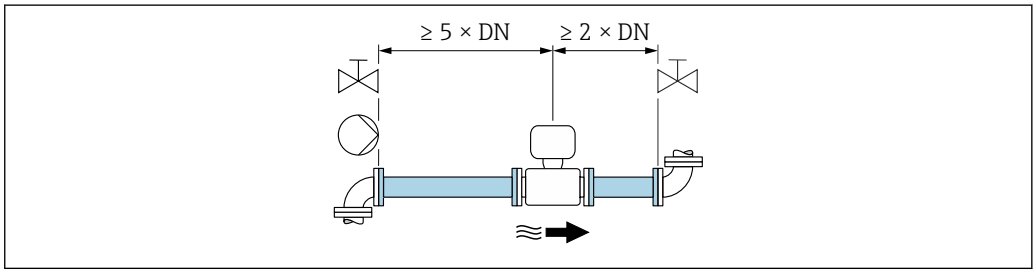
Installation with inlet and outlet runs

Installation requires inlet and outlet runs: devices with the order code for "Design", option D, E, F and G.

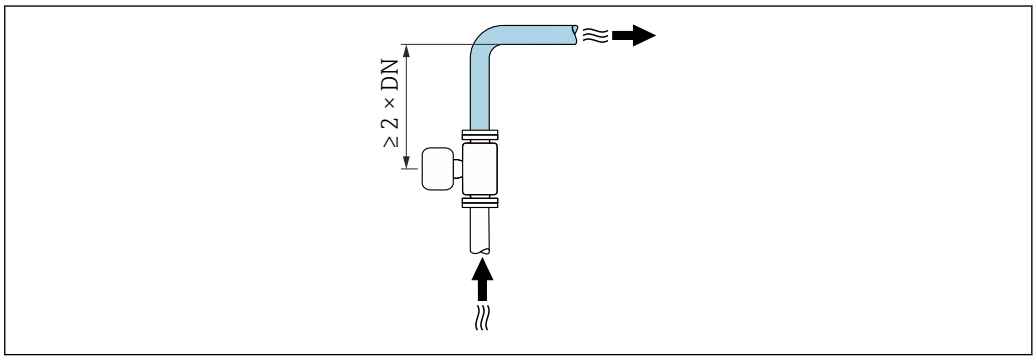
Installation with elbows, pumps or valves

To avoid a vacuum and to maintain the specified level of accuracy, install the device upstream from assemblies that produce turbulence (e.g. valves, T-sections) and downstream from pumps, wherever possible.

Maintain straight, unimpeded inlet and outlet runs.



A0028997



A0042132

Installation without inlet and outlet runs

Depending on the device design and installation location, the inlet and outlet runs can be reduced or omitted entirely.

Maximum measured error
When the device is installed with the inlet and outlet runs described, a maximum measured error of ±0.5 % of the reading ±1 mm/s (0.04 in/s) can be guaranteed.

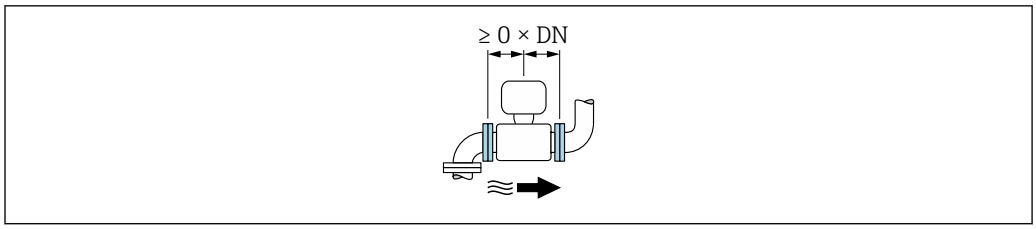
Devices and possible order options

Order code for "Design"		
Option	**Description**	**Design**
C	Fixed flange, constricted measuring tube, 0 x DN inlet/outlet runs	Constricted measuring tube [1]
H	Lap joint flange, 0 x DN inlet/outlet runs	Full Bore [2]
I	Fixed flange, 0 x DN inlet/outlet runs	
J	Fixed flange, short installed length, 0 x DN inlet/outlet runs	
K	Fixed flange, long installed length, 0 x DN inlet/outlet runs	

1) "Constricted measuring tube" stands for a reduction of the internal diameter of the measuring tube. The reduced internal diameter causes a higher flow velocity inside the measuring tube.
2) "Full Bore" stands for the full diameter of the measuring tube. There is no pressure loss with a full diameter.

Installation before or after bends

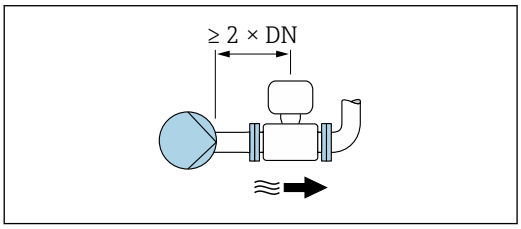
Installation without inlet and outlet runs is possible: devices with the order code for "Design", option C, H, I, J and K.



Installation downstream of pumps

Installation without inlet and outlet runs is possible: devices with the order code for "Design", option C, H and I.

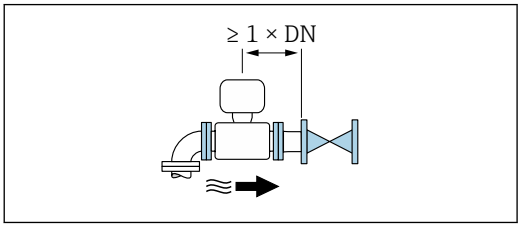
In the case of devices with the order code for "Design", option J and K, an inlet run of only ≥ 2 x DN must be taken into consideration.



Installation upstream of valves

Installation without inlet and outlet runs is possible: devices with the order code for "Design", option C, H and I.

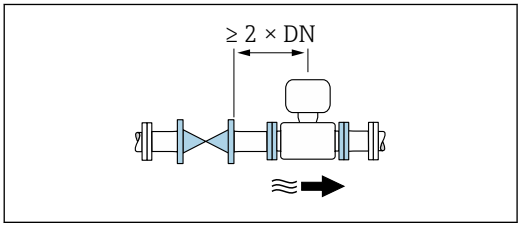
In the case of devices with the order code for "Design", option J and K, an outlet run of only ≥ 1 x DN must be taken into consideration.



Installation downstream of valves

Installation without inlet and outlet runs is possible if the valve is 100% open during operation: devices with the order code for "Design", option C, H and I.

In the case of devices with the order code for "Design", option J and K, an inlet run of only ≥ 2 x DN must be taken into consideration if the valve is 100% open during operation.



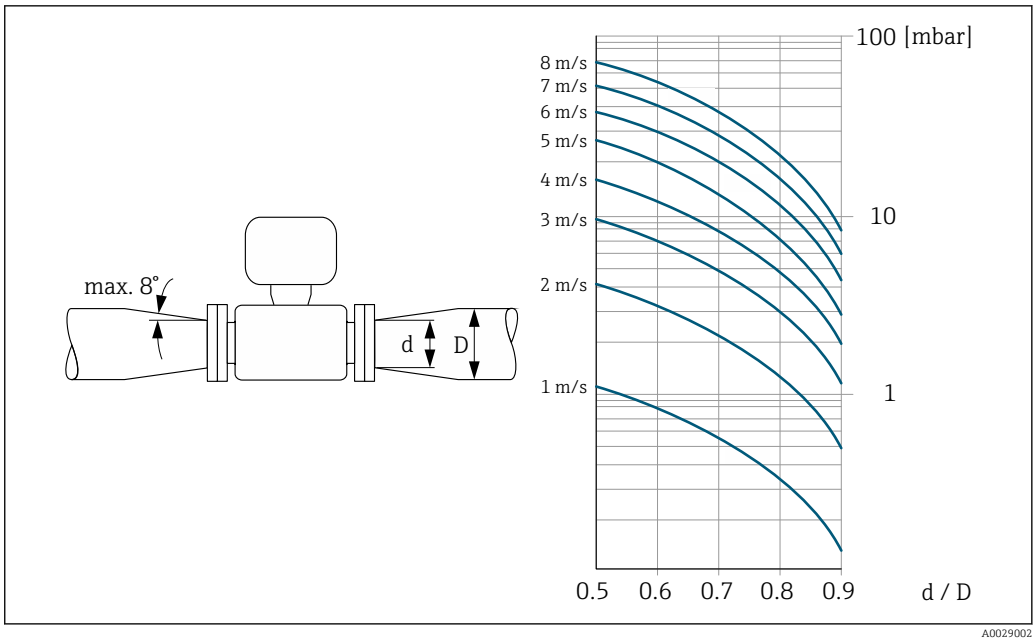
Adapters

Suitable adapters to DIN EN 545 (double-flange reducers) can be used to install the sensor in larger-diameter pipes. The resultant increase in the rate of flow improves measuring accuracy with very slow-moving fluids.

The nomogram shown here can be used to calculate the pressure loss caused by reducers and expanders:

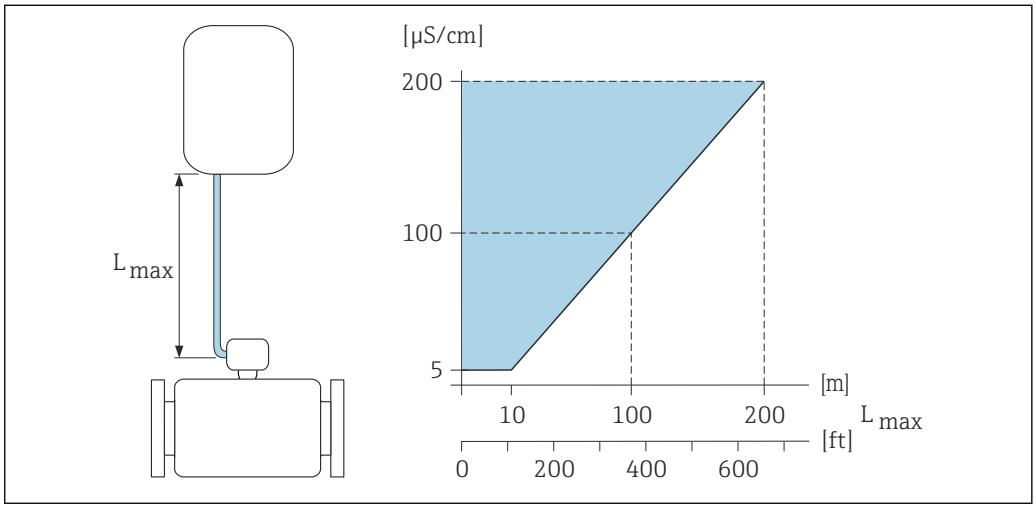
- Calculate the ratio of the diameters d/D.
- From the nomogram read off the pressure loss as a function of flow velocity (downstream from the reduction) and the d/D ratio.

The nomogram only applies to liquids with a viscosity similar to that of water.



Length of connecting cable

To obtain correct measurement results, observe the permitted connecting cable length of L_{max}. This length is determined by the conductivity of the fluid. If measuring liquids in general: 5 µS/cm



17 *Permitted length of connecting cable*

Colored area = permitted range
L_{max} = length of connecting cable in [m] ([ft])
[µS/cm] = fluid conductivity

Special mounting instructions

Display guard

To ensure that the optional display guard can be easily opened, maintain the following minimum head clearance: 350 mm (13.8 in)

Immersion in water

- Only the remote version of the device with IP68 protection, Type 6P is suitable for underwater use: order code for "Sensor option", options CB, CC, CD, CE and CQ.
- Pay attention to regional installation instructions.

NOTICE

If the maximum water depth and operating duration is exceeded, this can damage the device!

▶ Observe the maximum water depth and operating duration.

Order code for "Sensor option", options CB, CC

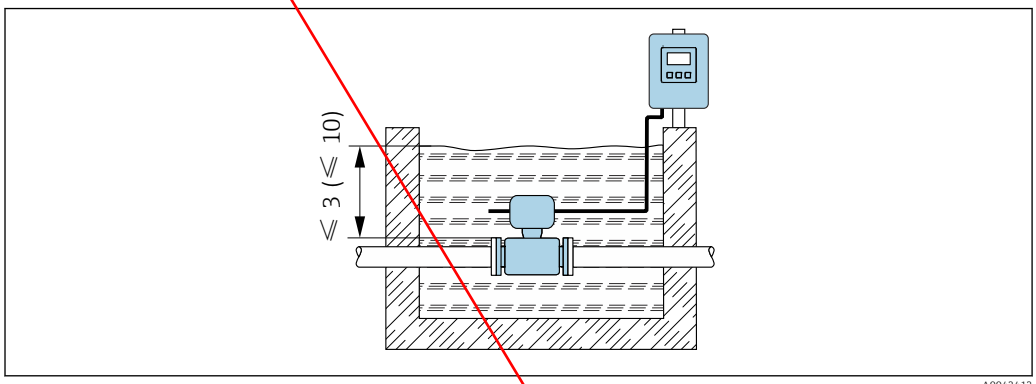
- For the operation of the device under water
- Operating duration at a maximum depth of:
  - 3 m (10 ft): permanent use
  - 10 m (30 ft): maximum 48 hours

Order code for "Sensor option", option CQ "Temporarily water-proof "

- For the temporary operation of the device under non-corrosive water
- Operating duration at a maximum depth of:
  3 m (10 ft): maximum 168 hours

Order code for "Sensor option", options CD, CE

- For the operation of the device under water and in saline water
- Operating duration at a maximum depth of:
  - 3 m (10 ft): permanent use
  - 10 m (30 ft): maximum 48 hours



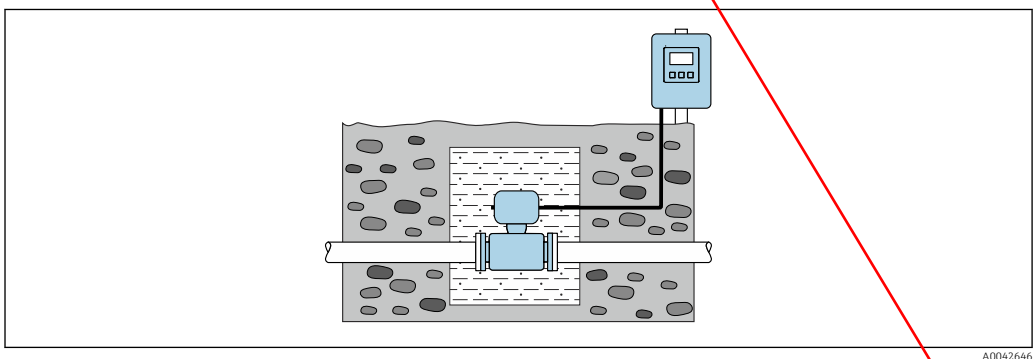
A0042412

Use in buried applications

- Only the remote version of the device with IP68 protection is suitable for use in buried applications: order code for "Sensor option", options CD and CE.
- Pay attention to regional installation instructions.

Order code for "Sensor option", options CD, CE

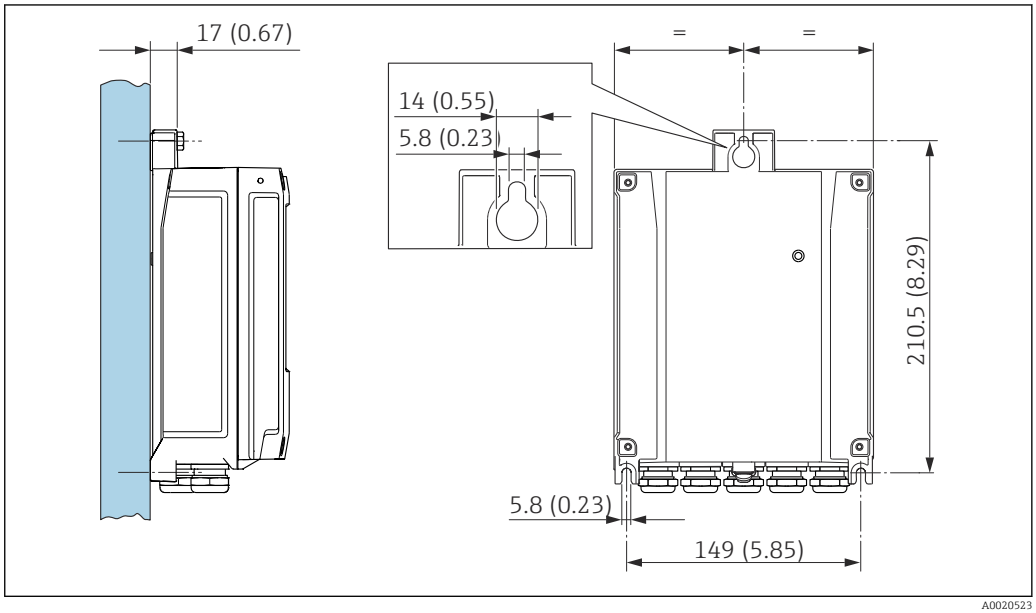
For the use of the device in buried applications.



A0042646

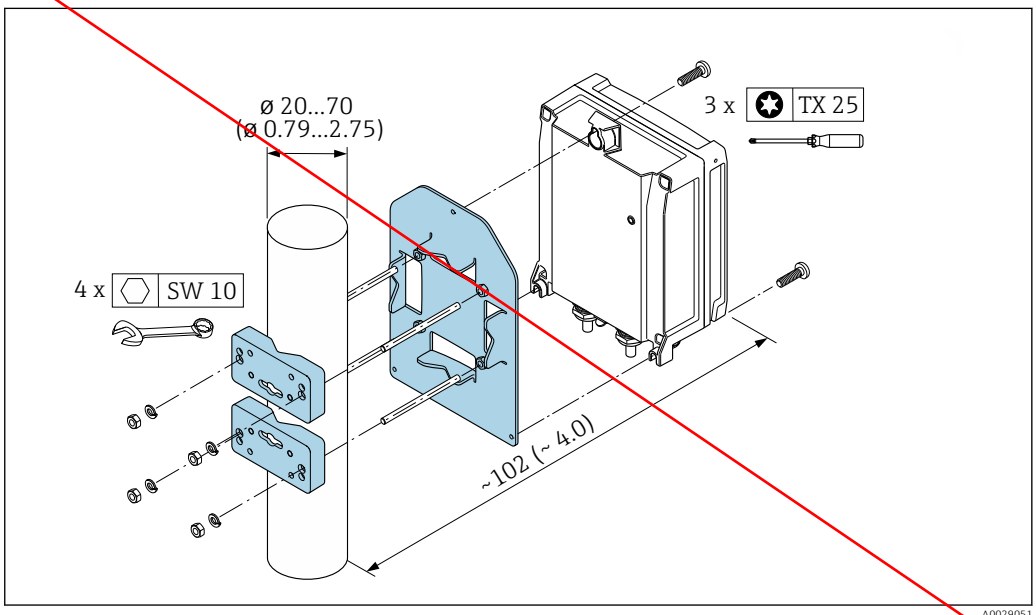
Mounting the transmitter housing

Wall mounting



18 *Engineering unit mm (in)*

Post mounting



19 *Engineering unit mm (in)*

Environment

Ambient temperature range

Transmitter	−40 to +60 °C (−40 to +140 °F)
Local display	−20 to +60 °C (−4 to +140 °F), the legibility of the local display may be impaired at temperatures outside the temperature range.

Sensor	▪ Process connection material, carbon steel: −10 to +60 °C (+14 to +140 °F) ▪ Process connection material, stainless steel: −40 to +60 °C (−40 to +140 °F) If both the ambient and the medium temperatures are high, mount the sensor separately from the transmitter.
Liner	Do not exceed or fall below the permitted temperature range of the liner → 48.

If operating outdoors:
- Install the measuring device in a shady location.
- Avoid direct sunlight, particularly in warm climatic regions.
- Avoid direct exposure to weather conditions.
- If the compact version of the device is insulated at low temperatures, the insulation must also include the device neck.
- Protect the display against impact.
- Protect the display from abrasion, e.g. caused by sand in desert areas.

Display guard available as an accessory → 103.

Temperature tables

Observe the interdependencies between the permitted ambient and fluid temperatures when operating the device in hazardous areas.

For detailed information on the temperature tables, see the separate document entitled "Safety Instructions" (XA) for the device.

Storage temperature

The storage temperature corresponds to the operating temperature range of the transmitter and the sensor → 45.

- Protect the measuring device against direct sunlight during storage in order to avoid unacceptably high surface temperatures.
- Select a storage location where moisture cannot collect in the measuring device as fungus or bacteria infestation can damage the liner.
- If protection caps or protective covers are mounted these should never be removed before installing the measuring device.

Atmosphere

If a plastic transmitter housing is permanently exposed to certain steam and air mixtures, this can damage the housing.

In cases of doubt, please contact the Sales Center.

Degree of protection

Transmitter

- IP66/67, type 4X enclosure
- When housing is open: IP20, type 1 enclosure
- Display module: IP20, type 1 enclosure

Sensor

Compact and remote version

IP66/67, type 4X enclosure

Optionally available for compact and remote version:

Order code for "Sensor option", option CA, C3
- IP66/67, type 4X enclosure
- Fully welded, with protective coating as per EN ISO 12944 C5-M
- For the operation of the device in corrosive environments

Optionally available for remote version:

Order code for "Sensor option", option CB, CC
- IP68, type 6P enclosure
- Fully welded, with protective coating as per EN ISO 12944 C5-M/Im1 and EN 60529
- For the operation of the device under water
- Operating duration at a maximum depth of:
  - 3 m (10 ft): permanent use
  - 10 m (30 ft): maximum 48 hours

Order code for "Sensor option", option CQ
- IP68, type 6P, temporarily waterproof
- Sensor with aluminum half-shell housing
- For the temporary operation of the device under non-corrosive water
- Operating duration at a maximum depth of:
  3 m (10 ft): maximum 168 hours

Order code for "Sensor option", option CD, CE
- IP68, type 6P enclosure
- Fully welded, with protective coating as per EN ISO 12944 Im2/Im3 and EN 60529
- For the operation of the device in buried applications
- For the operation of the device under water and in saline water
- Operating duration at a maximum depth of:
  - 3 m (10 ft): permanent use
  - 10 m (30 ft): maximum 48 hours

Vibration- and shock-resistance

Sinusoidal vibration according to IEC 60068-2-6

Compact version; order code for "Housing", option A "Compact, aluminum, coated"
- 2 to 8.4 Hz, 3.5 mm peak
- 8.4 to 2 000 Hz, 1 g peak

Compact version; order code for "Housing", option M "Compact, polycarbonate"
- 2 to 8.4 Hz, 7.5 mm peak
- 8.4 to 2 000 Hz, 2 g peak

Remote version; order code for "Housing", option N "Remote, polycarbonate" and option P "Remote, aluminum, coated"
- 2 to 8.4 Hz, 7.5 mm peak
- 8.4 to 2 000 Hz, 2 g peak

Vibration broad-band random, according to IEC 60068-2-64

Compact version; order code for "Housing", option A "Compact, aluminum, coated"
- 10 to 200 Hz, 0.003 g^2/Hz
- 200 to 2 000 Hz, 0.001 g^2/Hz
- Total: 1.54 g rms

Compact version; order code for "Housing", option M "Compact, polycarbonate"
- 10 to 200 Hz, 0.01 g^2/Hz
- 200 to 2 000 Hz, 0.003 g^2/Hz
- Total: 2.70 g rms

Remote version; order code for "Housing", option N "Remote, polycarbonate" and option P "Remote, aluminum, coated"
- 10 to 200 Hz, 0.01 g^2/Hz
- 200 to 2 000 Hz, 0.003 g^2/Hz
- Total: 2.70 g rms

Shock half-sine, according to IEC 60068-2-27

- Compact version; order code for "Housing", option A "Compact, aluminum, coated"
  6 ms 30 g
- Compact version; order code for "Housing", option M "Compact, polycarbonate"
  6 ms 50 g
- Remote version; order code for "Housing", option N "Remote, polycarbonate" and option P "Remote, aluminum, coated"
  6 ms 50 g

Rough handling shocks according to IEC 60068-2-31

Mechanical load

- Protect the transmitter housing against mechanical effects, such as shock or impact; the use of the remote version is sometimes preferable.
- Never use the transmitter housing as a ladder or climbing aid.

Electromagnetic compatibility (EMC)

- As per IEC/EN 61326 and NAMUR Recommendation 21 (NE 21)
- Complies with emission limits for industry as per EN 55011 (Class A)
- Device version with PROFIBUS DP: Complies with emission limits for industry as per EN 50170 Volume 2, IEC 61784

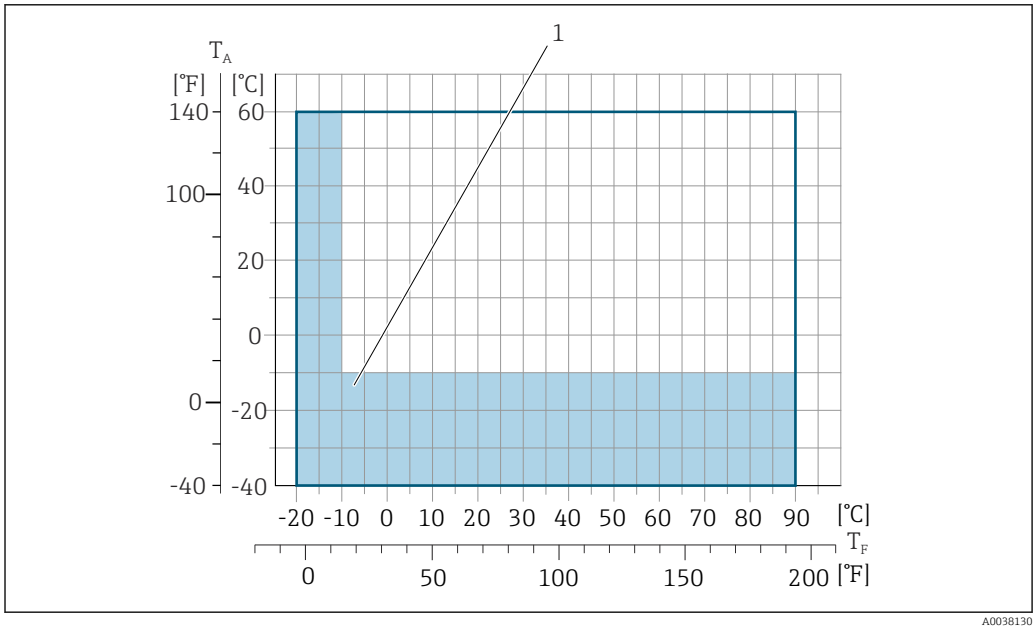
The following applies for PROFIBUS DP: If baud rates > 1.5 MBaud, an EMC cable entry must be used and the cable shield must continue as far as the terminal wherever possible.

Details are provided in the Declaration of Conformity.

Process

Medium temperature range

- ~~0 to +80 °C (+32 to +176 °F) for hard rubber, DN 50 to 3000 (2 to 120")~~
- ~~–20 to +50 °C (–4 to +122 °F) for polyurethane, DN 25 to 1200 (1 to 48")~~
- –20 to +90 °C (–4 to +194 °F) for PTFE, DN 25 to 300 (1 to 12")



T_A *Ambient temperature*
T_F *Medium temperature*
1 *Colored area: The ambient temperature range of –10 to –40 °C (+14 to –40 °F) and the medium temperature range of –10 to –20 °C (+14 to –4 °F) only apply for stainless flanges*

The permitted fluid temperature in custody transfer is 0 to +50 °C (+32 to +122 °F).

Conductivity

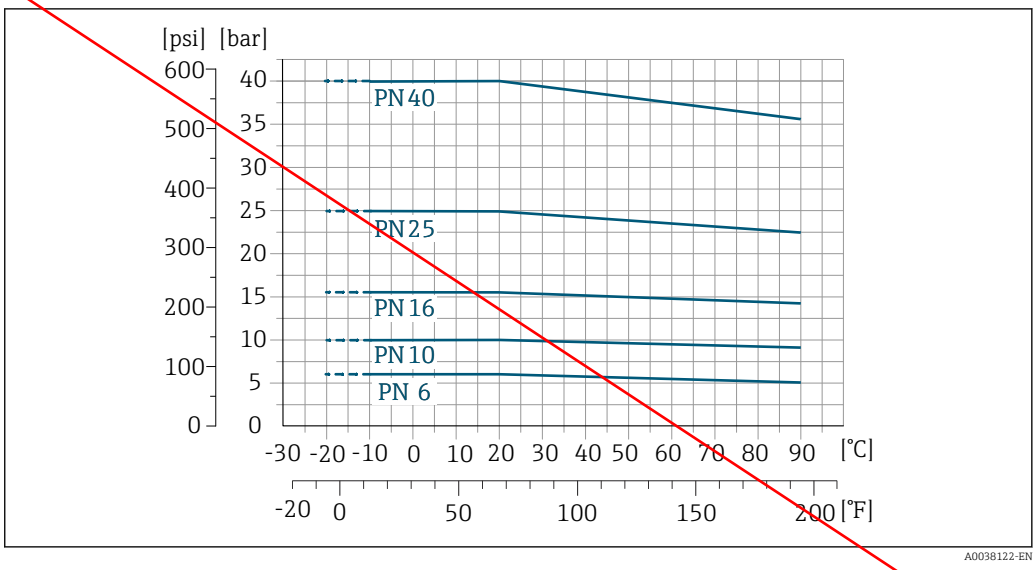
≥5 µS/cm for liquids in general.

- Note that in the case of the remote version, the requisite minimum conductivity additionally depends on the length of the connecting cable → 43.
- Maximum measured error for electrical conductivity → 35.

Pressure/temperature ratings

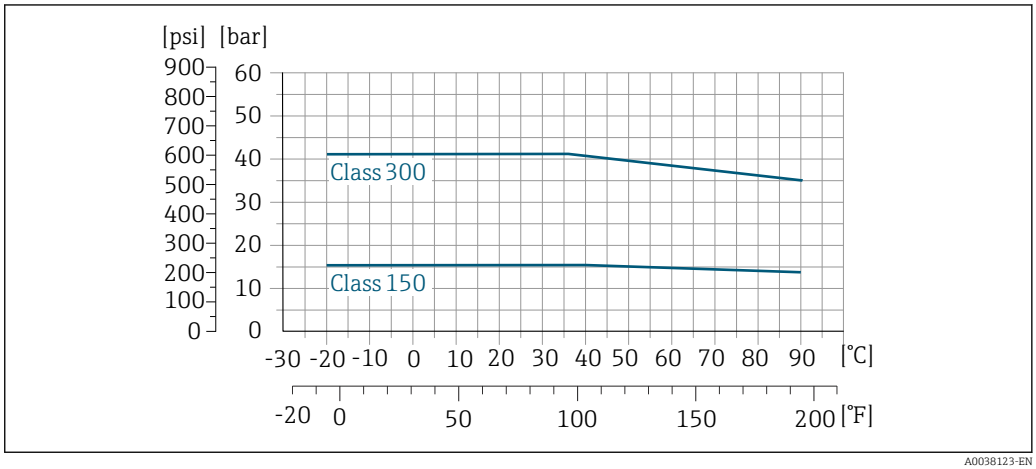
The following pressure/temperature diagrams apply to all pressure-bearing parts of the device and not just the process connection. The diagrams show the maximum permissible medium pressure depending on the specific medium temperature.

Process connection: fixed flange according to EN 1092-1 (DIN 2501)

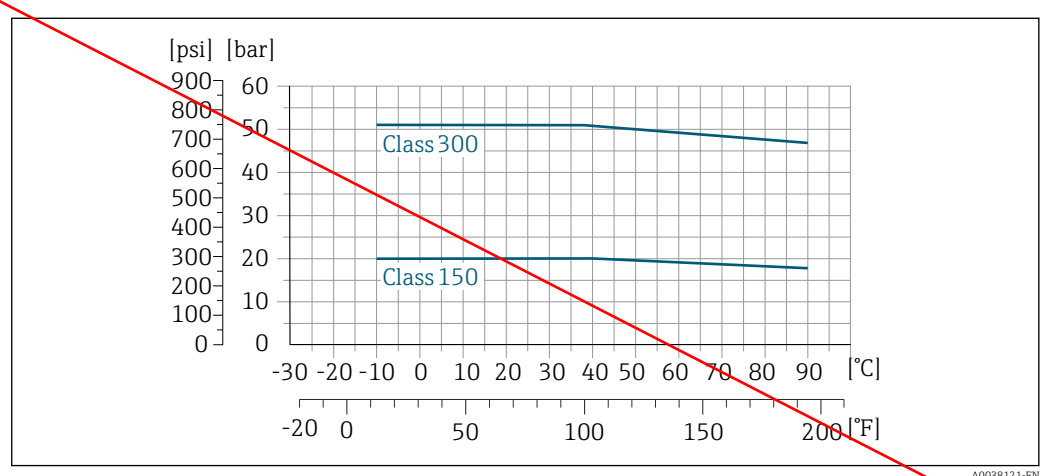


20 *Process connection material: stainless steel (−20 °C (−4 °F)); carbon steel (−10 °C (14 °F))*

Process connection: fixed flange according to ASME B16.5

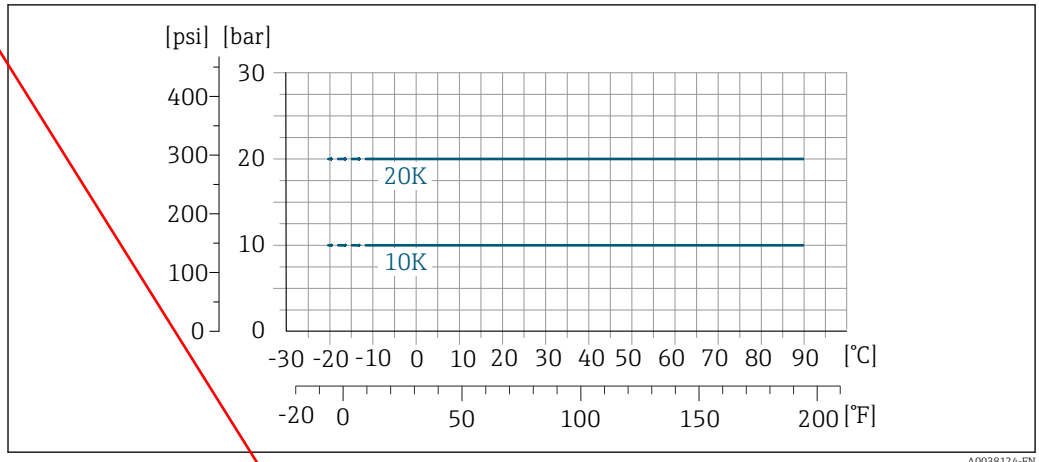


21 *Process connection material: stainless steel*



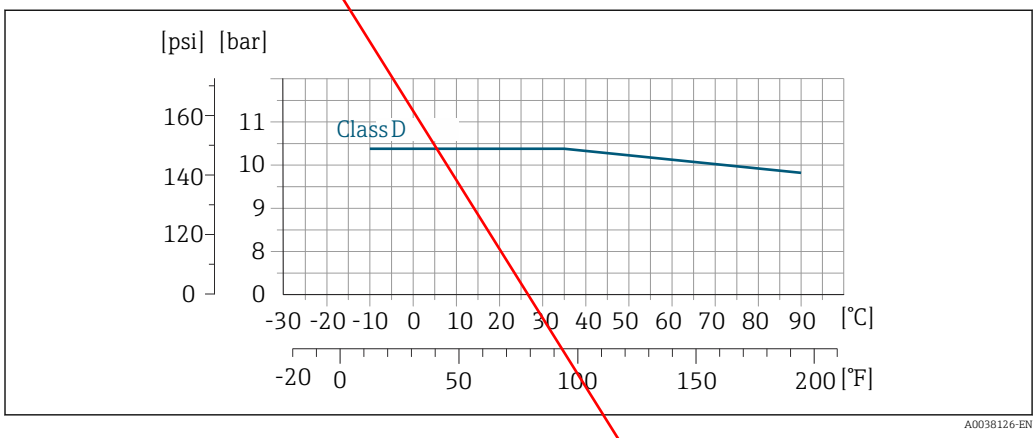
22 *Process connection material: carbon steel*

Process connection: fixed flange according to JIS B2220



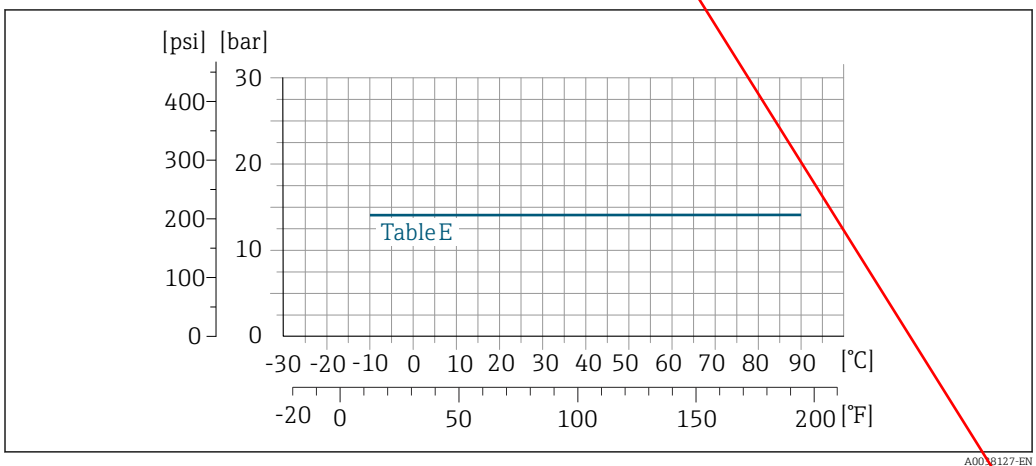
23 Process connection material: stainless steel (−20 °C (−4 °F)); carbon steel (−10 °C (14 °F))

Process connection: fixed flange according to AWWA C207



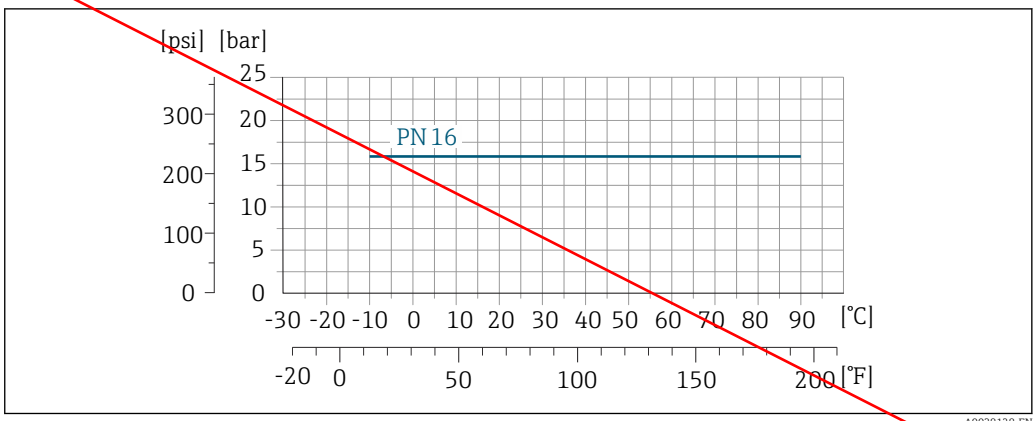
24 Process connection material: carbon steel

Process connection: fixed flange according to AS 2129



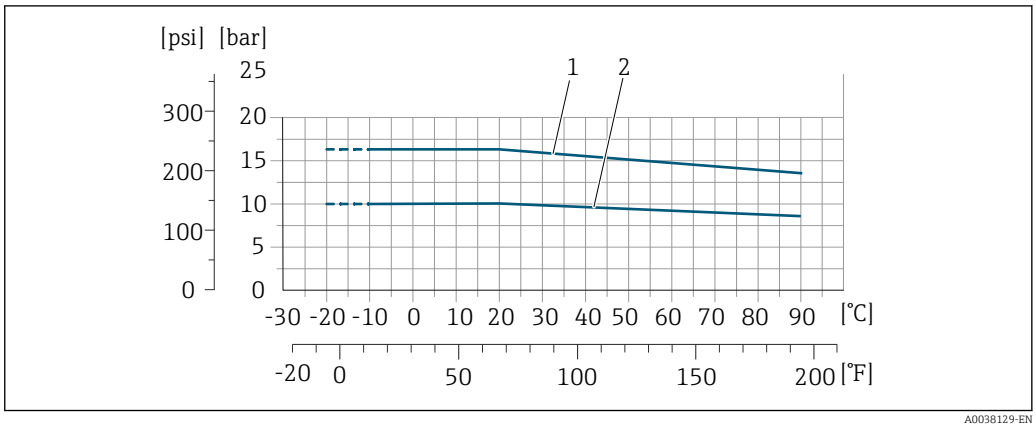
25 Process connection material: carbon steel

Process connection: fixed flange according to AS 4087



26 *Process connection material: carbon steel*

Process connection: lap joint flange/lap joint flange, stamped plate according to EN 1092-1 (DIN 2501) and ASME B16.5; DN 25 to 300 (1 to 12")



27 *Process connection material: stainless steel (−20 °C (−4 °F)); carbon steel (−10 °C (14 °F))*

1 *Lap joint flange PN16/ Class150*
2 *Lap joint flange, stamped plate PN10, lap joint flange PN10*

Pressure tightness

Liner: hard rubber

Nominal diameter		Limit values for absolute pressure in [mbar] ([psi]) for medium temperatures:		
[mm]	[in]	+25 °C (+77 °F)	+50 °C (+122 °F)	+80 °C (+176 °F)
50 … 3000	2 … 120	0 (0)	0 (0)	0 (0)

Liner: polyurethane

Nominal diameter		Limit values for absolute pressure in [mbar] ([psi]) for medium temperatures:	
[mm]	[in]	+25 °C (+77 °F)	+50 °C (+122 °F)
25 … 1200	1 … 48	0 (0)	0 (0)

Liner: PTFE

Nominal diameter		Limit values for absolute pressure in [mbar] ([psi]) for medium temperatures:	
[mm]	[in]	+25 °C (+77 °F)	+90 °C (+194 °F)
25	1	0 (0)	0 (0)
40	2	0 (0)	0 (0)

Nominal diameter		Limit values for absolute pressure in [mbar] ([psi]) for medium temperatures:	
[mm]	[in]	+25 °C (+77 °F)	+90 °C (+194 °F)
50	2	0 (0)	0 (0)
65	2 ½	0 (0)	40 (0.58)
80	3	0 (0)	40 (0.58)
100	4	0 (0)	135 (2.0)
125	5	135 (2.0)	240 (3.5)
150	6	135 (2.0)	240 (3.5)
200	8	200 (2.9)	290 (4.2)
250	10	330 (4.8)	400 (5.8)
300	12	400 (5.8)	500 (7.3)

Flow limit

The diameter of the pipe and the flow rate determine the nominal diameter of the sensor. The optimum velocity of flow is between 2 to 3 m/s (6.56 to 9.84 ft/s). Also match the velocity of flow (v) to the physical properties of the medium:

- v < 2 m/s (6.56 ft/s): for abrasive media (e.g. potter's clay, lime milk, ore slurry)
- v > 2 m/s (6.56 ft/s): for media producing buildup (e.g. wastewater sludge)

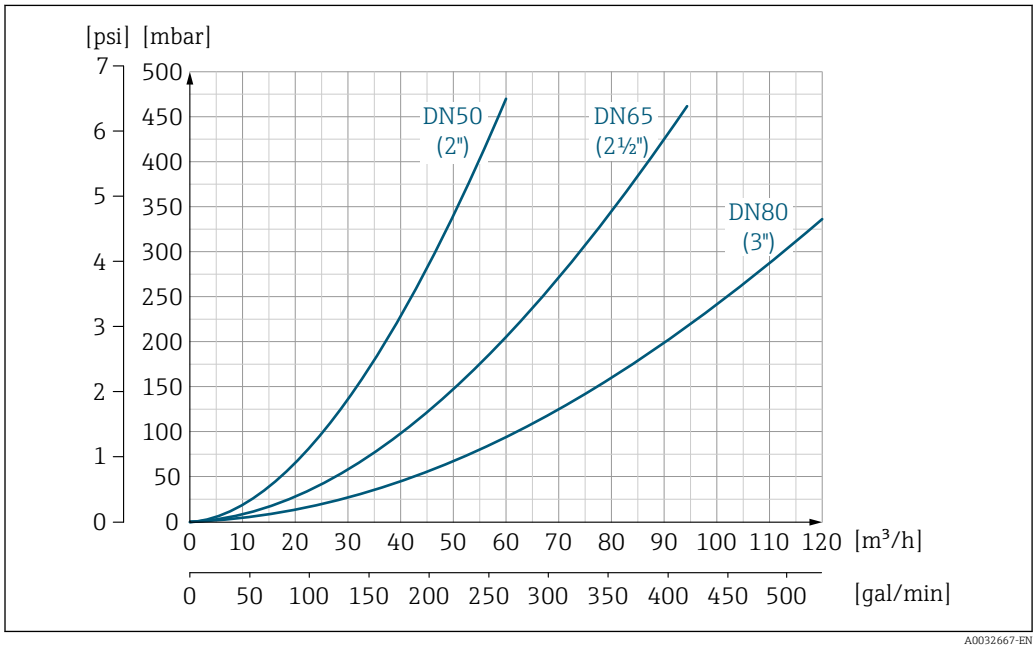
A necessary increase in the flow velocity can be achieved by reducing the sensor nominal diameter.

For an overview of the full scale values for the measuring range, see the "Measuring range" section → 8

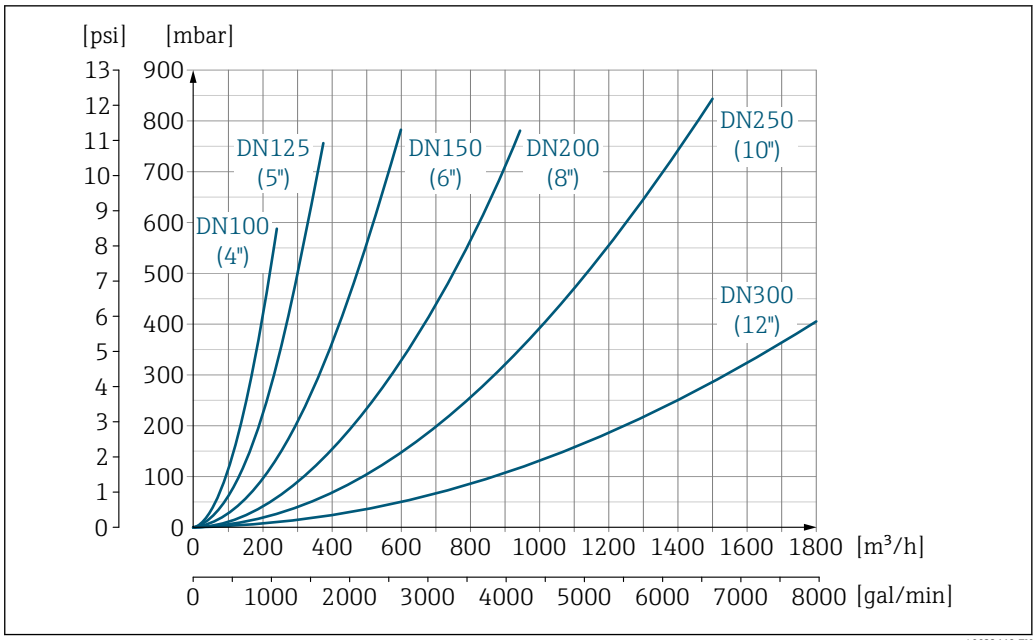
For custody transfer, the applicable approval determines the permitted measuring range.

Pressure loss

- No pressure loss occurs if the sensor is installed in a pipe with the same nominal diameter.
- Pressure losses for configurations incorporating adapters according to DIN EN 545 → 42



28 *Pressure loss DN 50 to 80 (2 to 3") for order code for "Design", option C "Fixed flange, constricted measuring tube", 0 x DN inlet/outlet runs"*



29 *Pressure loss DN 100 to 300 (4 to 12") for order code for "Design", option C "Fixed flange, constricted measuring tube", 0 x DN inlet/outlet runs"*

System pressure	Installation near pumps → 38
Vibrations	Installation in event of pipe vibrations → 39

Custody transfer mode

The measuring device is optionally tested in accordance with OIML R49 and has an EU type-examination certificate according to Measuring Instruments Directive 2014/32/EU for service subject to legal metrological control ("custody transfer") for cold water (Annex III).

The permitted medium temperature in these applications is 0 to +50 °C (+32 to +122 °F).

The device is used with a legally controlled totalizer on the local display and optionally with legally controlled outputs.

Measuring devices subject to legal metrological control totalize in both directions, i.e. all the outputs consider flow components in the positive (forward) and negative (reverse) flow direction.

Generally a measuring device subject to legal metrological control is secured against tampering by seals on the transmitter or sensor. These seals may normally only be opened by a representative of the competent authority for legal metrology controls.

After putting the device into circulation or after sealing the device, operation is only possible to a limited extent.

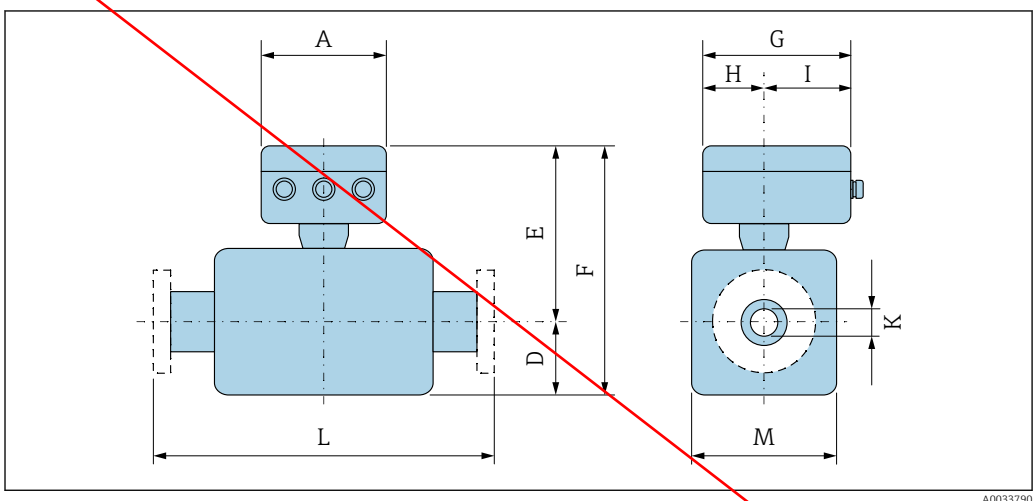
Detailed ordering information is available from your local Endress+Hauser sales center for national approvals (outside Europe) as cold water meters based on OIML R49.

Mechanical construction

Dimensions in SI units

Compact version

Order code for "Housing", option A "Compact, aluminum, coated" or option M "Compact, polycarbonate"



A0033790

A [mm]	G [1] [mm]	H [mm]	I [1] [mm]
167	193	90	103

1) Depending on the cable gland used: values up to + 30 mm

DN 25 to 300 mm (1 to 12 in): Sensor with aluminum half-shell housing

DN		Order code for "Design"								K	L
		Options D, E, H, I				Option C					
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]		
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
25	1	84	201	285	120	–	–	–	–	[2]	200
32	–	84	201	285	120	–	–	–	–	[2]	200
40	1 ½	84	201	285	120	–	–	–	–	[2]	200
50	2	84	201	285	120	84	201	285	120	[2]	200
65	–	109	226	335	180	84	201	285	120	[2]	200
80	3	109	226	335	180	84	201	285	120	[2]	200
100	4	109	226	335	180	109	226	335	180	[2]	250
125	–	150	266	416	260	109	226	335	180	[2]	250
150	6	150	266	416	260	109	226	335	180	[2]	300
200	8	180	291	471	324	150	266	416	260	[2]	350
250	10	205	316	521	400	150	266	416	260	[2]	450
300	12	230	341	571	460	180	291	471	324	[2]	500

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 90

DN 350 to 400 mm (14 to 16 in)

DN		Order code for "Design" Options E, I				K	L
		D [1]	E [1]	F [1]	M [1]		
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
350	14	282	379	679	564	[2]	550
375	15	308	423	731	616	[2]	600
400	16	308	423	731	616	[2]	600

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 90

DN 450 to 900 mm (18 to 36 in)

DN		Order code for "Design"								K	L	
		Options F, J				Options G, K						
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]			
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	
450	18	290	405	695	580	333	448	781	666	[2]	600 [3]	650 [4]
500	20	315	430	745	630	359	474	833	717	[2]	600 [3]	650 [4]
600	24	365	480	845	730	411	526	937	821	[2]	600 [3]	780 [4]
700	28	426	541	967	851	512	627	1139	1024	[2]	700 [3]	910 [4]
750	30	463	578	1041	926	512	627	1139	1024	[2]	750 [3]	975 [4]

DN		Order code for "Design"								K	L	
		Options F, J				Options G, K						
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]			
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	
800	32	482	597	1079	964	534	649	1183	1065	[2]	800 [3]	1040 [4]
900	36	532	647	1179	1064	610	725	1335	1218	[2]	900 [3]	1170 [4]

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 🖹 90
3) Order code for "Design", option F "Fixed flange, short installed length" and option J "Fixed flange, short installed length, 0 x DN inlet/outlet runs"
4) Order code for "Design", option G "Fixed flange, long installed length" and option K "Fixed flange, long installed length 0 x DN inlet/outlet runs"

DN 1000 to 2000 mm (40 to 78 in)

DN		Order code for "Design" Options F, G, J, K				K	L	
		D [1]	E [1]	F [1]	M [1]			
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	
1000	40	582	697	1279	1164	[2]	1000 [3]	1300 [4]
–	42	618	733	1351	1236	[2]	1050 [3]	1365 [4]
1200	48	696	811	1507	1392	[2]	1200 [3]	1560 [4]
–	54	809	924	1733	1617	[2]	1350 [3]	1755 [4]
1400	–	809	924	1733	1617	[2]	1400 [3]	1820 [4]
–	60	909	1024	1933	1817	[2]	1500 [3]	1950 [4]
1600	–	909	1024	1933	1817	[2]	1600 [3]	2080 [4]
–	66	960	1075	2035	1919	[2]	1650 [3]	2145 [4]
1800	72	1016	1131	2147	2032	[2]	1800 [3]	2340 [4]
–	78	1127	1242	2369	2254	[2]	2000 [3]	2600 [4]
2000	–	1127	1242	2369	2254	[2]	2000 [3]	2600 [4]

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 🖹 90
3) Order code for "Design", option F "Fixed flange, short installed length" and option J "Fixed flange, short installed length, 0 x DN inlet/outlet runs"
4) Order code for "Design", option G "Fixed flange, long installed length" and option K "Fixed flange, long installed length 0 x DN inlet/outlet runs"

DN 2200 to 3000 mm (84 to 120 in)

DN		Order code for "Design" Option F, J				K	L
		D [1]	E [1]	F [1]	M [1]		
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
–	84	1227	1342	2569	2454	[2]	2200
2200	–	1227	1342	2569	2454	[2]	2200
–	90	1332	1447	2779	2664	[2]	2400
2400	–	1332	1447	2783	2664	[2]	2400
–	96	1431	1546	2977	2861	[2]	2450

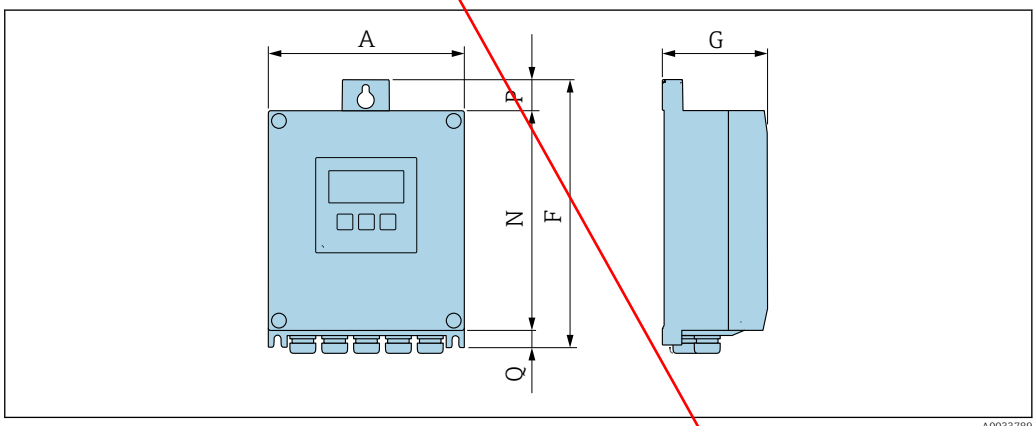
DN		Order code for "Design" Option F, J					
		D [1]	E [1]	F [1]	M [1]	K	L
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
–	102	1516	1631	3147	3032	[2]	2600
2600	–	1442	1557	2999	2883	[2]	2600
–	108	1602	1718	3320	3204	[2]	2750
2800	–	1547	1662	3209	3093	[2]	2800
–	114	1688	1803	3491	3375	[2]	2900
3000	–	1647	1762	3409	3293	[2]	3000
–	120	1774	1889	3663	3547	[2]	3050

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 90

Remote version

Transmitter remote version

Order code for "Housing", option N "Remote, polycarbonate" or option P "Remote, aluminum coated"



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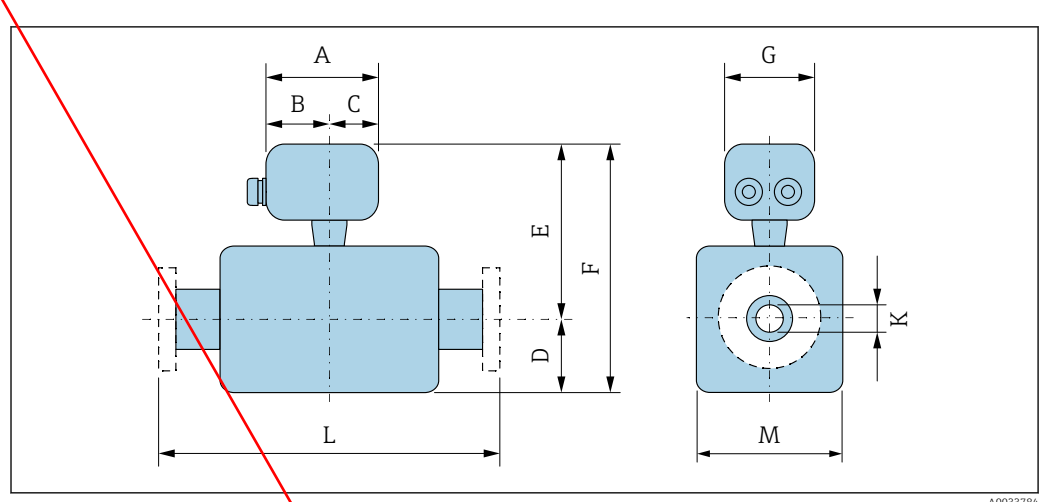
Order code for "Transmitter housing", option P "Remote, aluminum, coated"

A [mm]	F [mm]	G [mm]	N [mm]	P [mm]	Q [mm]
167	232	80	187	24	21

Order code for "Transmitter housing", option N "Remote, polycarbonate"

A [mm]	F [mm]	G [mm]	N [mm]	P [mm]	Q [mm]
177	234	90	197	17	22

Sensor connection housing



Aluminum, coated

A [mm]	B [mm]	C [mm]	G [mm]
148	94	54	136

Polycarbonate (only in conjunction with order code for "Sensor option", options CA...CE)

A [mm]	B [mm]	C [mm]	G [mm]
113	62	51	112

DN 25 to 300 mm (1 to 12 in): Sensor with aluminum half-shell housing

DN		Order code for "Design"									
		Options D, E, H, I				Option C					
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]	K	L
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
25	1	84	200	284	120	–	–	–	–	[2]	200
32	–	84	200	284	120	–	–	–	–	[2]	200
40	1 ½	84	200	284	120	–	–	–	–	[2]	200
50	2	84	200	284	120	84	200	284	120	[2]	200
65	–	109	225	334	180	84	200	284	120	[2]	200
80	3	109	225	334	180	84	200	284	120	[2]	200
100	4	109	225	334	180	109	225	334	180	[2]	250
125	–	150	265	415	260	109	225	334	180	[2]	250
150	6	150	265	415	260	109	225	334	180	[2]	300
200	8	180	290	470	324	150	265	415	260	[2]	350
250	10	205	315	520	400	150	265	415	260	[2]	450
300	12	230	340	570	460	180	290	470	324	[2]	500

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 90

DN 25 to 300 mm (1 to 12 in): Sensor with fully welded carbon steel housing

DN		Order code for "Design"									
		Option E				Option C					
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]	K	L
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
25	1	70	200	270	140	–	–	–	–	[2]	200
32	–	70	200	270	140	–	–	–	–	[2]	200
40	1 ½	70	200	270	140	–	–	–	–	[2]	200
50	2	70	200	270	140	70	200	270	140	[2]	200
65	–	82	225	307	165	70	200	270	140	[2]	200
80	3	87	225	312	175	70	200	270	140	[2]	200
100	4	100	225	325	200	82	225	307	165	[2]	250
125	–	113	265	378	226	87	225	312	175	[2]	250
150	6	134	265	399	269	100	225	325	200	[2]	300
200	8	160	290	450	320	113	265	378	226	[2]	350
250	10	193	315	508	387	134	265	399	269	[2]	450
300	12	218	340	558	437	160	290	450	320	[2]	500

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 90

DN 350 to 400 mm (14 to 16 in)

DN		Order code for "Design" Options E, I					
		D [1]	E [1]	F [1]	M [1]	K	L
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
350	14	282	379	679	564	[2]	550
375	15	308	423	731	616	[2]	550
400	16	308	423	731	616	[2]	600

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 90

DN 450 to 900 mm (18 to 36 in)

DN		Order code for "Design"										
		Options F, J				Options G, K						
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]	K	L	
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	
450	18	290	405	695	580	333	448	781	666	[2]	600 [3]	650 [4]
500	20	315	430	745	630	359	474	833	717	[2]	600 [3]	650 [4]
600	24	365	480	845	730	411	526	937	821	[2]	600 [3]	780 [4]
700	28	426	541	967	851	512	627	1139	1024	[2]	700 [3]	910 [4]
750	30	463	578	1041	926	512	627	1139	1024	[2]	750 [3]	975 [4]

DN		Order code for "Design"								K	L	
		Options F, J				Options G, K						
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]			
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	
800	32	482	597	1079	964	534	649	1183	1065	[2]	800 [3]	1040 [4]
900	36	532	647	1179	1064	610	725	1335	1218	[2]	900 [3]	1170 [4]

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 🖹 90
3) Order code for "Design", option F "Fixed flange, short installed length" and option J "Fixed flange, short installed length, 0 x DN inlet/outlet runs"
4) Order code for "Design", option G "Fixed flange, long installed length" and option K "Fixed flange, long installed length 0 x DN inlet/outlet runs"

DN 1000 to 2000 mm (40 to 78 in)

DN		Order code for "Design" Options F, G, J, K				K	L	
		D [1]	E [1]	F [1]	M [1]			
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	
1000	40	582	697	1279	1164	[2]	1000 [3]	1300 [4]
–	42	618	733	1351	1236	[2]	1050 [3]	1365 [4]
1200	48	696	811	1507	1392	[2]	1200 [3]	1560 [4]
–	54	809	924	1733	1617	[2]	1350 [3]	1755 [4]
1400	–	809	924	1733	1617	[2]	1400 [3]	1820 [4]
–	60	909	1024	1933	1817	[2]	1500 [3]	1950 [4]
1600	–	909	1024	1933	1817	[2]	1600 [3]	2080 [4]
–	66	960	1075	2035	1919	[2]	1650 [3]	2145 [4]
1800	72	1016	1131	2147	2032	[2]	1800 [3]	2340 [4]
–	78	1127	1242	2369	2254	[2]	2000 [3]	2600 [4]
2000	–	1127	1242	2369	2254	[2]	2000 [3]	2600 [4]

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Internal diameter depends on the liner, see the measuring tube specification → 🖹 90
3) Order code for "Design", option F "Fixed flange, short installed length" and option J "Fixed flange, short installed length, 0 x DN inlet/outlet runs"
4) Order code for "Design", option G "Fixed flange, long installed length" and option K "Fixed flange, long installed length 0 x DN inlet/outlet runs"

DN 2200 to 3000 mm (84 to 120 in)

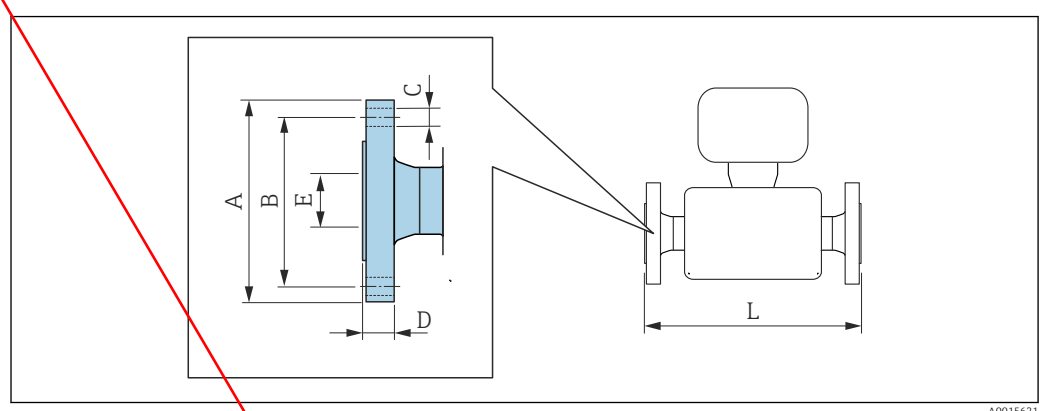
DN		Order code for "Design" Option F, J				K	L
		D [1]	E [1]	F [1]	M [1]		
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
–	84	1227	1342	2569	2454	[2]	2200
2200	–	1227	1342	2569	2454	[2]	2200
–	90	1332	1447	2779	2664	[2]	2400
2400	–	1332	1447	2783	2664	[2]	2400
–	96	1431	1546	2977	2861	[2]	2450

DN		Order code for "Design" Option F, J				K	L
		D [1]	E [1]	F [1]	M [1]		
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
–	102	1516	1631	3147	3032	[2]	2600
2600	–	1442	1557	2999	2883	[2]	2600
–	108	1602	1718	3320	3204	[2]	2750
2800	–	1547	1662	3209	3093	[2]	2800
–	114	1688	1803	3491	3375	[2]	2900
3000	–	1647	1762	3409	3293	[2]	3000
–	120	1774	1889	3663	3547	[2]	3050

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Internal diameter depends on the liner, see the measuring tube specification → 🖹 90

Flange connections

Fixed flange



A0015621

Flange in accordance with EN 1092-1 (DIN 2501 / DIN 2512N): PN 6 **Carbon steel:** *order code for "Process connection", option* **D1K** **Stainless steel:** *order code for "Process connection", option* **D1S**						
DN **[mm]**	**A** **[mm]**	**B** **[mm]**	**C** **[mm]**	**D** **[mm]**	**E** **[mm]**	**L** **[mm]**
350	490	445	12 × Ø22	22	1)	2)
400	540	495	16 × Ø22	22		
450	595	565	20 × Ø26	26		
500	645	600	20 × Ø22	24		
600	755	705	20 × Ø26	30		
700	860	810	24 × Ø26	30		
800	975	920	24 × Ø30	30		
900	1075	1020	24 × Ø30	34		
1000	1175	1120	28 × Ø30	38		
1200	1405	1340	32 × Ø33	42		
1400	1630	1560	36 × Ø36	56		
1600	1830	1760	40 × Ø36	63		
1800	2045	1970	44 × Ø39	69		
2000	2265	2180	48 × Ø42	74		
2200	2475	2390	52 × Ø42	81		
2400	2685	2600	56 × Ø42	87		
2600	2905	2810	60 × Ø48	91		
2800	3115	3020	64 × Ø48	101		
3000	3315	3220	68 × Ø48	102		
Surface roughness (flange): EN 1092-1 Form B1 (DIN 2526 Form C), Ra 6.3 to 12.5 µm						

1) Depends on the liner → 🖹 90
2) Total installed length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Flange in accordance with EN 1092-1 (DIN 2501 / DIN 2512N): PN 10
Carbon steel: *order code for "Process connection", option* **D2K**
Stainless steel: *order code for "Process connection", option* **D2S**

DN [mm]	A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	L [mm]
200	340	295	8 × Ø22	26	1)	2)
250	395	350	12 × Ø22	28		
300	445	400	12 × Ø22	28		
350	505	460	16 × Ø22	26		
400	565	515	16 × Ø26	26		
450	615	565	20 × Ø26	26		
500	670	620	20 × Ø26	28		
600	780	725	20 × Ø30	30		
700	895	840	24 × Ø30	35		
800	1015	950	24 × Ø33	38		
900	1115	1050	28 × Ø33	38		
1000	1230	1160	28 × Ø36	44		
1200	1455	1380	32 × Ø39	55		
1400	1675	1590	36 × Ø42	65		
1600	1915	1820	40 × Ø48	75		
1800	2115	2020	44 × Ø48	85		
2000	2325	2230	48 × Ø48	90		
2200	2550	2440	52 × Ø56	100		
2400	2760	2650	56 × Ø56	110		
2600	2960	2850	60 × Ø56	110		
2800	3180	3070	64 × Ø56	124		
3000	3405	3290	68 × Ø62	132		

Surface roughness (flange): EN 1092-1 Form B1 (DIN 2526 Form C), Ra 6.3 to 12.5 µm

1) Depends on the liner → 🖹 90
2) Total installed length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Flange in accordance with EN 1092-1 (DIN 2501 / DIN 2512N): PN 16
Carbon steel: *order code for "Process connection", option* **D3K**
Stainless steel: *order code for "Process connection", option* **D3S**

DN [mm]	A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	L [mm]
65	185	145	8 × Ø18	20	1)	2)
80	200	160	8 × Ø18	20		
100	220	180	8 × Ø18	22		
125	250	210	8 × Ø18	24		
150	285	240	8 × Ø22	24		
200	340	295	12 × Ø22	26		
250	405	355	12 × Ø26	32		
300	460	410	12 × Ø26	32		

Flange in accordance with EN 1092-1 (DIN 2501 / DIN 2512N): PN 16 **Carbon steel:** *order code for "Process connection", option* **D3K** **Stainless steel:** *order code for "Process connection", option* **D3S**						
DN [mm]	**A [mm]**	**B [mm]**	**C [mm]**	**D [mm]**	**E [mm]**	**L [mm]**
350	520	470	16 × Ø26	30		
400	580	525	16 × Ø30	32		
450	640	585	20 × Ø30	34		
500	715	650	20 × Ø33	36		
600	840	770	20 × Ø36	40		
700	910	840	24 × Ø36	40		
800	1025	950	24 × Ø39	41		
900	1125	1050	28 × Ø39	48		
1000	1255	1170	28 × Ø42	59		
1200	1485	1390	32 × Ø48	78		
1400	1685	1590	36 × Ø48	84		
1600	1930	1820	40 × Ø56	102		
1800	2130	2020	44 × Ø56	110		
2000	2345	2230	48 × Ø62	124		
Surface roughness (flange): EN 1092-1 Form B1 (DIN 2526 Form C), Ra 6.3 to 12.5 µm						

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Flange in accordance with EN 1092-1 (DIN 2501 / DIN 2512N): PN 25 **Carbon steel:** *order code for "Process connection", option* **D4K** **Stainless steel:** *order code for "Process connection", option* **D4S**						
DN [mm]	**A [mm]**	**B [mm]**	**C [mm]**	**D [mm]**	**E [mm]**	**L [mm]**
200	360	310	12 × Ø26	32	1)	2)
250	425	370	12 × Ø30	36		
300	485	430	16 × Ø30	40		
350	555	490	16 × Ø33	38		
400	620	550	16 × Ø36	40		
450	670	600	20 × Ø36	46		
500	730	660	20 × Ø36	48		
600	845	770	20 × Ø39	48		
700	960	875	24 × Ø42	50		
800	1085	990	24 × Ø48	53		
900	1185	1090	28 × Ø48	57		
1000	1320	1210	28 × Ø56	63		
Surface roughness (flange): EN 1092-1 Form B1 (DIN 2526 Form C), Ra 6.3 to 12.5 µm						

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Flange in accordance with EN 1092-1 (DIN 2501 / DIN 2512N): PN 40
Carbon steel: *order code for "Process connection", option* **D5K**
Stainless steel: *order code for "Process connection", option* **D5S**

DN [mm]	A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	L [mm]
25	115	85	4 × Ø14	16	1)	2)
32	140	100	4 × Ø18	18		
40	150	110	4 × Ø18	18		
50	165	125	4 × Ø18	20		
65	185	145	8 × Ø18	24		
80	200	160	8 × Ø18	26		
100	235	190	8 × Ø22	26		
125	270	220	8 × Ø26	28		
150	300	250	8 × Ø26	30		
Surface roughness (flange): EN 1092-1 Form B1 (DIN 2526 Form C), Ra 6.3 to 12.5 µm						

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Flange according to ASME B16.5, Class 150
Carbon steel: *order code for "Process connection", option* **A1K**
Stainless steel: *order code for "Process connection", option* **A1S**

DN		A	B	C	D	E	L
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
25	1	108	79.2	4 × Ø16	12.6	1)	2)
40	1 ½	127	98.6	4 × Ø16	15.9		
50	2	152.4	120.7	4 × Ø19.1	17.5		
80	3	190.5	152.4	4 × Ø19.1	22.3		
100	4	228.6	190.5	8 × Ø19.1	22.3		
150	6	279.4	241.3	8 × Ø22.4	23.8		
200	8	342.9	298.5	8 × Ø22.4	26.8		
250	10	406.4	362	12 × Ø25.4	29.6		
300	12	482.6	431.8	12 × Ø25.4	30.2		
350	14	535	476.3	12 × Ø28.6	35.4		
400	16	595	539.8	16 × Ø28.6	37		
450	18	635	577.9	16 × Ø31.8	40.1		
500	20	700	635	20 × Ø31.8	43.3		
600	24	815	749.3	20 × Ø34.9	48.1		
Surface roughness (flange): Ra 6.3 to 12.5 µm							

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Flange according to ASME B16.5, Class 300
Carbon steel: *order code for "Process connection", option* **A2K**
Stainless steel: *order code for "Process connection", option* **A2S**

DN		A	B	C	D	E	L
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
25	1	123.9	88.9	4 × Ø19.1	15.9	1)	2)
40	1 ½	155.4	114.3	4 × Ø22.4	19		
50	2	165.1	127	8 × Ø19.1	20.8		
80	3	209.6	168.1	8 × Ø22.4	26.8		
100	4	254	200.2	8 × Ø22.4	30.2		
150	6	317.5	269.7	12 × Ø22.4	35		
Surface roughness (flange): Ra 6.3 to 12.5 µm							

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Flange according to JIS B2220, 10K
Carbon steel: *order code for "Process connection", option* **N3K**
Stainless steel: *order code for "Process connection", option* **N3S**

DN [mm]	A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	L [mm]
50	155	120	4 × Ø19	16	1)	2)
65	175	140	4 × Ø19	18		
80	185	150	8 × Ø19	18		
100	210	175	8 × Ø19	18		
125	250	210	8 × Ø23	20		
150	280	240	8 × Ø23	22		
200	330	290	12 × Ø23	22		
250	400	355	12 × Ø25	24		
300	445	400	16 × Ø25	24		
Surface roughness (flange): Ra 6.3 to 12.5 µm						

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Flange according to JIS B2220, 20K
Carbon steel: *order code for "Process connection", option* **N4K**
Stainless steel: *order code for "Process connection", option* **N4S**

DN [mm]	A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	L [mm]
25	125	90	4 × Ø19	16	1)	2)
32	135	100	4 × Ø19	18		
40	140	105	4 × Ø19	18		
50	155	120	8 × Ø19	18		
65	175	140	8 × Ø19	20		
80	200	160	8 × Ø23	22		
100	225	185	8 × Ø23	24		

Flange according to JIS B2220, 20K
Carbon steel: *order code for "Process connection", option* **N4K**
Stainless steel: *order code for "Process connection", option* **N4S**

DN [mm]	A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	L [mm]
125	270	225	8 × Ø25	26		
150	305	260	12 × Ø25	28		
200	350	305	12 × Ø25	30		
250	430	380	12 × Ø27	34		
300	480	430	16 × Ø27	36		
Surface roughness (flange): Ra 6.3 to 12.5 µm						

1) Depends on the liner → 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Flange according to AWWA, Class D
Order code for "Process connection", option **W1K**

DN [mm]	DN [in]	A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	L [mm]
700	28	927	863.6	28 × Ø35	33.4	1)	2)
750	30	984	914.4	28 × Ø35	35.0		
800	32	1060	977.9	28 × Ø42	38.1		
900	36	1168	1085.9	32 × Ø42	41.3		
1000	40	1289	1200.2	36 × Ø42	41.3		
–	42	1346	1257.3	36 × Ø42	44.5		
1200	48	1511	1422.4	44 × Ø42	47.7		
–	54	1683	1593.9	44 × Ø48	54.0		
–	60	1855	1759.0	52 × Ø48	57.2		
–	66	2032	1930.4	52 × Ø48	63.5		
1800	72	2197	2095.5	60 × Ø48	66.7		
–	78	2362	2260.6	64 × Ø54	69.9		
–	84	2535	2425.7	64 × Ø54	73.1		
–	90	2705	2717.8	68 × Ø60	76.2		
–	96	2877	2755.9	68 × Ø60.3	82.55		
–	102	3048	2908.3	68 × Ø66.7	82.55		
–	108	3219	3067.0	68 × Ø66.7	85.73		
–	114	3391	3219.5	68 × Ø73	88.90		
–	120	3562	3371.8	68 × Ø73	88.90		
Surface roughness (flange): Ra 6.3 to 12.5 µm							

1) Depends on the liner → 🖹 90
2) Total length is independent of the process connections. Installed length according to DVGW → 🖹 54 (compact version) → 🖹 58 (remote version)

Flange according to AS 2129, Tab. E
Order code for "Process connection", option **M2K**

DN [mm]	A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	L [mm]
80	185	146	4 × Ø18	12	1)	2)
100	215	178	8 × Ø18	13		
150	280	235	8 × Ø22	17		
200	335	292	8 × Ø22	19		
250	405	356	12 × Ø22	22		
300	455	406	12 × Ø26	25		
350	525	470	12 × Ø26	30		
400	580	521	12 × Ø26	32		
450	640	584	16 × Ø26	35		
500	705	641	16 × Ø26	38		
600	825	756	16 × Ø33	48		
700	910	845	20 × Ø33	51		
750	995	927	20 × Ø36	54		
800	1060	984	20 × Ø36	54		
900	1175	1092	24 × Ø36	64		
1000	1255	1175	24 × Ø39	67		
1200	1490	1410	32 × Ø39	79		
Surface roughness (flange): Ra 6.3 to 12.5 µm						

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

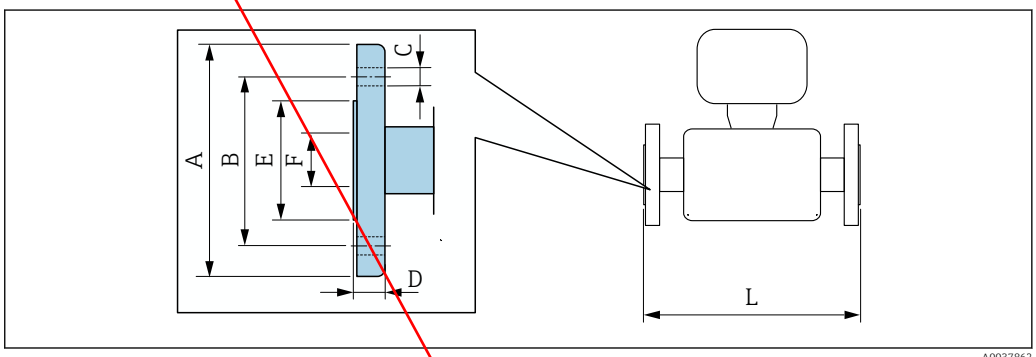
Flange according to AS 4087, PN 16
Order code for "Process connection", option **M3K**

DN [mm]	A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	L [mm]
80	185	146	4 × Ø18	12	1)	2)
100	215	178	4 × Ø18	13		
150	280	235	8 × Ø18	13		
200	335	292	8 × Ø18	19		
250	405	356	8 × Ø22	19		
300	455	406	12 × Ø22	23		
350	525	470	12 × Ø26	30		
375	550	495	12 × Ø26	30		
400	580	521	12 × Ø26	32		
450	640	584	12 × Ø26	30		
500	705	641	16 × Ø26	38		
600	825	756	16 × Ø30	48		
700	910	845	20 × Ø30	56		
750	995	927	20 × Ø33	56		
800	1060	984	20 × Ø36	56		

Flange according to AS 4087, PN 16 *Order code for "Process connection", option* **M3K**						
DN [mm]	**A [mm]**	**B [mm]**	**C [mm]**	**D [mm]**	**E [mm]**	**L [mm]**
900	1175	1092	24 × Ø36	66		
1000	1255	1175	24 × Ø36	66		
1200	1490	1410	32 × Ø36	76		
Surface roughness (flange): Ra 6.3 to 12.5 µm						

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Lap joint flange



A0037862

Lap joint flange in accordance with EN 1092-1 (DIN 2501 / DIN 2512N): PN 10 **Carbon steel:** *order code for "Process connection", option* **D22** **Stainless steel:** *order code for "Process connection", option* **D24**								
DN		**A**	**B**	**C**	**D**	**E**	**F**	**L**
[mm]	**[in]**	**[mm]**	**[mm]**	**[mm]**	**[mm]**	**[mm]**	**[mm]**	**[mm]**
200	8	340	295	8 × Ø22	24	264	1)	2)
250	10	395	350	12 × Ø22	26	317		
300	12	445	400	12 × Ø22	26	367		
Surface roughness (flange): Ra 6.3 to 12.5 µm								

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Lap joint flange in accordance with EN 1092-1 (DIN 2501 / DIN 2512N): PN 16 **Carbon steel:** *order code for "Process connection", option* **D32** **Stainless steel:** *order code for "Process connection", option* **D34**								
DN		**A**	**B**	**C**	**D**	**E**	**F**	**L**
[mm]	**[in]**	**[mm]**	**[mm]**	**[mm]**	**[mm]**	**[mm]**	**[mm]**	**[mm]**
25	1	115	85	4 × Ø14	16	49	1)	2)
32	-	140	100	4 × Ø18	18	65		
40	1 ½	150	110	4 × Ø18	18	71		
50	2	165	125	4 × Ø18	20	88		
65	-	185	145	8 × Ø18	20	103		
80	3	200	160	8 × Ø18	20	120		

Lap joint flange in accordance with EN 1092-1 (DIN 2501 / DIN 2512N): PN 16
Carbon steel: *order code for "Process connection", option* **D32**
Stainless steel: *order code for "Process connection", option* **D34**

DN		A	B	C	D	E	F	L
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
100	4	220	180	8 × Ø18	22	148		
125	-	250	210	8 × Ø18	22	177		
150	6	285	240	8 × Ø22	24	209		
200	8	340	295	12 × Ø22	26	264		
250	10	405	355	12 × Ø26	29	317		
300	12	460	410	12 × Ø26	32	367		
Surface roughness (flange): Ra 6.3 to 12.5 µm								

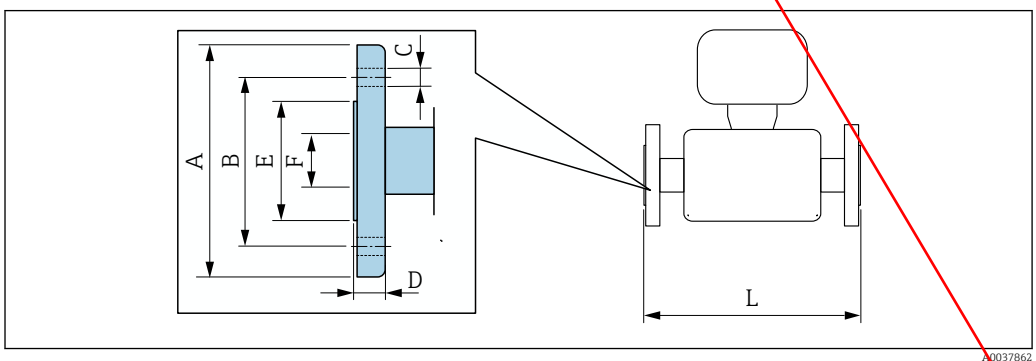
1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Lap joint flange according to ASME B16.5, Class 150
Carbon steel: *order code for "Process connection", option* **A12**
Stainless steel: *order code for "Process connection", option* **A14**

DN		A	B	C	D	E	F	L
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
25	1	110	80	4 × Ø16	14	49	1)	2)
40	1 ½	125	98	4 × Ø16	17.5	71		
50	2	150	121	4 × Ø19	19	88		
80	3	190	152	4 × Ø19	24	120		
100	4	230	190	8 × Ø19	24	148		
150	6	280	241	8 × Ø23	25	209		
200	8	345	298	8 × Ø23	29	264		
250	10	405	362	12 × Ø25	30	317		
300	12	485	432	12 × Ø25	32	378		
Surface roughness (flange): Ra 6.3 to 12.5 µm								

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Lap joint flange, stamped plate

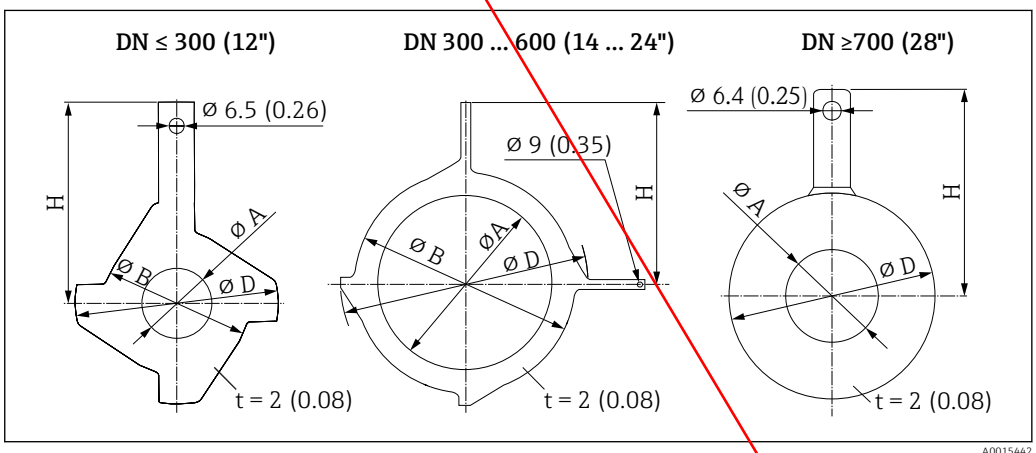


Lap joint flange, stamped plate in accordance with EN 1092-1 (DIN 2501 / DIN 2512N): PN 10 **Carbon steel:** *order code for "Process connection", option* **D21** **Stainless steel:** *order code for "Process connection", option* **D23**							
DN **[mm]**	**A** **[mm]**	**B** **[mm]**	**C** **[mm]**	**D** **[mm]**	**E** **[mm]**	**F** **[mm]**	**L** **[mm]**
25	115	85	4 x Ø13.5	16.5	49	1)	2)
32	140	100	4 x Ø17.5	17	65		
40	150	110	4 x Ø17.5	16.5	71		
50	165	125	4 x Ø17.5	18.5	88		
65	185	145	4 x Ø17.5	20	103		
80	200	160	8 x Ø17.5	23.5	120		
100	220	180	8 x Ø17.5	24.5	148		
125	250	210	8 x Ø17.5	24	177		
150	285	240	8 x Ø21.5	25	209		
200	340	295	8 x Ø21.5	27.5	264		
250	405	350	12 x Ø21.5	30.5	317		
300	445	400	12 x Ø21.5	34.5	367		
Surface roughness (flange): Ra 6.3 to 12.5 µm							

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Accessories

Ground disks for flange connections



A0015442

DN		**Pressure rating**	**A**		**B**		**D**		**H**	
[mm]	**[inch]**		**[mm]**	**[inch]**	**[mm]**	**[inch]**	**[mm]**	**[inch]**	**[mm]**	**[inch]**
25	1"	1)	26	1.02	62	2.44	77.5	3.05	87.5	3.44
32	1 ¼"	1)	35	1.38	80	3.15	87.5	3.44	94.5	3.72
40	1 ½"	1)	41	1.61	82	3.23	101	3.98	103	4.06
50	2"	1)	52	2.05	101	3.98	115.5	4.55	108	4.25
65	2 ½"	1)	68	2.68	121	4.76	131.5	5.18	118	4.65
80	3"	1)	80	3.15	131	5.16	154.5	6.08	135	5.31

DN		Pressure rating	A		B		D		H	
[mm]	[inch]		[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]
100	4"	[1]	104	4.09	156	6.14	186.5	7.34	153	6.02
125	5"	[1]	130	5.12	187	7.36	206.5	8.13	160	6.30
150	6"	[1]	158	6.22	217	8.54	256	10.08	184	7.24
200	8"	[1]	206	8.11	267	10.51	288	11.34	205	8.07
250	10"	[1]	260	10.2	328	12.91	359	14.13	240	9.45
300	12"	PN 10 PN 16 Cl. 150	312	12.3	375	14.76	413	16.26	273	10.75
		PN 25 JIS 10K JIS 20K	310	12.2	375	14.76	404	15.91	268	10.55
350	14"	PN 6	420	16.5	420	16.54	479	18.86	365	14.37
		PN 10								
		PN 16								
375	15"	PN 16	461	18.2	461	18.2	523	20.6	395	15.6
400	16"	PN 6	470	18.5	470	18.50	542	21.34	395	15.55
		PN 10								
		PN 16								
450	18"	PN 6	525	20.7	525	20.67	583	22.95	417	16.42
		PN 10								
		PN 16								
500	20"	PN 6	575	22.6	575	22.64	650	25.59	460	18.11
		PN 10								
		PN 16								
600	24"	PN 6	676	26.6	676	26.61	766	30.16	522	20.55
		PN 10								
		PN 16								
700	28"	PN 6	697	27.4	–	–	786	30.94	460	18.11
		PN10	693	27.3	–	–	813	32.01	480	18.9
		PN16	687	27.1	–	–	807	31.77	490	19.29
		Cl, D	693	27.3	–	–	832	32.76	494	19.45
750	30"	Cl, D	743	29.3	–	–	833	32.8	523	20.59
800	32"	PN 6	799	31.5	–	–	893	35.16	520	20.47
		PN 10	795	31.3	–	–	920	36.22	540	21.26
		PN 16	789	31.1	–	–	914	35.98	550	21.65
		Cl, D	795	31.3	–	–	940	37.01	561	22.09
900	36"	PN 6	897	35.3	–	–	993	39.09	570	22.44
		PN 10	893	35.2	–	–	1020	40.16	590	23.23
		PN 16	886	34.9	–	–	1014	39.92	595	23.43
		Cl, D	893	35.2	–	–	1048	41.26	615	24.21
1000	40"	PN 6	999	39.3	–	–	1093	43.03	620	24.41
		PN 10	995	39.2	–	–	1127	44.37	650	25.59
		PN 16	988	38.9	–	–	1131	44.53	660	25.98

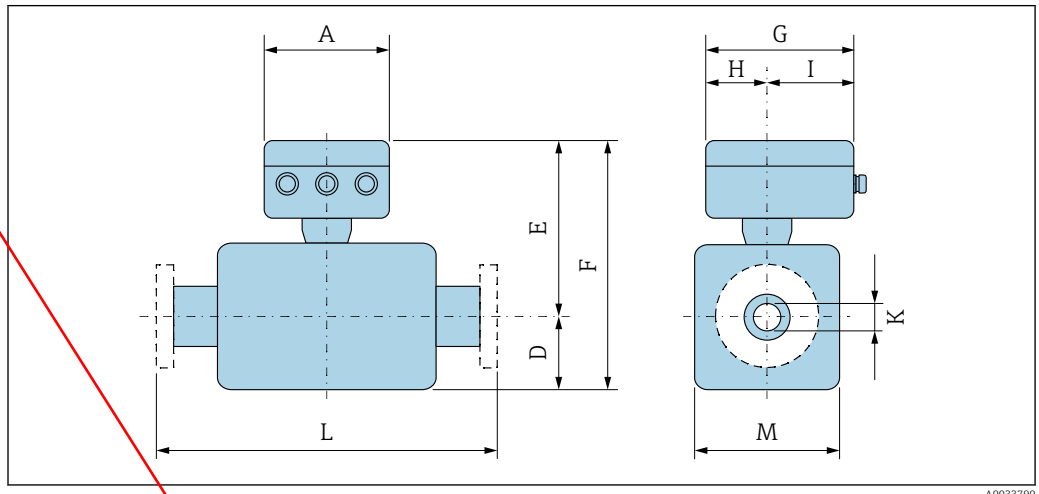
DN		Pressure rating	A		B		D		H	
[mm]	[inch]		[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]
		Cl, D	995	39.2	–	–	1163	45.79	675	26.57
–	42"	PN 6	1044	41.1	–	–	1220	48.03	704	27.72
1200	48"	PN 6	1203	47.4	–	–	1310	51.57	733	28.86
		PN 10	1196	47.1	–	–	1344	52.91	760	29.92
		PN 16	1196	47.1	–	–	1385	54.53	786	30.94
		Cl, D	1188	46.8	–	–	1345	52.95	775	30.51

1) In the case of DN 25 to 250, ground disks can be used for all the flange standards/pressure ratings which can be supplied in the standard version

Dimensions in US units

Compact version

Order code for "Housing", option A "Compact, aluminum, coated" or option M "Compact, polycarbonate"



A [in]	G [1] [in]	H [in]	I [1] [in]
6.57	7.60	3.54	4.06

1) Depending on the cable gland used: values up to + 1.18 in

DN 1 to 12 in (25 to 300 mm): Sensor with aluminum half-shell housing

DN		Order code for "Design"									
		Options D, E, H, I				Option C					
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]	K	L
[mm]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]
25	1	3.31	7.91	11.22	4.72	–	–	–	–	[2]	7.87
32	–	3.31	7.91	11.22	4.72	–	–	–	–	[2]	7.87
40	1 ½	3.31	7.91	11.22	4.72	–	–	–	–	[2]	7.87
50	2	3.31	7.91	11.22	4.72	3.31	7.91	11.22	4.72	[2]	7.87
65	–	4.29	8.9	13.19	7.09	3.31	7.91	11.22	4.72	[2]	7.87
80	3	4.29	8.9	13.19	7.09	3.31	7.91	11.22	4.72	[2]	7.87
100	4	4.29	8.9	13.19	7.09	4.29	8.9	13.19	7.09	[2]	9.84
125	–	5.91	10.47	16.38	10.24	4.29	8.9	13.19	7.09	[2]	9.84
150	6	5.91	10.47	16.38	10.24	4.29	8.9	13.19	7.09	[2]	11.81
200	8	7.09	11.46	18.54	12.76	5.91	10.47	16.38	10.24	[2]	13.78
250	10	8.07	12.44	20.51	15.75	5.91	10.47	16.38	10.24	[2]	17.72
300	12	9.06	13.43	22.48	18.11	7.09	11.46	18.54	12.76	[2]	19.69

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 90

DN 14 to 16 in (350 to 400 mm)

DN		Order code for "Design" Options E, I				K	L
		D [1]	E [1]	F [1]	M [1]		
[mm]	[in]	[in]	[in]	[in]	[in]	[in]	[in]
350	14	11.10	15.63	26.73	22.20	[2]	21.65
375	15	12.13	16.65	28.78	24.25	[2]	23.62
400	16	12.13	16.65	28.78	24.25	[2]	23.62

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 90

DN 18 to 36 in (450 to 900 mm)

DN		Order code for "Design" Options F, J				Options G, K				K	L	
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]			
[mm]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	
450	18	11.42	15.94	27.36	22.83	13.11	17.64	30.75	26.22	[2]	23.62 [3]	25.59 [4]
500	20	12.40	16.93	29.33	24.80	14.13	18.66	32.80	28.23	[2]	23.62 [2]	25.59 [4]
600	24	14.37	18.90	33.27	28.74	16.18	20.71	36.89	32.32	[2]	23.62 [2]	30.71 [4]
700	28	16.77	21.30	38.07	33.50	20.16	24.69	44.84	40.31	[2]	27.56 [2]	35.83 [4]
750	30	18.23	22.76	40.98	36.46	20.16	24.69	44.84	40.31	[2]	29.53 [2]	38.39 [4]
800	32	18.98	23.50	42.48	37.95	21.02	25.55	46.57	41.93	[2]	31.5 [2]	40.94 [4]
900	36	20.94	25.47	46.42	41.89	24.02	28.54	52.56	47.95	[2]	35.43 [2]	46.06 [4]

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 90
3) Order code for "Design", option F "Fixed flange, short installed length" and option J "Fixed flange, short installed length, 0 x DN inlet/outlet runs"
4) Order code for "Design", option G "Fixed flange, long installed length" and option K "Fixed flange, long installed length 0 x DN inlet/outlet runs"

DN 40 to 78 in (1000 to 2000 mm)

DN		Order code for "Design" Options F, G, J, K				K	L	
		D [1]	E [1]	F [1]	M [1]			
[mm]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	
1000	40	22.91	27.44	50.35	45.83	[2]	39.37 [3]	51.18 [4]
–	42	24.33	28.86	53.19	48.66	[2]	41.34 [3]	53.74 [4]
1200	48	27.40	31.93	59.33	54.80	[2]	47.24 [3]	61.42 [4]
–	54	31.85	36.38	68.23	63.66	[2]	53.15 [3]	69.09 [4]
1400	–	31.85	36.38	68.23	63.66	[2]	55.12 [3]	71.65 [4]
–	60	35.79	40.31	76.10	71.54	[2]	59.06 [3]	76.77 [4]
1600	–	35.79	40.31	76.10	71.54	[2]	62.99 [3]	81.89 [4]
–	66	37.80	42.32	80.12	75.55	[2]	64.96 [3]	84.45 [4]
1800	72	40.00	44.53	84.53	80.00	[2]	70.87 [3]	92.13 [4]

DN		Order code for "Design" Options F, G, J, K				K	L	
		D [1]	E [1]	F [1]	M [1]			
[mm]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	
–	78	44.37	48.90	93.27	88.74	[2]	78.74 [3]	102.36 [4]
2000	–	44.37	48.90	93.27	88.74	[2]	78.74 [3]	102.36 [4]

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 🖹 90
3) Order code for "Design", option F "Fixed flange, short installed length" and option J "Fixed flange, short installed length, 0 x DN inlet/outlet runs"
4) Order code for "Design", option G "Fixed flange, long installed length" and option K "Fixed flange, long installed length 0 x DN inlet/outlet runs"

DN 84 to 120 in (2200 to 3000 mm)

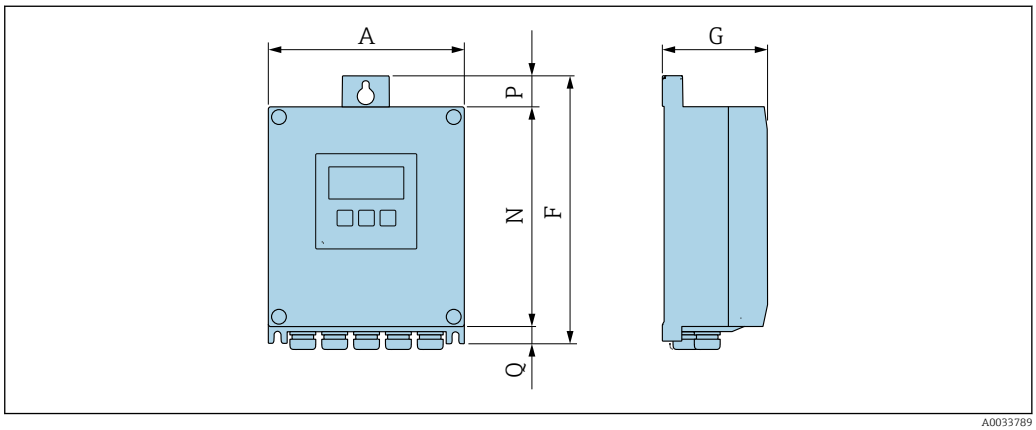
DN		Order code for "Design" Option F, J				K	L
		D [1]	E [1]	F [1]	M [1]		
[mm]	[in]	[in]	[in]	[in]	[in]	[in]	[in]
–	84	48.31	52.83	101.14	96.61	[2]	86.61
2200	–	48.31	52.83	101.14	96.61	[2]	86.61
–	90	52.44	56.97	109.41	104.88	[2]	94.49
2400	–	52.44	56.97	109.57	104.88	[2]	94.49
–	96	56.34	60.87	117.20	112.64	[2]	96.46
–	102	59.69	64.21	123.90	119.37	[2]	102.36
2600	–	56.77	61.30	118.07	113.50	[2]	102.36
–	108	63.07	67.64	130.71	126.14	[2]	108.27
2800	–	60.91	65.43	126.34	121.77	[2]	110.24
–	114	66.46	70.98	137.44	132.87	[2]	114.17
3000	–	64.84	69.37	134.21	129.65	[2]	118.11
–	120	69.84	74.37	144.21	139.65	[2]	120.08

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 🖹 90

Remote version

Transmitter remote version

Order code for "Housing", option N "Remote, polycarbonate" or option P "Remote, aluminum coated"



A0033789

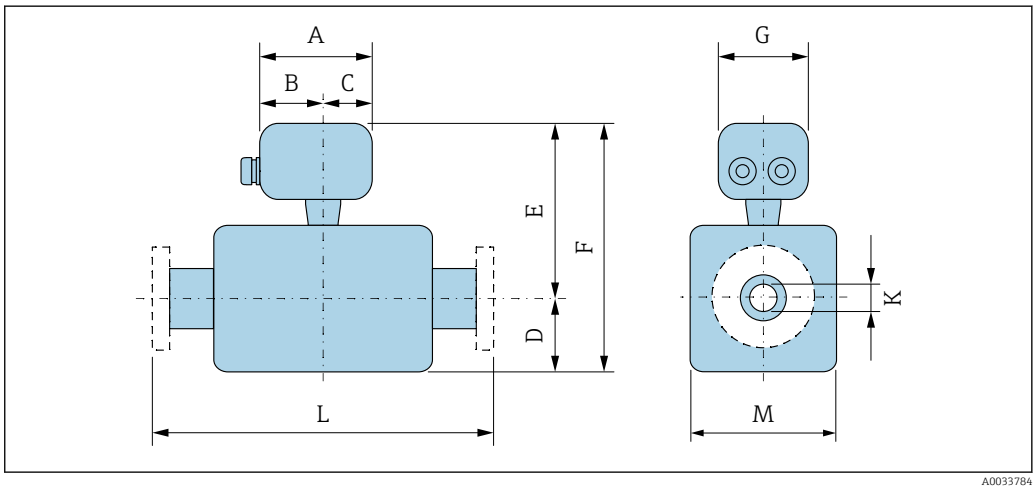
Order code for "Transmitter housing", option P "Remote, aluminum, coated"

A [in]	F [in]	G [in]	N [in]	P [in]	Q [in]
6.57	9.13	3.15	7.36	0.94	0.83

Order code for "Transmitter housing", option N "Remote, polycarbonate"

A [in]	F [in]	G [in]	N [in]	P [in]	Q [in]
6.97	9.21	3.54	7.76	0.67	0.87

Sensor connection housing



A0033784

Aluminum, coated

A [in]	B [in]	C [in]	G [in]
5.83	3.7	2.13	5.35

Polycarbonate (only in conjunction with order code for "Sensor option", options CA...CE)

A [in]	B [in]	C [in]	G [in]
4.45	2.44	2.01	4.41

DN 1 to 12 in (25 to 300 mm): Sensor with aluminum half-shell housing

DN		Order code for "Design"									
		Options D, E, H, I				Option C					
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]	K	L
[mm]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]
25	1	3.31	7.87	11.18	4.72	–	–	–	–	[2]	7.87
32	–	3.31	7.87	11.18	4.72	–	–	–	–	[2]	7.87
40	1 ½	3.31	7.87	11.18	4.72	–	–	–	–	[2]	7.87
50	2	3.31	7.87	11.18	4.72	3.31	7.87	11.18	4.72	[2]	7.87
65	–	4.29	8.86	13.15	7.09	3.31	7.87	11.18	4.72	[2]	7.87
80	3	4.29	8.86	13.15	7.09	3.31	7.87	11.18	4.72	[2]	7.87
100	4	4.29	8.86	13.15	7.09	4.29	8.86	13.15	7.09	[2]	9.84
125	–	5.91	10.43	16.34	10.24	4.29	8.86	13.15	7.09	[2]	9.84
150	6	5.91	10.43	16.34	10.24	4.29	8.86	13.15	7.09	[2]	11.81
200	8	7.09	11.42	18.5	12.76	5.91	10.43	16.34	10.24	[2]	13.78
250	10	8.07	12.4	20.47	15.75	5.91	10.43	16.34	10.24	[2]	17.72
300	12	9.06	13.39	22.44	18.11	7.09	11.42	18.5	12.76	[2]	19.69

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 🖹 90

DN 1 to 12 in (25 to 300 mm): Sensor with fully welded carbon steel housing

DN		Order code for "Design"									
		Option E				Option C					
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]	K	L
[mm]	[in]	[mm]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]
25	1	2.76	7.87	10.63	5.51	–	–	–	–	[2]	7.87
32	–	2.76	7.87	10.63	5.51	–	–	–	–	[2]	7.87
40	1 ½	2.76	7.87	10.63	5.51	–	–	–	–	[2]	7.87
50	2	2.76	7.87	10.63	5.51	2.76	7.87	10.63	5.51	[2]	7.87
65	–	3.23	8.86	12.09	6.5	2.76	7.87	10.63	5.51	[2]	7.87
80	3	3.43	8.86	12.28	6.89	2.76	7.87	10.63	5.51	[2]	7.87
100	4	3.94	8.86	12.8	7.87	3.23	8.86	12.09	6.5	[2]	9.84
125	–	4.45	10.43	14.88	8.9	3.43	8.86	12.28	6.89	[2]	9.84
150	6	5.28	10.43	15.71	10.59	3.94	8.86	12.8	7.87	[2]	11.81
200	8	6.3	11.42	17.72	12.6	4.45	10.43	14.88	8.9	[2]	13.78

DN		Order code for "Design"									
		Option E				Option C					
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]	K	L
[mm]	[in]	[mm]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]
250	10	7.6	12.4	20	15.24	5.28	10.43	15.71	10.59	[2]	17.72
300	12	8.58	13.39	21.97	17.2	6.3	11.42	17.72	12.6	[2]	19.69

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 90

DN 14 to 16 in (350 to 400 mm)

DN		Order code for "Design" Options E, I					
		D [1]	E [1]	F [1]	M [1]	K	L
[mm]	[in]	[in]	[in]	[in]	[in]	[in]	[in]
350	14	11.10	15.63	26.73	22.20	[2]	21.65
375	15	12.13	16.65	28.78	24.25	[2]	23.62
400	16	12.13	16.65	28.78	24.25	[2]	23.62

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 90

DN 18 to 36 in (450 to 900 mm)

DN		Order code for "Design"										
		Options F, J				Options G, K						
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]	K	L	
[mm]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	
450	18	11.42	15.94	27.36	22.83	13.11	17.64	30.75	26.22	[2]	23.62 [3]	25.59 [4]
500	20	12.40	16.93	29.33	24.80	14.13	18.66	32.80	28.23	[2]	23.62 [3]	25.59 [4]
600	24	14.37	18.90	33.27	28.74	16.18	20.71	36.89	32.32	[2]	23.62 [3]	30.71 [4]
700	28	16.77	21.30	38.07	33.50	20.16	24.69	44.84	40.31	[2]	27.56 [3]	35.83 [4]
750	30	18.23	22.76	40.98	36.46	20.16	24.69	44.84	40.31	[2]	29.53 [3]	38.39 [4]
800	32	18.98	23.50	42.48	37.95	21.02	25.55	46.57	41.93	[2]	31.5 [3]	40.94 [4]
900	36	20.94	25.47	46.42	41.89	24.02	28.54	52.56	47.95	[2]	35.43 [3]	46.06 [4]

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 90
3) Order code for "Design", option F "Fixed flange, short installed length" and option J "Fixed flange, short installed length, 0 x DN inlet/outlet runs"
4) Order code for "Design", option G "Fixed flange, long installed length" and option K "Fixed flange, long installed length 0 x DN inlet/outlet runs"

DN 40 to 78 in (1000 to 2000 mm)

DN		Order code for "Design" Options F, G, J, K				K	L	
[mm]	[in]	D [1] [in]	E [1] [in]	F [1] [in]	M [1] [in]	[in]	[in]	
1000	40	22.91	27.44	50.35	45.83	2)	39.37 3)	51.18 4)
–	42	24.33	28.86	53.19	48.66	2)	41.34 3)	53.74 4)
1200	48	27.40	31.93	59.33	54.80	2)	47.24 3)	61.42 4)
–	54	31.85	36.38	68.23	63.66	2)	53.15 3)	69.09 4)
1400	–	31.85	36.38	68.23	63.66	2)	55.12 3)	71.65 4)
–	60	35.79	40.31	76.10	71.54	2)	59.06 3)	76.77 4)
1600	–	35.79	40.31	76.10	71.54	2)	62.99 3)	81.89 4)
–	66	37.80	42.32	80.12	75.55	2)	64.96 3)	84.45 4)
1800	72	40.00	44.53	84.53	80.00	2)	70.87 3)	92.13 4)
–	78	44.37	48.90	93.27	88.74	2)	78.74 3)	102.36 4)
2000	–	44.37	48.90	93.27	88.74	2)	78.74 3)	102.36 4)

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Internal diameter depends on the liner, see the measuring tube specification → 🖹 90
3) Order code for "Design", option F "Fixed flange, short installed length" and option J "Fixed flange, short installed length, 0 x DN inlet/outlet runs"
4) Order code for "Design", option G "Fixed flange, long installed length" and option K "Fixed flange, long installed length 0 x DN inlet/outlet runs"

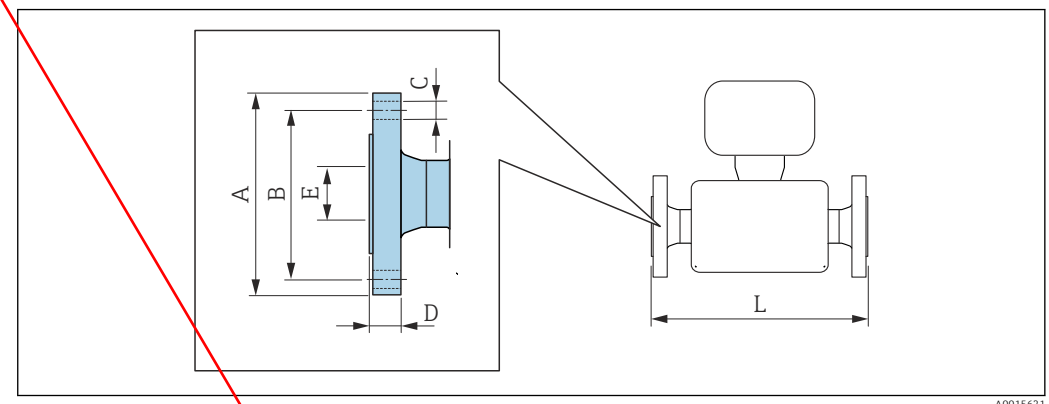
DN 84 to 120 in (2200 to 3000 mm)

DN		Order code for "Design" Option F, J				K	L
[mm]	[in]	D [1] [in]	E [1] [in]	F [1] [in]	M [1] [in]	[in]	[in]
–	84	48.31	52.83	101.14	96.61	2)	86.61
2200	–	48.31	52.83	101.14	96.61	2)	86.61
–	90	52.44	56.97	109.41	104.88	2)	94.49
2400	–	52.44	56.97	109.57	104.88	2)	94.49
–	96	56.34	60.87	117.20	112.64	2)	96.46
–	102	59.69	64.21	123.90	119.37	2)	102.36
2600	–	56.77	61.30	118.07	113.50	2)	102.36
–	108	63.07	67.64	130.71	126.14	2)	108.27
2800	–	60.91	65.43	126.34	121.77	2)	110.24
–	114	66.46	70.98	137.44	132.87	2)	114.17
3000	–	64.84	69.37	134.21	129.65	2)	118.11
–	120	69.84	74.37	144.21	139.65	2)	120.08

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Internal diameter depends on the liner, see the measuring tube specification → 🖹 90

Flange connections

Fixed flange



A0015621

Flange according to ASME B16.5, Class 150 **Carbon steel:** *order code for "Process connection", option* **A1K** **Stainless steel:** *order code for "Process connection", option* **A1S**							
DN		**A**	**B**	**C**	**D**	**E**	**L**
[mm]	**[in]**	**[in]**	**[in]**	**[in]**	**[in]**	**[in]**	**[in]**
25	1	4.25	3.12	4 × Ø0.63	0.5	1)	2)
40	1 ½	5	3.88	4 × Ø0.63	0.63		
50	2	6	4.75	4 × Ø0.75	0.69		
80	3	7.5	6	4 × Ø0.75	0.88		
100	4	9	7.5	8 × Ø0.75	0.88		
150	6	11	9.5	8 × Ø0.88	0.94		
200	8	13.5	11.75	8 × Ø0.88	1.06		
250	10	16	14.25	12 × Ø1	1.17		
300	12	19	17	12 × Ø1	1.19		
350	14	21.06	18.75	12 × Ø1.13	1.39		
400	16	23.43	21.25	16 × Ø1.13	1.46		
450	18	25	22.75	16 × Ø1.25	1.58		
500	20	27.56	25	20 × Ø1.25	1.7		
600	24	32.09	29.5	20 × Ø1.37	1.89		
Surface roughness (flange): Ra 250 to 492 µm							

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 74 (compact version) → 🖹 77 (remote version)

Flange according to ASME B16.5, Class 300 **Carbon steel:** *order code for "Process connection", option* **A2K** **Stainless steel:** *order code for "Process connection", option* **A2S**							
DN		**A**	**B**	**C**	**D**	**E**	**L**
[in]	**[mm]**	**[in]**	**[in]**	**[in]**	**[in]**	**[in]**	**[in]**
1	25	4.88	3.5	4 × Ø0.75	0.63	1)	2)
1 ½	40	6.12	4.5	4 × Ø0.88	0.75		
2	50	6.5	5	8 × Ø0.75	0.82		

Flange according to ASME B16.5, Class 300
Carbon steel: *order code for "Process connection", option* **A2K**
Stainless steel: *order code for "Process connection", option* **A2S**

DN		A	B	C	D	E	L
[in]	[mm]	[in]	[in]	[in]	[in]	[in]	[in]
3	80	8.25	6.62	8 × Ø0.88	1.06		
4	100	10	7.88	8 × Ø0.88	1.19		
6	150	12.5	10.62	12 × Ø0.88	1.38		
Surface roughness (flange): Ra 250 to 492 µm							

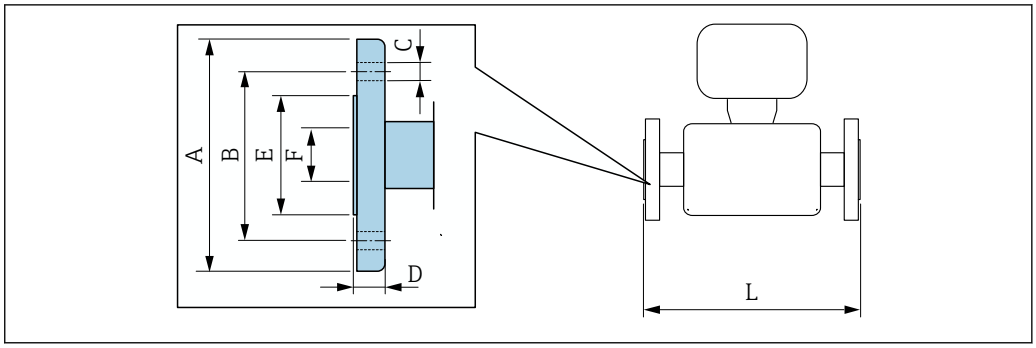
1) Depends on the liner → 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 74 (compact version) → 🖹 77 (remote version)

Flange according to AWWA, Cl. D
Order code for "Process connection", option **W1K**

DN		A	B	C	D	E	L
[in]	[mm]	[in]	[in]	[in]	[in]	[in]	[in]
28	700	36.50	34.00	28 × Ø1.38	1.31	1)	2)
30	–	38.74	36.00	28 × Ø1.38	1.38		
32	800	41.73	38.50	28 × Ø1.65	1.50		
36	900	45.98	42.75	32 × Ø1.65	1.63		
40	1000	50.75	47.25	36 × Ø1.65	1.63		
42	–	52.99	49.50	36 × Ø1.65	1.75		
48	1200	59.49	56.00	44 × Ø1.65	1.88		
54	–	66.26	62.75	44 × Ø1.89	2.13		
60	–	73.03	69.25	52 × Ø1.89	2.25		
66	–	80.00	76.00	52 × Ø1.89	2.50		
72	1800	86.50	82.50	60 × Ø1.89	2.63		
78	–	92.99	89.00	64 × Ø2.13	2.75		
84	–	99.80	95.50	64 × Ø2.13	2.88		
90	–	106.50	107.00	68 × Ø2.36	3.00		
96	–	113.27	108.50	68 × Ø2.37	3.25		
102	–	120.00	114.50	68 × Ø2.63	3.25		
108	–	126.73	120.75	68 × Ø2.63	3.38		
114	–	133.50	126.75	68 × Ø2.87	3.50		
120	–	140.24	132.75	68 × Ø2.87	3.50		
Surface roughness (flange): Ra 250 to 492 µin							

1) Depends on the liner → 🖹 90
2) Total length is independent of the process connections. Installed length according to DVGW → 🖹 74 (compact version) → 🖹 77 (remote version)

Lap joint flange



A0037862

Lap joint flange according to ASME B16.5, Class 150
Carbon steel: *order code for "Process connection", option* **A12**
Stainless steel: *order code for "Process connection", option* **A14**

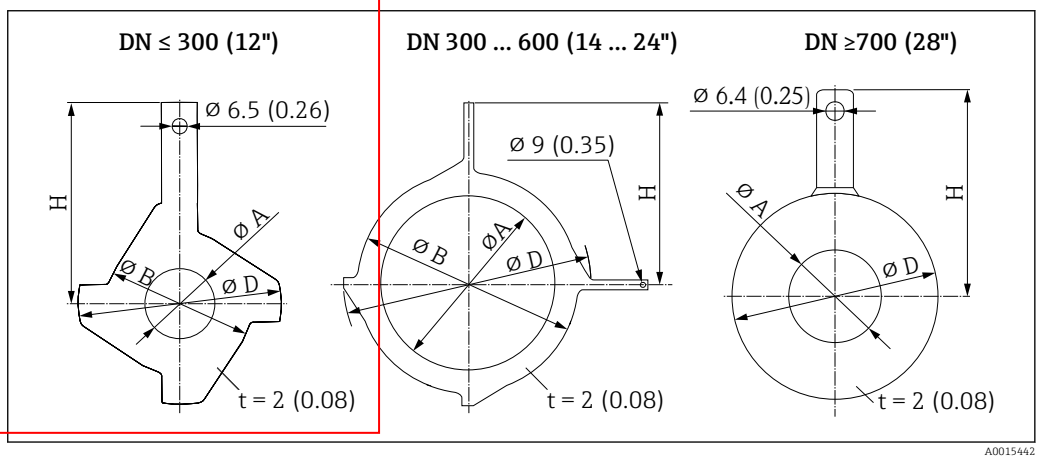
DN [mm]	DN [in]	A [in]	B [in]	C [in]	D [in]	E [in]	F [in]	L [in]
25	1	4.33	3.15	4 × Ø0.63	0.55	1.93	1)	2)
40	1 ½	4.92	3.86	4 × Ø0.63	0.69	2.8		
50	2	5.91	4.76	4 × Ø0.75	0.75	3.46		
80	3	7.48	5.98	4 × Ø0.75	0.94	4.72		
100	4	9.06	7.48	8 × Ø0.75	0.94	5.83		
150	6	11.02	9.49	8 × Ø0.91	0.98	8.23		
200	8	13.58	11.73	8 × Ø0.91	1.14	10.39		
250	10	15.94	14.25	12 × Ø0.98	1.18	12.48		
300	12	19.09	17.01	12 × Ø0.98	1.26	14.88		

Surface roughness (flange): Ra 248 to 492 µin

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 74 (compact version) → 🖹 77 (remote version)

Accessories

Ground disks for flange connections



A0015442

DN		Pressure rating	A		B		D		H	
[mm]	[inch]		[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]
25	1"	1)	26	1.02	62	2.44	77.5	3.05	87.5	3.44
32	1 ¼"	1)	35	1.38	80	3.15	87.5	3.44	94.5	3.72
40	1 ½"	1)	41	1.61	82	3.23	101	3.98	103	4.06
50	2"	1)	52	2.05	101	3.98	115.5	4.55	108	4.25
65	2 ½"	1)	68	2.68	121	4.76	131.5	5.18	118	4.65
80	3"	1)	80	3.15	131	5.16	154.5	6.08	135	5.31
100	4"	1)	104	4.09	156	6.14	186.5	7.34	153	6.02
125	5"	1)	130	5.12	187	7.36	206.5	8.13	160	6.30
150	6"	1)	158	6.22	217	8.54	256	10.08	184	7.24
200	8"	1)	206	8.11	267	10.51	288	11.34	205	8.07
250	10"	1)	260	10.2	328	12.91	359	14.13	240	9.45
300	12"	PN 10 PN 16 Cl. 150	312	12.3	375	14.76	413	16.26	273	10.75
		PN 25 JIS 10K JIS 20K	310	12.2	375	14.76	404	15.91	268	10.55
350	14"	PN 6	420	16.5	420	16.54	479	18.86	365	14.37
		PN 10								
		PN 16								
375	15"	PN 16	461	18.2	461	18.2	523	20.6	395	15.6
400	16"	PN 6	470	18.5	470	18.50	542	21.34	395	15.55
		PN 10								
		PN 16								
450	18"	PN 6	525	20.7	525	20.67	583	22.95	417	16.42
		PN 10								
		PN 16								
500	20"	PN 6	575	22.6	575	22.64	650	25.59	460	18.11
		PN 10								
		PN 16								
600	24"	PN 6	676	26.6	676	26.61	766	30.16	522	20.55
		PN 10								
		PN 16								
700	28"	PN 6	697	27.4	–	–	786	30.94	460	18.11
		PN10	693	27.3	–	–	813	32.01	480	18.9
		PN16	687	27.1	–	–	807	31.77	490	19.29
		Cl, D	693	27.3	–	–	832	32.76	494	19.45
750	30"	Cl, D	743	29.3	–	–	833	32.8	523	20.59
800	32"	PN 6	799	31.5	–	–	893	35.16	520	20.47
		PN 10	795	31.3	–	–	920	36.22	540	21.26
		PN 16	789	31.1	–	–	914	35.98	550	21.65
		Cl, D	795	31.3	–	–	940	37.01	561	22.09
900	36"	PN 6	897	35.3	–	–	993	39.09	570	22.44

DN		Pressure rating	A		B		D		H	
[mm]	[inch]		[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]
		PN 10	893	35.2	–	–	1020	40.16	590	23.23
		PN 16	886	34.9	–	–	1014	39.92	595	23.43
		Cl, D	893	35.2	–	–	1048	41.26	615	24.21
1000	40"	PN 6	999	39.3	–	–	1093	43.03	620	24.41
		PN 10	995	39.2	–	–	1127	44.37	650	25.59
		PN 16	988	38.9	–	–	1131	44.53	660	25.98
		Cl, D	995	39.2	–	–	1163	45.79	675	26.57
–	42"	PN 6	1044	41.1	–	–	1220	48.03	704	27.72
1200	48"	PN 6	1203	47.4	–	–	1310	51.57	733	28.86
		PN 10	1196	47.1	–	–	1344	52.91	760	29.92
		PN 16	1196	47.1	–	–	1385	54.53	786	30.94
		Cl, D	1188	46.8	–	–	1345	52.95	775	30.51

1) In the case of DN 25 to 250, ground disks can be used for all the flange standards/pressure ratings which can be supplied in the standard version

Weight

All values (weight exclusive of packaging material) refer to devices with flanges of the standard pressure rating.
The weight may be lower than indicated depending on the pressure rating and design.

Weight in SI units

Order code for "Design", option C, D, E, H, I : DN 25 to 400 mm (1 to 16 in)			
Nominal diameter		Reference values EN (DIN), AS, JIS	
[mm]	[in]	Pressure rating	[kg]
25	1	PN 40	10
32	–	PN 40	11
40	1 ½	PN 40	12
50	2	PN 40	13
65	–	PN 16	13
80	3	PN 16	15
100	4	PN 16	18
125	–	PN 16	25
150	6	PN 16	31
200	8	PN 10	52
250	10	PN 10	81
300	12	PN 10	95
350	14	PN 6	106
375	15	PN 6	121
400	16	PN 6	121

Order code for "Design", option F, J: DN 450 to 2 000 mm (18 to 78 in)			
Nominal diameter		Reference values EN (DIN) (PN16)	AS (PN 16)
[mm]	[in]	[kg]	[kg]
450	18	142	138
500	20	182	186
600	24	227	266
700	28	291	369
–	30	–	447
800	32	353	524
900	36	444	704
1000	40	566	785
–	42	–	–
1200	48	843	1229
–	54	–	–
1400	–	1204	–
–	60	–	–
1600	–	1845	–
–	66	–	–

Order code for "Design", option F, J: DN 450 to 2 000 mm (18 to 78 in)			
Nominal diameter		Reference values	
		EN (DIN) (PN16)	AS (PN 16)
[mm]	[in]	[kg]	[kg]
1800	72	2 357	–
–	78	2 929	–
2000	–	2 929	–

Order code for "Design", option F, J: DN 2 200 to 3 000 mm (84 to 120 in)		
Nominal diameter		Reference values
		EN (DIN) (PN6)
[mm]	[in]	[kg]
–	84	–
2200	–	3 422
–	90	–
2400	–	4 094
–	96	–
–	102	–
2600	–	7 601.5
–	108	–
2800	–	9 466.5
–	114	–
3000	–	11 911
–	120	–

Order code for "Design", option G, K: DN 450 to 2 000 mm (18 to 78 in)		
Nominal diameter		Reference values
		EN (DIN) (PN 6)
[mm]	[in]	[kg]
450	18	161
500	20	156
600	24	208
700	28	304
–	30	–
800	32	357
900	36	485
1000	40	589
–	42	–
1200	48	850
–	54	850
1400	–	1 300
–	60	–
1600	–	1 845

Order code for "Design", option G, K: DN 450 to 2 000 mm (18 to 78 in)		
Nominal diameter		Reference values EN (DIN) (PN 6)
[mm]	[in]	[kg]
–	66	–
1800	72	2 357
–	78	2 929
2000	–	2 929

Weight in US units

Order code for "Design", option C, D, E, H, I: DN 1 to 16 in (25 to 400 mm)		
Nominal diameter		Reference values ASME (Class 150)
[mm]	[in]	[lb]
25	1	11
32	–	–
40	1 ½	15
50	2	20
65	–	–
80	3	31
100	4	42
125	–	–
150	6	73
200	8	115
250	10	198
300	12	284
350	14	379
375	15	–
400	16	448

Order code for "Design", option F, J: DN 18 to 120 in (450 to 3 000 mm)		
Nominal diameter		Reference values ASME (Class 150), AWWA (Class D)
[mm]	[in]	[lb]
450	18	421
500	20	503
600	24	666
700	28	587
–	30	701
800	32	845
900	36	1036
1000	40	1294
–	42	1477
1200	48	1987

Order code for "Design", option F, J: DN 18 to 120 in (450 to 3 000 mm)		
Nominal diameter		Reference values ASME (Class 150), AWWA (Class D)
[mm]	[in]	[lb]
–	54	2 807
1400	–	–
–	60	3 515
1600	–	–
–	66	4 699
1800	72	5 662
–	78	6 864
2000	–	6 864
–	84	8 280
2200	–	–
–	90	10 577
2400	–	–
–	96	15 574.6
–	102	18 023.9
2600	–	–
–	108	20 783.0
2800	–	–
–	114	24 060.2
3000	–	–
–	120	27 724.3

Order code for "Design", option G, K: DN 18 to 78 in (450 to 2 000 mm)		
Nominal diameter		Reference values ASME (Class 150), AWWA (Class D)
[mm]	[in]	[lb]
450	18	562
500	20	628
600	24	893
700	28	882
–	30	1 014
800	32	1 213
900	36	1 764
1000	40	1 984
–	42	2 426
1200	48	3 087
–	54	4 851
1400	–	–
–	60	5 954
1600	–	–
–	66	8 158

Order code for "Design", option G, K: DN 18 to 78 in (450 to 2000 mm)		
Nominal diameter		Reference values ASME (Class 150), AWWA (Class D)
[mm]	[in]	[lb]
1800	72	9040
–	78	10 143
2000	–	–

Measuring tube specification

The values are reference values and can vary depending on the pressure rating, design and order option.

Nominal diameter		Pressure rating				Measuring tube internal diameter					
		EN (DIN)	ASME AWWA	AS 2129 AS 4087	JIS	Hard rubber		Polyurethane		PTFE	
[mm]	[in]					[mm]	[in]	[mm]	[in]	[mm]	[in]
25	1	PN 40	Class 150	–	20K	–	–	24	0.93	25	1.00
32	–	PN 40	–	–	20K	–	–	32	1.28	34	1.34
40	1 ½	PN 40	Class 150	–	20K	–	–	38	1.51	40	1.57
50	2	PN 40	Class 150	Table E, PN 16	10K	50	1.98	50	1.98	52	2.04
50 [1]	2	PN 40	Class 150	Table E, PN 16	10K	32	1.26	–	–	–	–
65	–	PN 16	–	–	10K	66	2.60	66	2.60	68	2.67
65 [1]	–	PN 16	–	–	10K	38	1.50	–	–	–	–
80	3	PN 16	Class 150	Table E, PN 16	10K	79	3.11	79	3.11	80	3.15
80 [1]	3	PN 16	Class 150	Table E, PN 16	10K	50	1.97	–	–	–	–
100	4	PN 16	Class 150	Table E, PN 16	10K	101	3.99	104	4.11	104	4.09
100 [1]	4	PN 16	Class 150	Table E, PN 16	10K	66	2.60	–	–	–	–
125	–	PN 16	–	–	10K	127	4.99	130	5.11	129	5.08
125 [1]	–	PN 16	–	–	10K	79	3.11	–	–	–	–
150	6	PN 16	Class 150	Table E, PN 16	10K	155	6.11	158	6.23	156	6.15
150 [1]	6	PN 16	Class 150	Table E, PN 16	10K	102	4.02	–	–	–	–
200	8	PN 10	Class 150	Table E, PN 16	10K	204	8.02	207	8.14	202	7.96
200 [1]	8	PN 16	Class 150	Table E, PN 16	10K	127	5.00	–	–	–	–
250	10	PN 10	Class 150	Table E, PN 16	10K	258	10.14	261	10.26	256	10.09
250 [1]	10	PN 16	Class 150	Table E, PN 16	10K	156	6.14	–	–	–	–
300	12	PN 10	Class 150	Table E, PN 16	10K	309	12.15	312	12.26	306	12.03
300 [1]	12	PN 16	Class 150	Table E, PN 16	10K	204	8.03	–	–	–	–
350	14	PN 10	Class 150	Table E, PN 16	10K	337	13.3	340	13.4	–	–
375	15	–	–	PN 16	10K	389	15.3	392	15.4	–	–
400	16	PN 10	Class 150	Table E, PN 16	10K	387	15.2	390	15.4	–	–
450	18	PN 10	Class 150	–	10K	436	17.2	439	17.3	–	–
500	20	PN 10	Class 150	Table E, PN 16	10K	487	19.2	490	19.3	–	–
600	24	PN 10	Class 150	Table E, PN 16	10K	585	23.0	588	23.1	–	–
700	28	PN 10	Class D	Table E, PN 16	10K	694	27.3	697	27.4	–	–
750	30	–	Class D	Table E, PN 16	10K	743	29.3	746	29.4	–	–
800	32	PN 10	Class D	Table E, PN 16	–	794	31.3	797	31.4	–	–

Nominal diameter		Pressure rating				Measuring tube internal diameter					
		EN (DIN)	ASME AWWA	AS 2129 AS 4087	JIS	Hard rubber		Polyurethane		PTFE	
[mm]	[in]					[mm]	[in]	[mm]	[in]	[mm]	[in]
900	36	PN 10	Class D	Table E, PN 16	–	895	35.2	898	35.4	–	–
1000	40	PN 6	Class D	Table E, PN 16	–	991	39.0	994	39.1	–	–
–	42	–	Class D	–	–	1043	41.1	1043	41.1	–	–
1200	48	PN 6	Class D	Table E, PN 16	–	1191	46.9	1197	47.1	–	–
–	54	–	Class D	–	–	1339	52.7	–	–	–	–
1400	–	PN 6	–	–	–	1402	55.2	–	–	–	–
–	60	–	Class D	–	–	1492	58.7	–	–	–	–
1600	–	PN 6	–	–	–	1600	63.0	–	–	–	–
–	66	–	Class D	–	–	1638	64.5	–	–	–	–
1800	72	PN 6	–	–	–	1786	70.3	–	–	–	–
–	78	–	Class D	–	–	1989	78.3	–	–	–	–
2000	–	PN 6	–	–	–	1989	78.3	–	–	–	–
–	84	–	Class D	–	–	2099	84.0	–	–	–	–
2200	–	PN 6	–	–	–	2194	87.8	–	–	–	–
–	90	–	Class D	–	–	2246	89.8	–	–	–	–
2400	–	PN 6	–	–	–	2391	94.1	–	–	–	–
–	96	–	Class D	–		2382	93.8	–	–	–	–
–	102	–	Class D	–		2533	99.7	–	–	–	–
2600	–	PN 6	–	–		2580	101.6	–	–	–	–
–	108	–	Class D	–		2683	105.6	–	–	–	–
2800	–	PN 6	–	–		2780	109.5	–	–	–	–
–	114	–	Class D	–		2832	111.5	–	–	–	–
3000	–	PN 6	–	–		2976	117.2	–	–	–	–
–	120	–	Class D	–		2980	117.3	–	–	–	–

1) Order code for "Design", option C

Materials

Transmitter housing

Compact version

- Order code for "Housing", option **A** "Compact, alu, coated": Aluminum, AlSi10Mg, coated
- Order code for "Housing", option **M**: polycarbonate plastic
- Window material:
  - For order code for "Housing", option **A**: glass
  - For order code for "Housing", option **M**: plastic

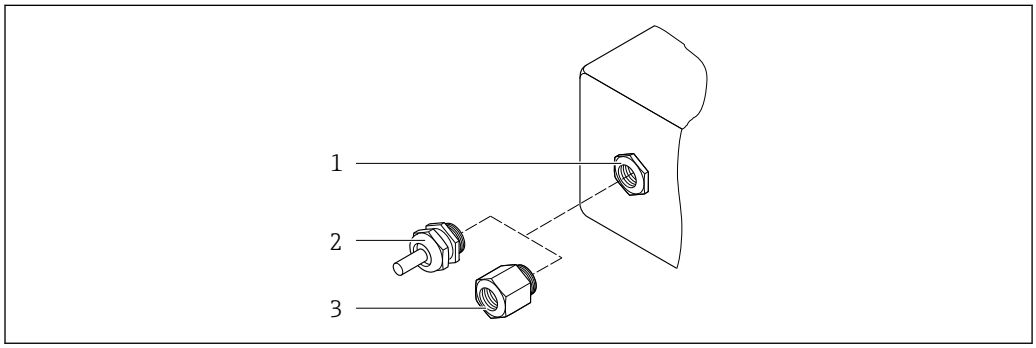
Remote version (wall-mount housing)

- Order code for "Housing", option **P** "Remote, alu, coated": Aluminum, AlSi10Mg, coated
- Order code for "Housing", option **N**: polycarbonate plastic
- Window material:
  - For order code for "Housing", option **P**: glass
  - For order code for "Housing", option **N**: plastic

Sensor connection housing

- Aluminum, AlSi10Mg, coated
- Polycarbonate plastic (only in conjunction with order code for "Sensor option", options CA, C3, CB, CC, CD, CD)

Cable entries/cable glands



30 *Possible cable entries/cable glands*

1 *Female thread M20 × 1.5*
2 *Cable gland M20 × 1.5*
3 *Adapter for cable entry with female thread G ½" or NPT ½"*

Compact and remote versions and sensor connection housing

Cable entry/cable gland	Material
Cable gland M20 × 1.5	▪ Plastic ▪ Nickel-plated brass
Remote version: cable gland M20 × 1.5 Option of armored connecting cable	▪ Sensor connection housing: Nickel-plated brass ▪ Transmitter wall-mount housing: Plastic
Adapter for cable entry with female thread G ½" or NPT ½"	Nickel-plated brass

Device plug

Electrical connection	Material
Plug M12x1	▪ Socket: Stainless steel, 1.4404 (316L) ▪ Contact housing: Polyamide ▪ Contacts: Gold-plated brass

Remote version connecting cable

UV rays can impair the cable outer sheath. Protect the cable from exposure to sun as much as possible.

Electrode and coil current cable:
- Standard cable: PVC cable with copper shield
- Armored cable: PVC cable with copper shield and additional steel wire braided jacket

Sensor housing

- DN 25 to 300 (1 to 12")
  - Aluminum half-shell housing, aluminum, AlSi10Mg, coated
  - Fully welded carbon steel housing with protective varnish
- DN 350 to 3000 (14 to 120")
  Fully welded carbon steel housing with protective varnish

Measuring tubes

- DN 25 to 600 (1 to 24")
  Stainless steel: 1.4301, 1.4306, 304, 304L
- DN 700 to 3000 (28 to 120")
  Stainless steel: 1.4301, 304

Liner

- DN 25 to 300 (1 to 12"): PTFE
- DN 25 to 1200 (1 to 48"): polyurethane
- DN 50 to 3000 (2 to 120"): hard rubber

Electrodes

- Stainless steel, 1.4435 (316L)
- Alloy C22, 2.4602 (UNS N06022)
- Tantalum

Process connections

For flanges made of carbon steel:
- DN ≤ 300 (12"): with Al/Zn protective coating or protective varnish
- DN ≥ 350 (14"): protective varnish

All carbon steel lap joint flanges are supplied with a hot-dip galvanized finish.

EN 1092-1 (DIN 2501)

Fixed flange
- Carbon steel:
  - DN ≤ 300: S235JRG2, S235JR+N, P245GH, A105, E250C
  - DN 350 to 3000: P245GH, S235JRG2, A105, E250C
- Stainless steel:
  - DN ≤ 300: 1.4404, 1.4571, F316L
  - DN 350 to 600: 1.4571, F316L, 1.4404
  - DN 700 to 1000: 1.4404, F316L

Lap joint flange
- Carbon steel DN ≤ 300: S235JRG2, A105, E250C
- Stainless steel DN ≤ 300: 1.4306,1.4404, 1.4571, F316L

Lap joint flange, stamped plate
- Carbon steel DN ≤ 300: S235JRG2 similar to S235JR+AR or 1.0038
- Stainless steel DN ≤ 300: 1.4301 similar to 304

ASME B16.5

Fixed flange, lap joint flange
- Carbon steel: A105
- Stainless steel: F316L

JIS B2220

- Carbon steel: A105, A350 LF2
- Stainless steel: F316L

AWWA C207

Carbon steel: A105, P265GH, A181 Class 70, E250C, S275JR

AS 2129

Carbon steel: A105, E250C, P235GH, P265GH, S235JRG2

AS 4087

Carbon steel: A105, P265GH, S275JR

Seals

As per DIN EN 1514-1, form IBC

Accessories

Display guard

Stainless steel, 1.4301 (304L)

Ground disks

- Stainless steel, 1.4435 (316L)
- Alloy C22, 2.4602 (UNS N06022)
- Tantalum

Fitted electrodes

Measurement, reference and empty pipe detection electrodes available as standard with:
- 1.4435 (316L)
- Alloy C22, 2.4602 (UNS N06022)
- Tantalum

Process connections

- EN 1092-1 (DIN 2501)
- ASME B16.5
- JIS B2220
- AS 2129 Table E
- AS 4087 PN 16
- AWWA C207 Class D

For information on the different materials used in the process connections → 93

Surface roughness

Electrodes with 1.4435 (316L); Alloy C22, 2.4602 (UNS N06022); tantalum: < 0.5 µm (19.7 µin)

(All data relate to parts in contact with medium)

Human interface

Operating concept

Operator-oriented menu structure for user-specific tasks
- Commissioning
- Operation
- Diagnostics
- Expert level

Fast and safe commissioning
- Guided menus ("Make-it-run" wizards) for applications
- Menu guidance with brief descriptions of the individual parameter functions
- Access to the device via Web server
- WLAN access to the device via mobile handheld terminal, tablet or smart phone

Reliable operation
- Operation in local language
- Uniform operating philosophy applied to device and operating tools
- If replacing electronic modules, transfer the device configuration via the integrated memory (HistoROM backup) which contains the process and measuring device data and the event logbook. No need to reconfigure.

Efficient diagnostic behavior increases measurement availability
- Troubleshooting measures can be called up via the device and in the operating tools
- Diverse simulation options, logbook for events that occur and optional line recorder functions

Languages

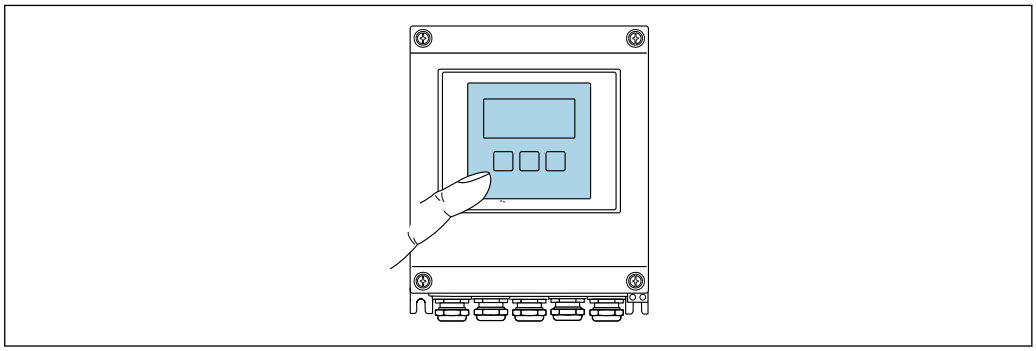
Can be operated in the following languages:
- Via local operation:
  English, German, French, Spanish, Italian, Dutch, Portuguese, Polish, Russian, Turkish, Chinese, Japanese, Bahasa (Indonesian), Vietnamese, Czech, Swedish
- Via "FieldCare", "DeviceCare" operating tool:
  English, German, French, Spanish, Italian, Chinese, Japanese
- Via Web browser (only available for device versions with HART, PROFIBUS DP and EtherNet/IP):
  English, German, French, Spanish, Italian, Dutch, Portuguese, Polish, Russian, Turkish, Chinese, Japanese, Bahasa (Indonesian), Vietnamese, Czech, Swedish

Local operation

Via display module

Equipment:
- Standard features 4-line, illuminated, graphic display; touch control
- Order code for "Display; operation", option BA "WLAN" offers standard equipment features in addition to access via Web browser

Information about WLAN interface → 98



A0032074

31 *Operation with touch control*

Display elements

- 4-line, illuminated, graphic display
- White background lighting; switches to red in event of device errors
- Format for displaying measured variables and status variables can be individually configured
- Permitted ambient temperature for the display: –20 to +60 °C (–4 to +140 °F)
  The readability of the display may be impaired at temperatures outside the temperature range.

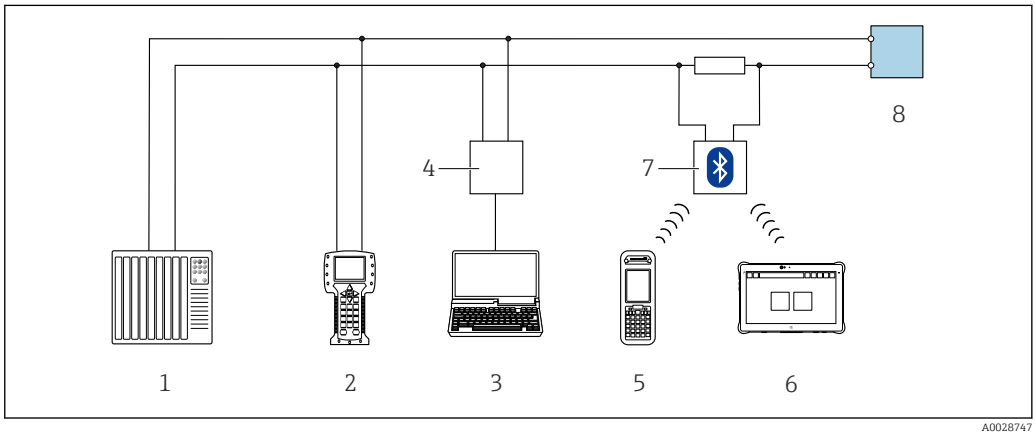
Operating elements

- External operation via touch control (3 optical keys) without opening the housing: ⊞, ⊟, Ⓔ
- Operating elements also accessible in the various zones of the hazardous area

Remote operation

Via HART protocol

This communication interface is available in device versions with a HART output.



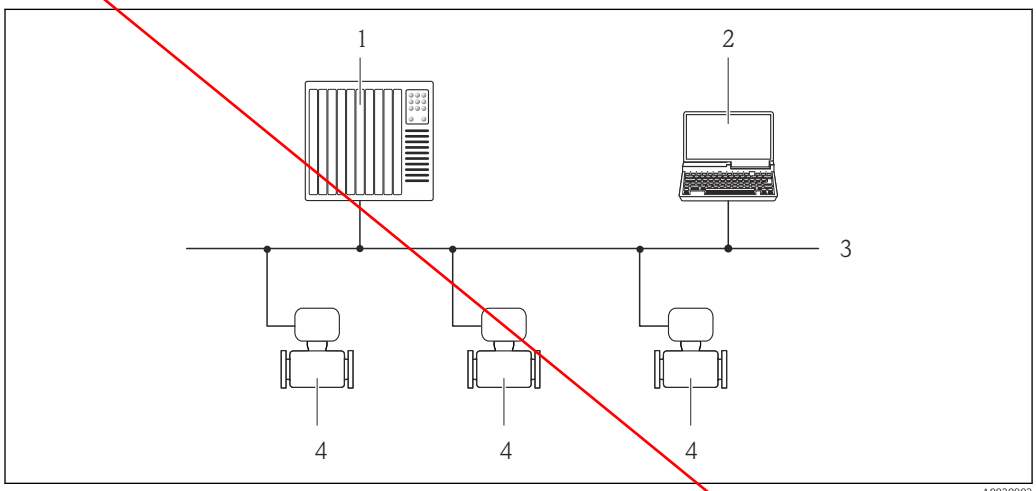
A0028747

32 *Options for remote operation via HART protocol*

1 *Control system (e.g. PLC)*
2 *Field Communicator 475*
3 *Computer with operating tool (e.g. FieldCare, AMS Device Manager, SIMATIC PDM)*
4 *Commubox FXA195 (USB)*
5 *Field Xpert SFX350 or SFX370*
6 *Field Xpert SMT70*
7 *VIATOR Bluetooth modem with connecting cable*
8 *Transmitter*

Via PROFIBUS DP network

This communication interface is available in device versions with PROFIBUS DP.

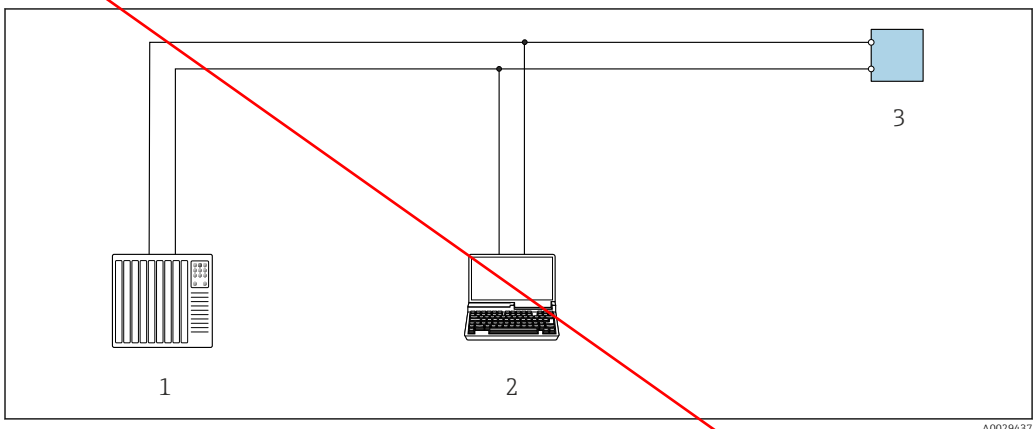


33 *Options for remote operation via PROFIBUS DP network*

1 *Automation system*
2 *Computer with PROFIBUS network card*
3 *PROFIBUS DP network*
4 *Measuring device*

Via Modbus RS485 protocol

This communication interface is available in device versions with a Modbus-RS485 output.



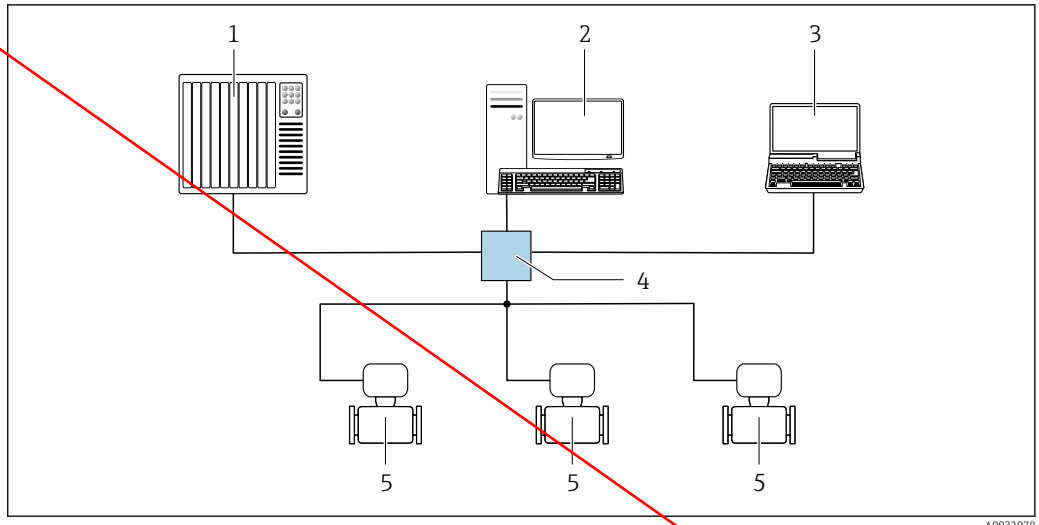
34 *Options for remote operation via Modbus-RS485 protocol (active)*

1 *Control system (e.g. PLC)*
2 *Computer with Web browser (e.g. Internet Explorer) for accessing the integrated device Web server or with operating tool (e.g. FieldCare, DeviceCare) with COM DTM "CDI Communication TCP/IP" or Modbus DTM*
3 *Transmitter*

Via EtherNet/IP network

This communication interface is available in device versions with EtherNet/IP.

Star topology



35 *Options for remote operation via EtherNet/IP network: star topology*

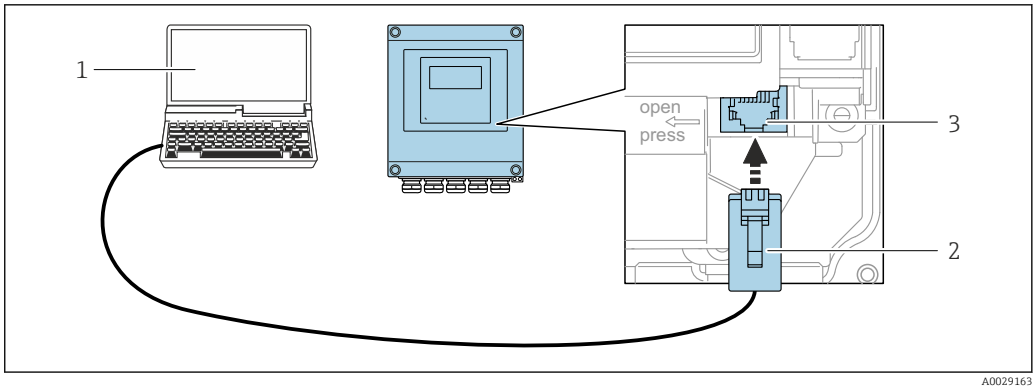
1 *Automation system, e.g. "RSLogix" (Rockwell Automation)*
2 *Workstation for measuring device operation: with Custom Add-On Profile for "RSLogix 5000" (Rockwell Automation) or with Electronic Data Sheet (EDS)*
3 *Computer with Web browser (e.g. Internet Explorer) for accessing the integrated device Web server or computer with operating tool (e.g. FieldCare, DeviceCare) with COM DTM "CDI Communication TCP/IP"*
4 *Ethernet switch*
5 *Measuring device*

Service interface

Via service interface (CDI-RJ45)

This communication interface is present in the following device version:

- Order code for "Output", option **H**: 4 to 20 mA HART, pulse/frequency output, switch output
- Order code for "Output", option **I**: 4 to 20 mA HART, 2 x pulse/frequency/switch output, status input
- Order code for "Output", option **J**: 4 to 20 mA HART, certified pulse output, switch output; status input
- Order code for "Output", option **L**: PROFIBUS DP
- Order code for "Output", option **M**: Modbus RS485
- Order code for "Output", option **O**: Modbus RS485, 4 to 20 mA, 2 x pulse/frequency/switch output
- Order code for "Output", option **P**: Modbus RS485, 4 to 20 mA, certified pulse output, pulse/frequency/switch output
- Order code for "Output", option **N**: EtherNet/IP

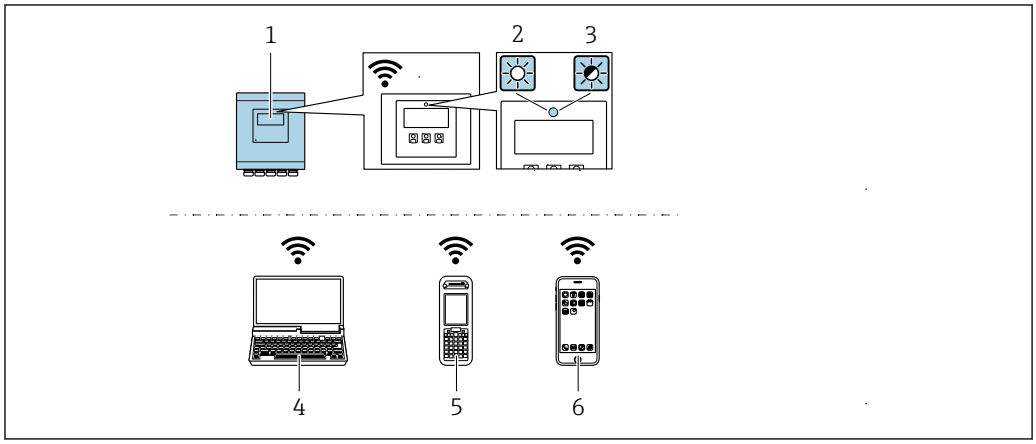


36 *Connection via service interface (CDI-RJ45)*

1 *Computer with Web browser (e.g. Microsoft Internet Explorer, Microsoft Edge) for accessing the integrated device Web server or with "FieldCare", "DeviceCare" operating tool with COM DTM "CDI Communication TCP/IP" or Modbus DTM*
2 *Standard Ethernet connecting cable with RJ45 plug*
3 *Service interface (CDI-RJ45) of the measuring device with access to the integrated Web server*

Via WLAN interface

The optional WLAN interface is available on the following device version:
Order code for "Display", option BA "WLAN":
4-line, illuminated, graphic display; touch control + WLAN



A0043149

1 *Transmitter with integrated WLAN antenna*
2 *LED lit constantly: WLAN reception is enabled on measuring device*
3 *LED flashing: WLAN connection established between operating unit and measuring device*
4 *Computer with WLAN interface and Web browser (e.g. Microsoft Internet Explorer, Microsoft Edge) for accessing the integrated device Web server or with operating tool (e.g. FieldCare, DeviceCare)*
5 *Mobile handheld terminal with WLAN interface and Web browser (e.g. Microsoft Internet Explorer, Microsoft Edge) for accessing the integrated device Web server or operating tool (e.g. FieldCare, DeviceCare)*
6 *Smart phone or tablet (e.g. Field Xpert SMT70)*

Function	WLAN: IEEE 802.11 b/g (2.4 GHz) ▪ Access point with DHCP server (default setting) ▪ Network
Encryption	WPA2-PSK AES-128 (in accordance with IEEE 802.11i)
Configurable WLAN channels	1 to 11
Degree of protection	IP67
Available antenna	Internal antenna
Range	Typically 10 m (32 ft)

Supported operating tools

Different operating tools can be used for local or remote access to the measuring device. Depending on the operating tool used, access is possible with different operating units and via a variety of interfaces.

Supported operating tools	Operating unit	Interface	Additional information
Web browser	Notebook, PC or tablet with Web browser	▪ CDI-RJ45 service interface ▪ WLAN interface ▪ Ethernet-based fieldbus (EtherNet/IP)	Special Documentation for the device
DeviceCare SFE100	Notebook, PC or tablet with Microsoft Windows system	▪ CDI-RJ45 service interface ▪ WLAN interface ▪ Fieldbus protocol	→ 105

Supported operating tools	Operating unit	Interface	Additional information
FieldCare SFE500	Notebook, PC or tablet with Microsoft Windows system	▪ CDI-RJ45 service interface ▪ WLAN interface ▪ Fieldbus protocol	→ 🖹 105
Device Xpert	Field Xpert SFX 100/350/370	Fieldbus protocol HART	Operating Instructions BA01202S Device description files: Use update function of handheld terminal

Other operating tools based on FDT technology with a device driver such as DTM/iDTM or DD/EDD can be used for device operation. These operating tools are available from the individual manufacturers. Integration into the following operating tools, among others, is supported:

- FactoryTalk AssetCentre (FTAC) from Rockwell Automation → www.rockwellautomation.com
- Process Device Manager (PDM) from Siemens → www.siemens.com
- Asset Management Solutions (AMS) from Emerson → www.emersonprocess.com
- FieldCommunicator 375/475 from Emerson → www.emersonprocess.com
- Field Device Manager (FDM) from Honeywell → www.honeywellprocess.com
- FieldMate from Yokogawa → www.yokogawa.com
- PACTWare → www.pactware.com

The related device description files are available: www.endress.com → Downloads

Web server

Thanks to the integrated Web server, the device can be operated and configured via a Web browser and via a service interface (CDI-RJ45) or via a WLAN interface. The structure of the operating menu is the same as for the local display. In addition to the measured values, device status information is also displayed, allowing users to monitor the status of the device. Furthermore the device data can be managed and the network parameters can be configured.

A device that has a WLAN interface (can be ordered optionally) is required for the WLAN connection: order code for "Display", option BA "WLAN". The device acts as an Access Point and enables communication by computer or a mobile handheld terminal.

Supported functions
Data exchange between the operating unit (such as a notebook for example) and the measuring device:
- Upload the configuration from the measuring device (XML format, configuration backup)
- Save the configuration to the measuring device (XML format, restore configuration)
- Export event list (.csv file)
- Export parameter settings (.csv file or PDF file, document the measuring point configuration)
- Export the Heartbeat verification log (PDF file, only available with the "Heartbeat Verification" application package)
- Flash firmware version for device firmware upgrade, for instance
- Download driver for system integration
- Visualize up to 1000 saved measured values (only available with the **Extended HistoROM** application package → 🖹 103)

Web server special documentation → 🖹 106

HistoROM data management

The measuring device features HistoROM data management. HistoROM data management comprises both the storage and import/export of key device and process data, making operation and servicing far more reliable, secure and efficient.

Additional information on the data storage concept

There are different types of data storage units in which device data are stored and used by the device:

	HistoROM backup	T-DAT	S-DAT

Available data	▪ Event logbook such as diagnostic events for example
	▪ Device firmware package
	▪ Driver for system integration for exporting via Web server, e.g:
	  ▪ GSD for PROFIBUS DP
	  ▪ EDS for EtherNet/IP
		▪ Measured value logging ("Extended HistoROM" order option)
		▪ Current parameter data record (used by firmware at run time)
		▪ Peakhold indicator (min/max values)
		▪ Totalizer values
			▪ Sensor data: nominal diameter etc.
			▪ Serial number
			▪ Calibration data
			▪ Device configuration (e.g. SW options, fixed I/O or multi I/O)

Storage location	Fixed on the user interface board in the connection compartment	Attachable to the user interface board in the connection compartment	In the sensor plug in the transmitter neck part

Data backup

Automatic
- The most important device data (sensor and transmitter) are automatically saved in the DAT modules
- If the transmitter or measuring device is replaced: once the T-DAT containing the previous device data has been exchanged, the new measuring device is ready for operation again immediately without any errors
- If the sensor is replaced: once the sensor has been replaced, new sensor data are transferred from the S-DAT in the measuring device and the measuring device is ready for operation again immediately without any errors

Data transmission

Manual
- Transfer of a device configuration to another device using the export function of the specific operating tool, e.g. with FieldCare, DeviceCare or Web server: to duplicate the configuration or to store in an archive (e.g. for backup purposes)
- Transmission of the drivers for system integration via Web server, e.g.:
  - GSD for PROFIBUS DP
  - EDS for EtherNet/IP

Event list

Automatic
- Chronological display of up to 20 event messages in the events list
- If the **Extended HistoROM** application package (order option) is enabled: up to 100 event messages are displayed in the events list along with a time stamp, plain text description and remedial measures
- The events list can be exported and displayed via a variety of interfaces and operating tools e.g. DeviceCare, FieldCare or Web server

Data logging

Manual
If the **Extended HistoROM** application package (order option) is enabled:
- Record up to 1 000 measured values via 1 to 4 channels
- User configurable recording interval
- Record up to 250 measured values via each of the 4 memory channels
- Export the measured value log via a variety of interfaces and operating tools e.g. FieldCare, DeviceCare or web server

Certificates and approvals

Current certificates and approvals for the product are available via the Product Configurator at www.endress.com.

1. Select the product using the filters and search field.
2. Open the product page.

The **Configuration** button opens the Product Configurator.

CE mark

The device meets the legal requirements of the applicable EU Directives. These are listed in the corresponding EU Declaration of Conformity along with the standards applied.

Endress+Hauser confirms successful testing of the device by affixing to it the CE mark.

UKCA marking

The device meets the legal requirements of the applicable UK regulations (Statutory Instruments). These are listed in the UKCA Declaration of Conformity along with the designated standards. By selecting the order option for UKCA marking, Endress+Hauser confirms a successful evaluation and testing of the device by affixing the UKCA mark.

Contact address Endress+Hauser UK:
Endress+Hauser Ltd.
Floats Road
Manchester M23 9NF
United Kingdom
www.uk.endress.com

RCM mark

The measuring system meets the EMC requirements of the "Australian Communications and Media Authority (ACMA)".

Ex approval

The devices are certified for use in hazardous areas and the relevant safety instructions are provided in the separate "Control Drawing" document. Reference is made to this document on the nameplate.

Drinking water approval

- ACS
- KTW/W270
- NSF 61
- WRAS BS 6920

HART certification

HART interface

The measuring device is certified and registered by the FieldComm Group. The measuring system meets all the requirements of the following specifications:
- Certified according to HART 7
- The device can also be operated with certified devices of other manufacturers (interoperability)

PROFIBUS conformity

PROFIBUS interface

The measuring device is registered with PI (PROFIBUS and PROFINET International). It meets all the requirements of PROFIBUS PA Profile 3.02 specifications and can also be operated with certified devices of other manufacturers (interoperability).

Modbus RS485 certification

The measuring device meets all the requirements of the MODBUS/TCP conformity test and has the "MODBUS/TCP Conformance Test Policy, Version 2.0". The measuring device has successfully passed all the test procedures carried out.

EtherNet/IP certification

The measuring device is certified and registered by the ODVA (Open Device Vendor Association). The measuring system meets all the requirements of the following specifications:
- Certified in accordance with the ODVA Conformance Test
- EtherNet/IP Performance Test
- EtherNet/IP PlugFest compliance
- The device can also be operated with certified devices of other manufacturers (interoperability)

Radio approval

The measuring device has radio approval.

For detailed information regarding radio approval, see the Special Documentation → 106

Measuring instrument approval

The measuring device is (optionally) approved as a cold water meter (MI-001) for volume measurement in service subject to legal metrological control in accordance with the European Measuring Instruments Directive 2014/32/EU (MID).

The measuring device is qualified to OIML R49: 2013.

Other standards and guidelines

- EN 60529
  Degrees of protection provided by enclosures (IP code)
- EN 61010-1
  Safety requirements for electrical equipment for measurement, control and laboratory use - general requirements
- IEC/EN 61326-3-2
  Emission in accordance with Class A requirements. Electromagnetic compatibility (EMC requirements).
- ANSI/ISA-61010-1 (82.02.01)
  Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use - Part 1 General Requirements
- CAN/CSA-C22.2 No. 61010-1-12
  Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use - Part 1 General Requirements
- NAMUR NE 21
  Electromagnetic compatibility (EMC) of industrial process and laboratory control equipment
- NAMUR NE 32
  Data retention in the event of a power failure in field and control instruments with microprocessors
- NAMUR NE 43
  Standardization of the signal level for the breakdown information of digital transmitters with analog output signal.
- NAMUR NE 53
  Software of field devices and signal-processing devices with digital electronics
- NAMUR NE 105
  Specifications for integrating fieldbus devices in engineering tools for field devices
- NAMUR NE 107
  Self-monitoring and diagnosis of field devices
- NAMUR NE 131
  Requirements for field devices for standard applications

Ordering information

Detailed ordering information is available for your nearest sales organization www.addresses.endress.com or in the Product Configurator under www.endress.com :

1. Click Corporate
2. Select the country
3. Click Products
4. Select the product using the filters and search field
5. Open the product page

The Configuration button to the right of the product image opens the Product Configurator.

Product Configurator - the tool for individual product configuration
- Up-to-the-minute configuration data
- Depending on the device: Direct input of measuring point-specific information such as measuring range or operating language
- Automatic verification of exclusion criteria
- Automatic creation of the order code and its breakdown in PDF or Excel output format
- Ability to order directly in the Endress+Hauser Online Shop

Application packages

Many different application packages are available to enhance the functionality of the device. Such packages might be needed to address safety aspects or specific application requirements.

The application packages can be ordered with the device or subsequently from Endress+Hauser. Detailed information on the order code in question is available from your local Endress+Hauser sales center or on the product page of the Endress+Hauser website: www.endress.com.

Cleaning

Package	Description
Electrode cleaning circuit (ECC)	The electrode cleaning circuit (ECC) function has been developed to have a solution for applications where magnetite (Fe_3O_4) deposits frequently occur (e.g. hot water). Since magnetite is highly conductive this build up leads to measuring errors and ultimately to the loss of signal. The application package is designed to avoid build-up of very conductive matter and thin layers (typical of magnetite).

Diagnostics functions

Package	Description
Extended HistoROM	Comprises extended functions concerning the event log and the activation of the measured value memory. Event log: Memory volume is extended from 20 message entries (standard version) to up to 100 entries. Data logging (line recorder): ▪ Memory capacity for up to 1000 measured values is activated. ▪ 250 measured values can be output via each of the 4 memory channels. The recording interval can be defined and configured by the user. ▪ Measured value logs can be accessed via the local display or operating tool e.g. FieldCare, DeviceCare or Web server.

Heartbeat Technology

Package	Description
Heartbeat Verification +Monitoring	**Heartbeat Verification** Meets the requirement for traceable verification to DIN ISO 9001:2008 Chapter 7.6 a) "Control of monitoring and measuring equipment". ▪ Functional testing in the installed state without interrupting the process. ▪ Traceable verification results on request, including a report. ▪ Simple testing process via local operation or other operating interfaces. ▪ Clear measuring point assessment (pass/fail) with high test coverage within the framework of manufacturer specifications. ▪ Extension of calibration intervals according to operator's risk assessment. **Heartbeat Monitoring** Continuously supplies data, which are characteristic of the measuring principle, to an external condition monitoring system for the purpose of preventive maintenance or process analysis. These data enable the operator to: ▪ Draw conclusions - using these data and other information - about the impact process influences (such as corrosion, abrasion, buildup etc.) have on the measuring performance over time. ▪ Schedule servicing in time. ▪ Monitor the process or product quality, e.g. gas pockets.

Accessories

Various accessories, which can be ordered with the device or subsequently from Endress+Hauser, are available for the device. Detailed information on the order code in question is available from your local Endress+Hauser sales center or on the product page of the Endress+Hauser website: www.endress.com.

Device-specific accessories

For the transmitter

Accessories	Description
Promag 400 transmitter	Transmitter for replacement or storage. Use the order code to define the following specifications: ▪ Approvals ▪ Output/input ▪ Display/operation ▪ Housing ▪ Software For details, see Installation Instructions EA00104D

Display guard	Is used to protect the display against impact or scoring, for example from sand in desert areas. Order number: 71228792 Installation Instructions EA01093D
Connecting cable for remote version	Coil current and electrode cables, various lengths, reinforced cables available on request.
Ground cable	Set, consisting of two ground cables for potential equalization.
Post mounting kit	Post mounting kit for transmitter.
Compact → Remote conversion kit	For converting a compact device version to a remote device version.
Conversion kit Promag 50/53 → Promag 400	For converting a Promag with transmitter 50/53 to a Promag 400.

For the sensor

Accessory	Description
Ground disks	Are used to ground the medium in lined measuring tubes to ensure proper measurement. For details, see Installation Instructions EA00070D

Communication-specific accessories

Accessories	Description
Commubox FXA195 HART	For intrinsically safe HART communication with FieldCare via the USB interface. Technical Information TI00404F
Commubox FXA291	Connects Endress+Hauser field devices with a CDI interface (= Endress+Hauser Common Data Interface) and the USB port of a computer or laptop. Technical Information TI405C/07
HART Loop Converter HMX50	Is used to evaluate and convert dynamic HART process variables to analog current signals or limit values. ▪ Technical Information TI00429F ▪ Operating Instructions BA00371F
Wireless HART adapter SWA70	Is used for the wireless connection of field devices. The WirelessHART adapter can be easily integrated into field devices and existing infrastructures, offers data protection and transmission safety and can be operated in parallel with other wireless networks with minimum cabling complexity. Operating Instructions BA00061S
Fieldgate FXA42	Is used to transmit the measured values of connected 4 to 20 mA analog measuring devices, as well as digital measuring devices ▪ Technical Information TI01297S ▪ Operating Instructions BA01778S ▪ Product page: www.endress.com/fxa42

Field Xpert SMT70	The Field Xpert SMT70 tablet PC for device configuration enables mobile plant asset management in hazardous and non-hazardous areas. It is suitable for commissioning and maintenance staff to manage field instruments with a digital communication interface and to record progress. This tablet PC is designed as an all-in-one solution with a preinstalled driver library and is an easy-to-use, touch-sensitive tool which can be used to manage field instruments throughout their entire life cycle. ▪ Technical Information TI01342S ▪ Operating Instructions BA01709S ▪ Product page: www.endress.com/smt70
Field Xpert SMT77	The Field Xpert SMT77 tablet PC for device configuration enables mobile plant asset management in areas categorized as Ex Zone 1. ▪ Technical Information TI01418S ▪ Operating Instructions BA01923S ▪ Product page: www.endress.com/smt77

Service-specific accessories

Accessory	Description
Applicator	Software for selecting and sizing Endress+Hauser measuring devices: ▪ Choice of measuring devices with industrial requirements ▪ Calculation of all the necessary data for identifying the optimum flowmeter: e.g. nominal diameter, pressure loss, flow velocity and accuracy. ▪ Graphic illustration of the calculation results ▪ Determination of the partial order code, administration, documentation and access to all project-related data and parameters over the entire life cycle of a project. Applicator is available: ▪ Via the Internet: https://portal.endress.com/webapp/applicator ▪ As a downloadable DVD for local PC installation.
W@M	W@M Life Cycle Management Improved productivity with information at your fingertips. Data relevant to a plant and its components is generated from the first stages of planning and during the asset's complete life cycle. W@M Life Cycle Management is an open and flexible information platform with online and on-site tools. Instant access for your staff to current, in-depth data shortens your plant's engineering time, speeds up procurement processes and increases plant uptime. Combined with the right services, W@M Life Cycle Management boosts productivity in every phase. For more information, see: www.endress.com/lifecyclemanagement
FieldCare	FDT-based plant asset management tool from Endress+Hauser. It can configure all smart field units in your system and helps you manage them. By using the status information, it is also a simple but effective way of checking their status and condition. Operating Instructions BA00027S and BA00059S
DeviceCare	Tool for connecting and configuring Endress+Hauser field devices. Innovation brochure IN01047S
Commubox FXA291	Connects Endress+Hauser field devices with a CDI interface (= Endress +Hauser Common Data Interface) and the USB port of a computer or laptop. Technical Information TI00405C

System components

Accessories	Description
Memograph M graphic data manager	The Memograph M graphic data manager provides information on all the relevant measured variables. Measured values are recorded correctly, limit values are monitored and measuring points analyzed. The data are stored in the 256 MB internal memory and also on a SD card or USB stick. ▪ Technical Information TI00133R ▪ Operating Instructions BA00247R

Supplementary documentation

For an overview of the scope of the associated Technical Documentation, refer to the following:
- *W@M Device Viewer* (www.endress.com/deviceviewer): Enter the serial number from the nameplate
- *Endress+Hauser Operations App*: Enter the serial number from the nameplate or scan the matrix code on the nameplate

Standard documentation

Brief Operating Instructions

Brief Operating Instructions for the sensor

Measuring device	Documentation code
Proline Promag W	KA01266D

Transmitter Brief Operating Instructions

Measuring device	Documentation code			
	HART	PROFIBUS DP	Modbus RS485	EtherNet/IP
Proline 400	KA01263D	KA01420D	KA01419D	KA01418D

Operating Instructions

Measuring device	Documentation code			
	HART	PROFIBUS DP	Modbus RS485	EtherNet/IP
Promag W 400	BA01063D	BA01234D	BA01231D	BA01214D

Description of device parameters

Measuring device	Documentation code			
	HART	PROFIBUS DP	Modbus RS485	EtherNet/IP
Promag 400	GP01043D	GP01044D	GP01045D	GP01046D

Supplementary device-dependent documentation

Special Documentation

Content	Documentation code
Display modules A309/A310	SD01793D
Information on Custody Transfer Measurement	SD02038D
Information on Custody Transfer Measurement	SD02561D

Content	Documentation code			
	HART	PROFIBUS DP	Modbus RS485	EtherNet/IP
Web server	SD01811D	SD01813D	SD01812D	SD01814D
Heartbeat Verification + Monitoring	SD01847D	SD02569D	SD02568D	SD02570D

Installation Instructions

Content	Comment
Installation instructions for spare part sets and accessories	Documentation code: specified for each individual accessory → 🖹 103.

Registered trademarks

HART®
Registered trademark of the FieldComm Group, Austin, USA

PROFIBUS®
Registered trademark of the PROFIBUS User Organization, Karlsruhe, Germany

Modbus®
Registered trademark of SCHNEIDER AUTOMATION, INC.

EtherNet/IP™
Trademark of ODVA, Inc.



www.addresses.endress.com

Endress+Hauser

People for Process Automation

INSTRUMENTATION

INS-01

PERMEATE FLOW MAGMETER

For Earth, For Life
Kubota

Submittal Transmittal

Permeate Flow Magmeter

Project Name	TAYLOR BAY BEACH CLUB WWTF UPGRADE
Project Site	8220 178TH AVENUE, LONGBRANCH, WA 98351
Engineer	Gray & Osborne, Inc 1130 RAINIER AVENUE SOUTH, SUITE 300
Submit to	Gray & Osborne, Inc
Prepared by	Shingo Kubo | Lead Project Manager KUBOTA Water and Environment U.S.A. Corporation 19910 N Creek Pkwy, Suite 100 Bothell, WA 98011
KMU Project #	KMU-OPID85
Issued Date	August 24, 2025
Package #	OPID85- INS-01-B-Permeate Flow Magmeter
Item	Tag # 01 MFM 01 01 MFM 02

Clarifications;

1. Section1 contains Kubota scope list. The subjected item for this submittal is marked in red.

2. Section2 contains the manufacture submittal and datasheet for review.

Response to 60% review comment;

1) General – Make Corrections Noted

a. Note that BABA certifications from manufacturers should be included in the final

Kubota Response: Endress Hauser instruments do not comply with BABA requirement as shown in ATTACHMENT B.

ATTACHMENT B

SCOPE OF SUPPLY COMPONENTS THAT DO NOT COMPLY WITH BABA REQUIREMENTS

Part Identification (Name)	Equipment Description and Type	Manufacturer	Number of Units	Total Lump Sum Equipment Cost for Line Item
Kubota SMU Equipment	FS150 SMU Units + Associated Lifting Tool	Kubota	4 SMUs 1 Lifting Tool + Chains	$80,400.00
SMU Basin Associated Endress + Hauser Instrumentation	1. Air Pressure Transmitters 2. Blower Flow Meters 3. Permeate Flow Meter 4. Pump Pressure Transmitter 5. Level Transmitter	Endress + Hauser	Type 1 - QTY 3 Type 2 - QTY 2 Type 3 - QTY 1 Type 4 - QTY 2 Type 5 - QTY 2	$33,896.00
SMU Basin Hach Instrumentation	1. Air Pressure Transmitters 2. Blower Flow Meters 3. Permeate Flow Meters	Hach	Type 1 - QTY 1 Type 2 - QTY 1 Type 3 - QTY 1	$12,633.00
Kubota Standard CIP System	Kubota CIP system based around Mazzei injector, rotometer and flow control valve	Various	1 System of Supply	$18,500.00
PVC Isolation Valves + Check Valves	3 inch PVC Ball Valves 3 inch PVC Check Valves	Asahi	11 Ball Valves 3 Check Vavles	$11,072.00

b. Note that manufacturer services should be included in the final submittal.

Kubota Response: Manufacturer service is included per the specifications. For the items that Kubota is certified to provide service, Kubota will provide it.

13) INS-01-A-Permeate Magnetic Flow Meter – No Exceptions Taken / Make Corrections Noted / Amend & Resubmit

a. The model number listed is acceptable. Please edit the PDF to indicated only those items, models, or series of equipment that are being supplied and cross out all extraneous material per 01300.

Kubota Response: See section 2 for the equipment datasheet with cross out.

b. The flow meter liners should be either Teflon or neoprene rubber per 13426 2.2, instead of polyurethane as stated on submittal pg. 8.

Kubota Response: The submittal has been updated to have Teflon liners.

For Earth, For Life
Kubota

SECTION 1

KUBOTA Water and Environment U.S.A. Corporation
19910 N Creek Pkwy, Suite 100 Bothell, WA 98011| Phone: 425 898 2858 | Fax: 425-898-2853

No	Equipment Location	Tag	Category	Function	Name	Type	Chosen Size/Capacity	Unit	Material	Manufacturer	Model/ Specification	Motor HP	Voltage	FLA	QTY
	MBR Equipment	**x**													
1	MBR	02 MBR 01 02 MBR 02 02 MBR 03 02 MBR 04	SMU	Membrane Filtration	MBR SMU	Flat Plate			304SS	KUBOTA	FS150				4
2	MBR	n/a	SMU	SMU Maintenance	MBR SMU Lifting Tool	Lifting Tool			CS, SS	KUBOTA	TG150				1
3	MBR	n/a	SMU	SMU Maintenance	MBR SMU Lifting Chain	Lifting Tool			304SS	KUBOTA	CS30M				4
4	MBR	02 MOV 03 02 MOV 04	Auto Valve	Diffuser Cleaning	MBR Diffuser Cleaning Valve	ON/OFF Plug	3	inch	CI/CI	Auma/Pratt	SQ12.2-AC01.2/S601 w/extention stem	1/12	120 VAC	2.9	2
5	MBR	n/a	Other Valve	Isolation Valve	SMU Air Isolation Valve(inlet)	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S30				4
6	MBR	n/a	Other Valve	Isolation Valve	SMU Air Isolation Valve(outlet)	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S30				4
7	MBR	BV281 BV282 BV283 BV284	Other Valve	Isolation Valve	SMU PRMT Isolation Valve	Manual Butterfly	2	inch	DI, EPDM, Nylon Coat	Bray	S30				4
8	MBR	n/a	Other Valve	Manual Valves	Isolation Valves for CIP injection	Manual Ball	1	inch	PVC	ASAHI	Type21 True Union				4
9	MBR	02 LS 03 02 LS 04 02 LS 05 02 LS 06	Gauge, Switch	Level Measurement	MBR Level Switch	Float			PP, PU	Conery	2902-B8S1 w/ counter weight and brackets		Loop power		4
10	MBR	n/a	Fabrication	Fabrication	MBR SMU Guide & Stabilizer + Seismic Bracing				304SS	TBD					4
11	MBR	n/a	Fabrication	Fabrication	MBR SMU Fasteners				304SS	TBD					40
12	MBR	n/a	Fabrication	Fabrication	MBR In-Basin Pipe&Supports (Permeate Drop Pipe)				PVC	TBD					4
13	MBR	n/a	Fabrication	Fabrication	MBR In-Basin Pipe&Supports (Air Drop Pipe)				304SS	TBD					8
	Permeate (PRMT) Control Equipment	**x**													
14	PRMT	01 PMP 01 01 PMP 02 01 PMP 03	Permeate Pump	Permeate Extraction	PRMT Pump	Rotary Lobe	45	gpm		Boerger	AN 70 w/ piggyback mount	5	460 VAC	6.6	3
15	PRMT	PI169 PI170 PI171	Gauge, Switch	Pressure Gauge	PRMT Pump Pressuge Gauge(Inlet)		-15 - +15	psig	SS	Ashcroft or equivalent	1279 w/ grycelin filled				3
16	PRMT	PI172 PI173 PI174	Gauge, Switch	Pressure Gauge	PRMT Pump Pressuge Gauge (Inlet)		-15 - +15	psig	SS	Ashcroft or equivalent	1279 w/ grycelin filled				3
17	PRMT	01 PTR 01 01 PTR 02	Pressure Sensor	TMP Measurement	PRMT Pump Pressure Transmitter	Diaphragm	-15 - +15	psi	SS	Endress & Hauser	Cerabar PMCB51		Loop power		2
18	PRMT	01 MFM 01 01 MFM 02	Flow Sensor	Flow Measurement	PRMT Flow Meter	Electromagnetic	3	inch	PU	Endress & Hauser	Promag W 400		24VDC		2
19	MBR	n/a	Other Valve	Isolation Valve	MBR PRMT Pump isolation valve	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S30				8
20	MBR	CV261 CV261 CV261	Other Valve	Check valve	MBR PRMT Pump discharge check valve	Manual ball	3	inch	PVC, EPDM	ASAHI	True Union Ball Check				3
21	PRMT	01 TM 01	Other Instrument	Turbidity Measurement	PRMT Turbidity Meter	Laser	0-5	NTU		HACH	TU5300sc				1
22	PRMT	01 TM 01	Other Instrument	Turbidity Measurement	PRMT Turbidity Transmitter					HACH	SC4500		24VDC		1
23	PRMT	n/a	Other Instrument	Turbidity Measurement	Turbidity Meter Maintenance Kit					HACH					1
	Return Activated Sludge (RAS) Control	**x**													
24	MBR	Relocated from MBR 02 SLS02 02 SLS03	Other Instrument	Level Measurement	MBR Level Sensor	Hydrostatic	15	ft	SS	Endress & Hauser	Waterpilot FMX21 w/ brackets		Loop power		2
	MBR Blower	**x**													
25	MBR BLW	01 MSB 01 01 MSB 02 01 MSB 03	Blower	Blower	MBR Blower	Positive Displacement	114	scfm	CI	Aerzen	GM 4S DN 80	5	460 VAC	6.6	3

No	Equipment Location	Tag	Category	Function	Name	Type	Chosen Size/Capacity	Unit	Material	Manufacturer	Model/ Specification	Motor HP	Voltage	FLA	QTY
26	MBR BLW	n/a	Option	Noise Suppression	MBR Blower Sound Enclosure	With Blower									3
27	MBR BLW	n/a	Option	Blower Temperature	MBR Blower Temperature Gauge	With Blower									3
28	MBR BLW	n/a	Option	Blower Pressure	MBR Blower Pressure Gauge	With Blower									3
29	MBR BLW	n/a	Option	Blower Temperature	MBR Blower Temperature Switch	With Blower									3
30	MBR BLW	01 AFM 01 01 AFM 02	Flow Sensor	Air Flow Measurement	MBR Blower Flow Meter	Thermal Mass	3	inch	PU	Endress & Hauser	t-mass I 300, w/ flow conditioner plate		24VDC		2
31	MBR BLW	n/a	Other Valve	Manual Valves	Air Scour Blower Isolation Valves	Manual Butterfly	3	inch	DI, FKM, SS Disk	Bray	S30				4
	Clean-In-Place Equipment	**x**													
32	SMU CIP	n/a	Chemical Injection	Chemical Injection	SMU CIP System PVC pipes		1	inch	PVC	KUBOTA	Loose ship parts shown on xxx				1
33	SMU CIP	n/a	Flow Sensor	Flow Measurement	CIP solution Flow Meter	Electromagnetic	1	inch	PU				24 VDC		1
34	SMU CIP	n/a	Flow Sensor	Flow Measurement	CIP shelf chenical Flow Meter	Electromagnetic	3/8	inch	PU	Keyence	FD-Q10C		24VDC		1
35	SMU CIP	n/a	Auto Valve	Flow Control	CIP Flow Control Valve	ON/OFF Ball	1	inch	DI	ASAHI	S19-120VAC--1"-C20/S20		120VAC	0.18	1
36	SMU CIP	n/a	Other Valve	Manual Valves	Isolation Valves on CIP Station	Manual Ball	1, 0.5	inch	PVC	ASAHI	Type21 True Union				1
37	SMU CIP	n/a	Other Valve	Manual Valves	Pressure reducing valve	Pressure Reducing	1.5	inch	CI	Zurn	ZW209				1
	System Control Equipment	**x**													
38	CONTROL	n/a	Control Panel	Control Panel	Control Panel	OIT, PLC					NEMA 4/12, 72" x 72" x 18" floor mount enclosure (estimated size) , Allen Bradley 1756-L81E PLC (BABA-Version), FactoryTalk View SE		120VAC	TBD	1
39	D. SERVICE	n/a	D. Service	Direct Service	Direct Service						Design support, start-up, field service, remote service				1

SECTION 2

TI01046D/06/EN/10.21
71535814
2021-09-01

Technical Information
Proline Promag W 400

Electromagnetic flowmeter



Versatile standard flowmeter for the water and wastewater industry

Application

- The bidirectional measuring principle is virtually independent of pressure, density, temperature and viscosity
- Ideal for water measurement, e.g. drinking water, utility water and industrial/municipal wastewater

Device properties
- International drinking water approvals
- Degree of protection IP68 (Type 6P enclosure)
- Approved for custody transfer to MI-001/OIML R49
- Transmitter housing made of durable polycarbonate or aluminum
- WLAN access
- Integrated data logger: measured values monitoring

Your benefits

- Reliable measurement at constant accuracy with 0 x DN run without pressure loss
- Flexible engineering – sensors with fixed flanges or lap joint flanges
- Application suitability – corrosion protection according to EN ISO 12944 for buried or underwater installations
- Improved plant availability – sensor compliant with industry-specific requirements
- Safe operation – no need to open device
- Time-saving local operation without additional software and hardware – integrated web server
- Built-in verification and build-up detection – Heartbeat Technology

Endress+Hauser
People for Process Automation

Configuration summary

Mat. no.	Description Order code	Quantity	Unit
71215557	Promag W 400, 5W4C80, DN80 3" 5W4C80-C6DLHP1DQA12GN+AABAJA	1	ST

010	Approval:	C6	CSA C/US NI Cl.I Div.2 Gr. ABCD
011	Design:	D	Lap joint flange
015	Power Supply:	L	AC 100...240V, AC/DC 24V
020	Output; Input:	H	4-20mA HART, pulse/freq., switch output
040	Housing:	P	Remote, alu, coated
045	Cable, Remote Version:	1	5m/15ft coil and signal cable
050	Electrical Connection:	D	Thread NPT1/2
060	Liner:	Q	PTFE 90oC
070	Process Connection:	A12	Cl.150, carbon steel, lap joint flange ASME B16.5
075	Electrodes:	G	1.4435/316L, bullet nose
080	Flow Calibration:	N	0.2%, 3-point
500	>Operation Language Display:	AA	English
505	>Display; Operation:	BA	WLAN
580	>>Test, Certificate:	JA	Inspection certificate 3.1, EN10204 (material certificate meas. tube+flange)

2 grounding rings are provided for each magmeter

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About this document

Symbols

Electrical symbols

Symbol	Meaning
⎓	Direct current
~	Alternating current
⎓~	Direct current and alternating current
⏚	**Ground connection** A grounded terminal which, as far as the operator is concerned, is grounded via a grounding system.
⊜	**Protective Earth (PE)** A terminal which must be connected to ground prior to establishing any other connections. The ground terminals are situated inside and outside the device: ▪ Inner ground terminal: Connects the protectiv earth to the mains supply. ▪ Outer ground terminal: Connects the device to the plant grounding system.

Communication symbols

Symbol	Meaning
	Wireless Local Area Network (WLAN) Communication via a wireless, local network.
	Bluetooth Wireless data transmission between devices over a short distance.
	LED Light emitting diode is off.
	LED Light emitting diode is on.
	LED Light emitting diode is flashing.

Symbols for certain types of information

Symbol	Meaning
	Permitted Procedures, processes or actions that are permitted.
	Preferred Procedures, processes or actions that are preferred.
	Forbidden Procedures, processes or actions that are forbidden.
	Tip Indicates additional information.
	Reference to documentation
	Reference to page
	Reference to graphic
	Visual inspection

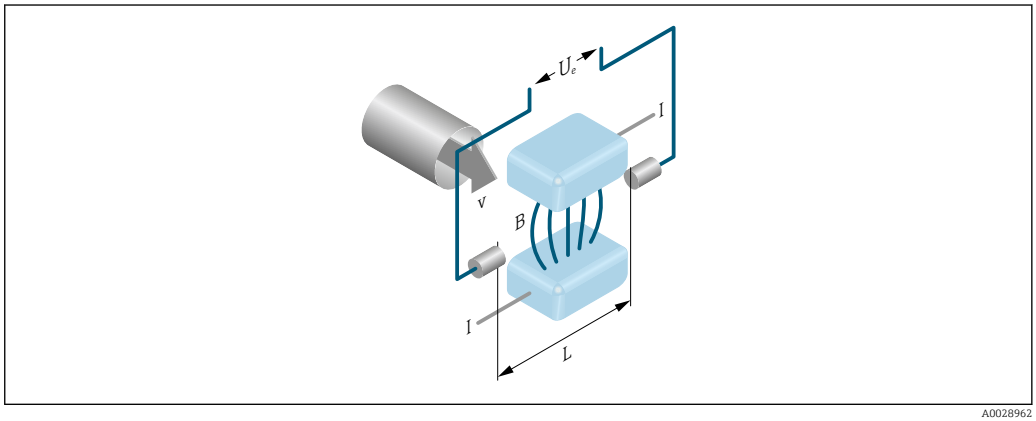
Symbols in graphics

Symbol	Meaning
1, 2, 3, ...	Item numbers
1., 2., 3., ...	Series of steps
A, B, C, ...	Views
A-A, B-B, C-C, ...	Sections
	Hazardous area
	Safe area (non-hazardous area)
	Flow direction

Function and system design

Measuring principle

Following *Faraday's law of magnetic induction*, a voltage is induced in a conductor moving through a magnetic field.



A0028962

Ue Induced voltage
B Magnetic induction (magnetic field)
L Electrode spacing
I Current
v Flow velocity

In the electromagnetic measuring principle, the flowing medium is the moving conductor. The voltage induced (U_e) is proportional to the flow velocity (v) and is supplied to the amplifier by means of two measuring electrodes. The flow volume (Q) is calculated via the pipe cross-section (A). The DC magnetic field is created through a switched direct current of alternating polarity.

Formulae for calculation

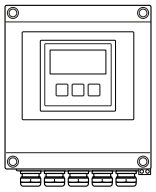
- Induced voltage $U_e = B \cdot L \cdot v$
- Volume flow $Q = A \cdot v$

Measuring system

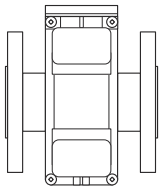
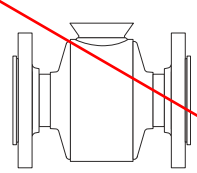
The device consists of a transmitter and a sensor.

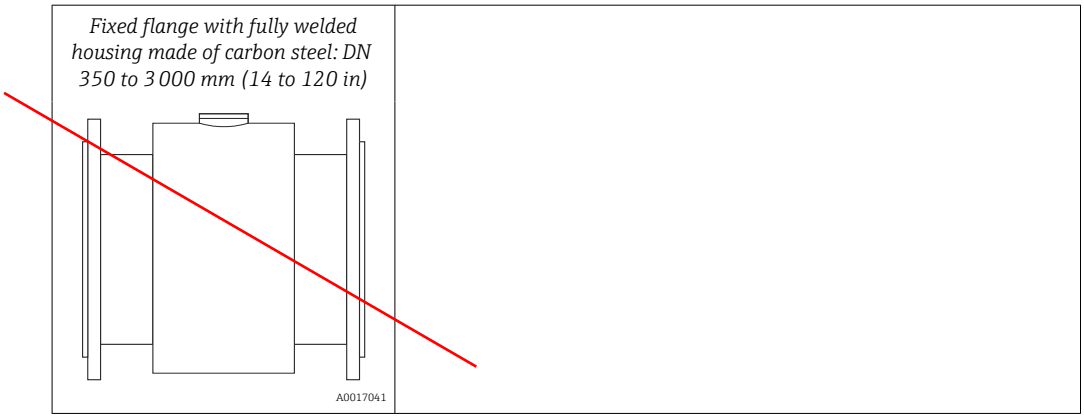
Two device versions are available:
- Compact version - transmitter and sensor form a mechanical unit.
- Remote version - transmitter and sensor are mounted in separate locations.

Transmitter

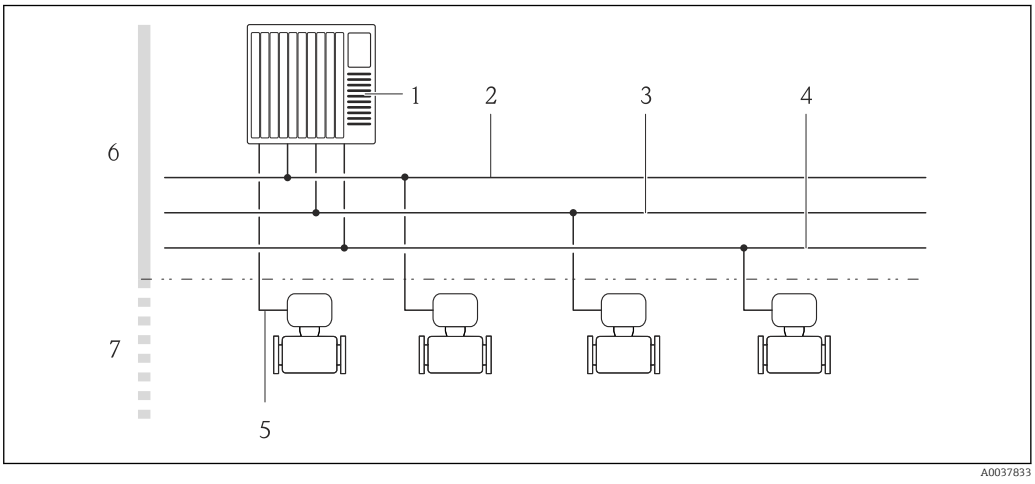
Proline 400

A0045222
	Device versions and materials:
	- Compact version: compact housing
	  - Polycarbonate plastic
	  - Aluminum, AlSi10Mg, coated
	- Remote version: wall-mount housing
	  - Polycarbonate plastic
	  - Aluminum, AlSi10Mg, coated
	Configuration:
	- External operation via four-line, illuminated local display with touch control and guided menus ("Make-it-run" wizards) for applications
	- Via operating tools (e.g. FieldCare)
	- Via Web browser (e.g. Microsoft Internet Explorer)
	- Also for device version with EtherNet/IP output:
	  - Via Add-on Profile Level 3 for automation system from Rockwell Automation
	  - Via Electronic Data Sheet (EDS)
	- Also for device version with PROFIBUS DP output:
	Via PDM driver for Siemens automation system

Sensor

Promag W *Lap joint flange, lap joint flange, stamped plate or fixed flange with aluminum half-shell housing: DN 25 to 300 mm (1 to 12 in)*  A0017040	- Nominal diameter range: DN 25 to 3 000 mm (1 to 120 in) - Materials → 91
Fixed flange with fully welded housing made of carbon steel: DN 25 to 300 mm (1 to 12 in)  A0022673	



Equipment architecture



1 *Possibilities for integrating measuring devices into a system*

1 *Control system (e.g. PLC)*
2 *EtherNet/IP*
3 *PROFIBUS DP*
4 *Modbus RS485*
5 *4 to 20 mA HART, pulse/frequency/switch output*
6 *Non-hazardous area*
7 *Non-hazardous area and Zone 2/Div. 2*

Safety

IT security

Our warranty is valid only if the device is installed and used as described in the Operating Instructions. The device is equipped with security mechanisms to protect it against any inadvertent changes to the settings.

IT security measures, which provide additional protection for the device and associated data transfer, must be implemented by the operators themselves in line with their security standards.

Device-specific IT security

The device offers a range of specific functions to support protective measures on the operator's side. These functions can be configured by the user and guarantee greater in-operation safety if used correctly. An overview of the most important functions is provided in the following section.

Protecting access via a password

Different passwords are available to protect write access to the device parameters or access to the device via the WLAN interface.

- User-specific access code
  Protect write access to the device parameters via the local display, Web browser or operating tool (e.g. FieldCare, DeviceCare). Access authorization is clearly regulated through the use of a user-specific access code.
- WLAN passphrase
  The network key protects a connection between an operating unit (e.g. notebook or tablet) and the device via the WLAN interface which can be ordered as an option.

User-specific access code

Write access to the device parameters via the local display or operating tool (e.g. FieldCare, DeviceCare) can be protected by the modifiable, user-specific access code.

WLAN passphrase: Operation as WLAN access point

A connection between an operating unit (e.g. notebook or tablet) and the device via the WLAN interface, which can be ordered as an optional extra, is protected by the network key. The WLAN authentication of the network key complies with the IEEE 802.11 standard.

When the device is delivered, the network key is pre-defined depending on the device. It can be changed via the **WLAN settings** submenu in the **WLAN passphrase** parameter.

General notes on the use of passwords

- The access code and network key supplied with the device should be changed during commissioning.
- Follow the general rules for generating a secure password when defining and managing the access code or network key.
- The user is responsible for the management and careful handling of the access code and network key.

Access via Web server

The device can be operated and configured via a Web browser with the integrated Web server. The connection is via the service interface (CDI-RJ45) or the WLAN interface. For device versions with the EtherNet/IP and PROFINET communication protocols, the connection can also be established via the terminal connection for signal transmission with EtherNet/IP or PROFINET (RJ45 plug).

The Web server is enabled when the device is delivered. The Web server can be disabled if necessary (e.g. after commissioning) via the **Web server functionality** parameter.

The device and status information can be hidden on the login page. This prevents unauthorized access to the information.

For detailed information on device parameters, see:
The "Description of Device Parameters" document → 106

Input

Measured variable

Direct measured variables

- Volume flow (proportional to induced voltage)
- Electrical conductivity

In custody transfer: only volume flow

Calculated measured variables

Mass flow

Measuring range

Typically v = 0.01 to 10 m/s (0.03 to 33 ft/s) with the specified accuracy

Electrical conductivity: ≥ 5 µS/cm for liquids in general

Flow characteristic values in SI units: DN 25 to 125 mm (1 to 4 in)

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.3...10 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 2 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.04 m/s)
[mm]	[in]	[dm³/min]	[dm³/min]	[dm³]	[dm³/min]
25	1	9 to 300	75	0.5	1
32	–	15 to 500	125	1	2

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.3...10 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 2 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.04 m/s)
[mm]	[in]	[dm³/min]	[dm³/min]	[dm³]	[dm³/min]
40	1 ½	25 to 700	200	1.5	3
50	2	35 to 1 100	300	2.5	5
65	–	60 to 2 000	500	5	8
80	3	90 to 3 000	750	5	12
100	4	145 to 4 700	1 200	10	20
125	–	220 to 7 500	1 850	15	30

Flow characteristic values in SI units: DN 150 to 3 000 mm (6 to 120 in)

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.3...10 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 2 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.04 m/s)
[mm]	[in]	[m³/h]	[m³/h]	[m³]	[m³/h]
150	6	20 to 600	150	0.025	2.5
200	8	35 to 1 100	300	0.05	5
250	10	55 to 1 700	500	0.05	7.5
300	12	80 to 2 400	750	0.1	10
350	14	110 to 3 300	1 000	0.1	15
375	15	140 to 4 200	1 200	0.15	20
400	16	140 to 4 200	1 200	0.15	20
450	18	180 to 5 400	1 500	0.25	25
500	20	220 to 6 600	2 000	0.25	30
600	24	310 to 9 600	2 500	0.3	40
700	28	420 to 13 500	3 500	0.5	50
750	30	480 to 15 000	4 000	0.5	60
800	32	550 to 18 000	4 500	0.75	75
900	36	690 to 22 500	6 000	0.75	100
1000	40	850 to 28 000	7 000	1	125
–	42	950 to 30 000	8 000	1	125
1200	48	1 250 to 40 000	10 000	1.5	150
–	54	1 550 to 50 000	13 000	1.5	200
1400	–	1 700 to 55 000	14 000	2	225
–	60	1 950 to 60 000	16 000	2	250
1600	–	2 200 to 70 000	18 000	2.5	300
–	66	2 500 to 80 000	20 500	2.5	325
1800	72	2 800 to 90 000	23 000	3	350
–	78	3 300 to 100 000	28 500	3.5	450
2000	–	3 400 to 110 000	28 500	3.5	450

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.3...10 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 2 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.04 m/s)
[mm]	[in]	[m³/h]	[m³/h]	[m³]	[m³/h]
–	84	3700 to 125000	31000	4.5	500
2200	–	4100 to 136000	34000	4.5	540
–	90	4300 to 143000	36000	5	570
2400	–	4800 to 162000	40000	5.5	650
–	96	5000 to 168000	42000	6	675
–	102	5700 to 190000	47500	7	750
2600	–	5700 to 191000	48000	7	775
–	108	6500 to 210000	55000	7	850
2800	–	6700 to 222000	55500	8	875
–	114	7100 to 237000	59500	8	950
3000	–	7600 to 254000	63500	9	1025
–	120	7900 to 263000	65500	9	1050

Flow characteristic values in SI units: DN 50 to 200 mm (2 to 8 in) for order code for "Design", option C "Fixed flange, constricted measuring tube, 0 x DN inlet/outlet runs"

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.12...5 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 4 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.01 m/s)
[mm]	[in]	[dm³/min]	[dm³/min]	[dm³]	[dm³/min]
50	2	15 to 600	300	1.25	1.25
65	–	25 to 1000	500	2	2
80	3	35 to 1500	750	3	3.25
100	4	60 to 2400	1200	5	4.75
125	–	90 to 3700	1850	8	7.5
150	6	145 to 5400	2500	10	11
200	8	220 to 9400	5000	20	19

Flow characteristic values in SI units: DN 250 to 300 mm (10 to 12 in) for order code for "Design", option C "Fixed flange, constricted measuring tube, 0 x DN inlet/outlet runs"

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.12...5 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 4 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.01 m/s)
[mm]	[in]	[m³/h]	[m³/h]	[m³]	[m³/h]
250	10	20 to 850	500	0.03	1.75
300	12	35 to 1300	750	0.05	2.75

Flow characteristic values in US units: DN 1 to 48 in (25 to 1200 mm)

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.3...10 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 2 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.04 m/s)
[in]	[mm]	[gal/min]	[gal/min]	[gal]	[gal/min]
1	25	2.5 to 80	18	0.2	0.25
–	32	4 to 130	30	0.2	0.5
1 ½	40	7 to 185	50	0.5	0.75
2	50	10 to 300	75	0.5	1.25
–	65	16 to 500	130	1	2
3	80	24 to 800	200	2	2.5
4	100	40 to 1250	300	2	4
–	125	60 to 1950	450	5	7
6	150	90 to 2650	600	5	12
8	200	155 to 4850	1200	10	15
10	250	250 to 7500	1500	15	30
12	300	350 to 10600	2400	25	45
14	350	500 to 15000	3600	30	60
15	375	600 to 19000	4800	50	60
16	400	600 to 19000	4800	50	60
18	450	800 to 24000	6000	50	90
20	500	1000 to 30000	7500	75	120
24	600	1400 to 44000	10500	100	180
28	700	1900 to 60000	13500	125	210
30	750	2150 to 67000	16500	150	270
32	800	2450 to 80000	19500	200	300
36	900	3100 to 100000	24000	225	360
40	1000	3800 to 125000	30000	250	480
42	–	4200 to 135000	33000	250	600
48	1200	5500 to 175000	42000	400	600

Flow characteristic values in US units: DN 54 to 120 in (1400 to 3000 mm)

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.3...10 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 2 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.04 m/s)
[in]	[mm]	[Mgal/d]	[Mgal/d]	[Mgal]	[Mgal/d]
54	–	9 to 300	75	0.0005	1.3
–	1400	10 to 340	85	0.0005	1.3
60	–	12 to 380	95	0.0005	1.3
–	1600	13 to 450	110	0.0008	1.7
66	–	14 to 500	120	0.0008	2.2
72	1800	16 to 570	140	0.0008	2.6

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.3...10 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 2 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.04 m/s)
[in]	[mm]	[Mgal/d]	[Mgal/d]	[Mgal]	[Mgal/d]
78	–	18 to 650	175	0.0010	3.0
–	2000	20 to 700	175	0.0010	2.9
84	–	24 to 800	190	0.0011	3.2
–	2200	26 to 870	210	0.0012	3.4
90	–	27 to 910	220	0.0013	3.6
–	2400	31 to 1030	245	0.0014	4.0
96	–	32 to 1066	265	0.0015	4.0
102	–	34 to 1203	300	0.0017	5.0
–	2600	34 to 1212	305	0.0018	5.0
108	–	35 to 1300	340	0.0020	5.0
–	2800	42 to 1405	350	0.0020	6.0
114	–	45 to 1503	375	0.0022	6.0
–	3000	48 to 1613	405	0.0023	6.0
120	–	50 to 1665	415	0.0024	7.0

Flow characteristic values in US units: DN 2 to 12 in (50 to 300 mm) for order code for "Design", option C "Fixed flange, constricted measuring tube, 0 x DN inlet/outlet runs"

Nominal diameter		Recommended flow	Factory settings		
		min./max. full scale value (v ~ 0.12...5 m/s)	Full scale value current output (v ~ 2.5 m/s)	Pulse value (~ 4 Pulse/s at v ~ 2.5 m/s)	Low flow cut off (v ~ 0.01 m/s)
[in]	[mm]	[gal/min]	[gal/min]	[gal]	[gal/min]
2	50	4 to 160	75	0.3	0.35
–	65	7 to 260	130	0.5	0.6
3	80	10 to 400	200	0.8	0.8
4	100	16 to 650	300	1.2	1.25
–	125	24 to 1000	450	1.8	2
6	150	40 to 1400	600	2.5	3
8	200	60 to 2500	1200	5	5
10	250	90 to 3700	1500	6	8
12	300	155 to 5700	2400	9	12

Recommended measuring range

Flow limit → 52

For custody transfer, the applicable approval determines the permitted measuring range, the pulse value and the low flow cut off.

Operable flow range

Over 1000 : 1

For custody transfer, the operable flow range is 100 : 1 to 630 : 1, depending on the nominal diameter. Further details are specified by the applicable approval.

Input signal

External measured values

Various pressure transmitters and temperature measuring devices can be ordered from Endress +Hauser: see "Accessories" section → 105

It is recommended to read in external measured values to calculate the following measured variables: Mass flow

HART protocol

The measured values are written from the automation system to the measuring device via the HART protocol. The pressure transmitter must support the following protocol-specific functions:
- HART protocol
- Burst mode

Digital communication

The measured values can be written from the automation system to the measuring via:
- PROFIBUS DP
- Modbus RS485
- EtherNet/IP

Status input

Maximum input values	▪ DC 30 V ▪ 6 mA
Response time	Configurable: 5 to 200 ms
Input signal level	▪ Low signal (low): DC −3 to +5 V ▪ High signal (high): DC 12 to 30 V
Assignable functions	▪ Off ▪ Reset totalizers 1-3 separately ▪ Reset all totalizers ▪ Flow override

Output

Output signal

Current output

Current output	Can be set as: ▪ 4 to 20 mA NAMUR ▪ 4 to 20 mA US ▪ 4 to 20 mA HART ▪ 0 to 20 mA
Maximum output values	▪ DC 24 V (no flow) ▪ 22.5 mA
Load	0 to 700 Ω
Resolution	0.5 µA

Damping	Configurable: 0.07 to 999 s
Assignable measured variables	▪ Volume flow ▪ Mass flow ▪ Corrected volume flow ▪ Flow velocity ▪ Conductivity [1)] ▪ Corrected conductivity [1)] ▪ Temperature [1)] ▪ Electronics temperature ▪ Reference electrode potential [1)] ▪ Coil current rise time [1)] ▪ Noise [1)] ▪ Build-up measured value [1)] ▪ Test points 1-3

1) Visible depending on order options or device settings

Pulse/frequency/switch output

Function	▪ With the order code for "Output; Input", option **H**: output 2 can be set as a pulse or frequency output ▪ With the order code for "Output; Input", option **I**: output 2 and 3 can be set as a pulse, frequency or switch output ▪ With the order code for "Output; Input", option **J**: output 2 firmly assigned as certified pulse output
Version	Passive, open collector
Maximum input values	▪ DC 30 V ▪ 250 mA
Voltage drop	At 25 mA: ≤ DC 2 V
Pulse output	
Pulse width	Configurable: 0.05 to 2 000 ms
Maximum pulse rate	10 000 Impulse/s
Pulse value	Configurable
Assignable measured variables	▪ Volume flow ▪ Mass flow ▪ Corrected volume flow
Frequency output	
Output frequency	Configurable: 0 to 12 500 Hz
Damping	Configurable: 0 to 999 s
Pulse/pause ratio	1:1
Assignable measured variables	▪ Volume flow ▪ Mass flow ▪ Corrected volume flow ▪ Flow velocity ▪ Conductivity [1)] ▪ Corrected conductivity [1)] ▪ Temperature [1)] ▪ Electronics temperature ▪ Noise [1)] ▪ Coil current rise time [1)] ▪ Reference electrode potential [1)] ▪ Build-up measured value [1)] ▪ Test points 1-3
Switch output	
Switching behavior	Binary, conductive or non-conductive
Switching delay	Configurable: 0 to 100 s

Number of switching cycles	Unlimited

Assignable functions	▪ Off
	▪ On
	▪ Diagnostic behavior
	▪ Limit value:
	  ▪ Off
	  ▪ Volume flow
	  ▪ Corrected volume flow
	  ▪ Mass flow
	  ▪ Flow velocity
	  ▪ Conductivity [1]
	  ▪ Corrected conductivity [1]
	  ▪ Totalizer 1-3
	  ▪ Temperature [1]
	  ▪ Electronics temperature
	▪ Flow direction monitoring
	▪ Status:
	  ▪ Empty pipe detection
	  ▪ Low flow cut off
	  ▪ Build-up limit value [1]

1) Visible depending on order options or device settings

PROFIBUS DP

Signal encoding	NRZ code
Data transmission	9.6 kBaud...12 MBaud

Modbus RS485

Physical interface	In accordance with EIA/TIA-485-A standard
Terminating resistor	Integrated, can be activated via DIP switch on the transmitter electronics module

EtherNet/IP

Standards	In accordance with IEEE 802.3

Signal on alarm

Depending on the interface, failure information is displayed as follows:

Current output 4 to 20 mA

4 to 20 mA

Failure mode	Choose from: ▪ 4 to 20 mA in accordance with NAMUR recommendation NE 43 ▪ 4 to 20 mA in accordance with US ▪ Min. value: 3.59 mA ▪ Max. value: 22.5 mA ▪ Freely definable value between: 3.59 to 22.5 mA ▪ Actual value ▪ Last valid value

0 to 20 mA

Failure mode	Choose from: ▪ Maximum alarm: 22 mA ▪ Freely definable value between: 0 to 22.5 mA

HART current output

Device diagnostics	Device condition can be read out via HART Command 48

Pulse/frequency/switch output

Pulse output	
Failure mode	Choose from: ▪ Actual value ▪ No pulses
Frequency output	
Failure mode	Choose from: ▪ Actual value ▪ 0 Hz ▪ Defined value: 0 to 12 500 Hz
Switch output	
Failure mode	Choose from: ▪ Current status ▪ Open ▪ Closed

PROFIBUS DP

Status and alarm messages	Diagnostics in accordance with PROFIBUS PA Profile 3.02

Modbus RS485

Failure mode	Choose from: ▪ NaN value instead of current value ▪ Last valid value

EtherNet/IP

Device diagnostics	Device condition can be read out in Input Assembly

Local display

Plain text display	With information on cause and remedial measures
Backlight	Red backlighting indicates a device error.

Status signal as per NAMUR recommendation NE 107

Interface/protocol

- Via digital communication:
  - HART protocol
  - ~~PROFIBUS DP~~
  - ~~Modbus RS485~~
  - ~~EtherNet/IP~~
- Via service interface
  - CDI-RJ45 service interface
  - WLAN interface

Plain text display	With information on cause and remedial measures

Additional information on remote operation → 95

Web browser

Plain text display	With information on cause and remedial measures

Light emitting diodes (LED)

Status information	Status indicated by various light emitting diodes The following information is displayed depending on the device version: ▪ Supply voltage active ▪ Data transmission active ▪ Device alarm/error has occurred ▪ EtherNet/IP network available ▪ EtherNet/IP connection established

Low flow cut off

The switch points for low flow cut off are user-selectable.

Galvanic isolation

The following connections are galvanically isolated from each other:
- Inputs
- Outputs
- Power supply

Protocol-specific data

HART

Manufacturer ID	0x11
Device type ID	0x1169
HART protocol revision	7
Device description files (DTM, DD)	Information and files under: www.endress.com
HART load	Min. 250 Ω
Dynamic variables PV, SV, TV, QV	▪ Read out the dynamic variables via HART command 3 ▪ The measured variables can be freely assigned to the dynamic variables
Device variables	▪ Read out the device variables via HART command 9 ▪ The measured variables can be freely assigned ▪ A maximum of 8 device variables can be transmitted
System integration	Operating Instructions for the device → 106

PROFIBUS DP

Manufacturer ID	0x11
Ident number	0x1562
Profile version	3.02
Device description files (GSD, DTM, DD)	Information and files under: ▪ www.endress.com ▪ www.profibus.org
Output values	Output values (from the measuring device to the automation system) ▪ 4 Analog input ▪ 2 Digital input ▪ 3 Totalizer

Input values	Input values (from the automation system to the measuring device) ▪ 2 Analog output (fixed assignment) ▪ 2 Digital output (fixed assignment) ▪ 3 Totalizer
Device address configuration options	Configuration of the device address ▪ Hardware: DIP switches on the I/O electronics module ▪ Software: Via operating tools (e.g. FieldCare)
Supported functions	▪ Identification & Maintenance: Simplest device identification on the part of the control system and nameplate ▪ PROFIBUS upload/download: Reading and writing parameters is up to ten times faster with PROFIBUS upload/download ▪ Condensed status: Simplest and self-explanatory diagnostic information by categorizing diagnostic messages that occur
System integration	Operating Instructions for the device → 🖹 106

Modbus RS485

Protocol	Modbus Applications Protocol Specification V1.1
Device type	Slave
Slave address range	1 to 247
Broadcast address range	0
Function codes	▪ 03: Read holding register ▪ 04: Read input register ▪ 06: Write single registers ▪ 08: Diagnostics ▪ 16: Write multiple registers ▪ 23: Read/write multiple registers
Broadcast messages	Supported by the following function codes: ▪ 06: Write single registers ▪ 16: Write multiple registers ▪ 23: Read/write multiple registers
Supported baud rate	▪ 1200 BAUD ▪ 2400 BAUD ▪ 4800 BAUD ▪ 9600 BAUD ▪ 19200 BAUD ▪ 38400 BAUD ▪ 57600 BAUD ▪ 115200 BAUD
Modus data transmission	▪ ASCII ▪ RTU
Data access	Each device parameter can be accessed via Modbus RS485. For detailed information on the "Modbus RS485 register information", see the Description of Device Parameters → 🖹 106
System integration	Operating Instructions for the device → 🖹 106

EtherNet/IP

Protocol	▪ The CIP Networks Library Volume 1: Common Industrial Protocol ▪ The CIP Networks Library Volume 2: EtherNet/IP Adaptation of CIP
Communication type	▪ 10Base-T ▪ 100Base-TX
Device profile	Generic device (product type: 0x2B)
Manufacturer ID	0x49E

Device type ID	0x1069
Baud rates	Automatic 10/100 Mbit with half-duplex and full-duplex detection
Polarity	Auto-polarity for automatic correction of crossed TxD and RxD pairs
Supported CIP connections	Max. 3 connections
Explicit connections	Max. 5 connections
I/O connections	Max. 6 connections (scanner)
Configuration options for measuring device	Configuration options for measuring device ▪ DIP switches on the electronics module for IP addressing ▪ Manufacturer-specific software (FieldCare) ▪ Custom Add-on Profile for Rockwell Automation control systems ▪ Web browser ▪ Electronic Data Sheet (EDS) integrated in the measuring device
EtherNet interface configuration options	Configuration of the EtherNet interface ▪ Speed: 10 MBit, 100 MBit, auto (factory setting) ▪ Duplex: half-duplex, full-duplex, auto (factory setting)
Device address configuration options	Configuration of the device address ▪ DIP switches on the electronics module for IP addressing (last octet) ▪ DHCP ▪ Manufacturer-specific software (FieldCare) ▪ Custom Add-on Profile for Rockwell Automation control systems ▪ Web browser ▪ EtherNet/IP tools, e.g. RSLinx (Rockwell Automation)
Device Level Ring (DLR)	No
Assembly	▪ Legacy Input Assembly Fix (Assem 100) ▪ Legacy Input Assembly Configurable (Assem 101) ▪ Legacy Output Assembly Fix (Assem 102) ▪ Legacy Configuration Assembly (Assem 104) ▪ Input Assembly Fix (Assem 120) ▪ Input Assembly Configurable (Assem 121) ▪ Output Assembly Fix (Assem 122) ▪ Configuration Assembly (Assem 124) ▪ Volume Flow Extended Fix Input (Assem 126) ▪ Volume Flow Universal Fix Input (Assem 127) ▪ Dummy Output Assembly Fix (Assem 199)
Requested Packet Interval (RPI)	5 ms to 10 s (factory setting: 20 ms)
System integration	Operating Instructions for the device → 106

Power supply

Terminal assignment

Transmitter: 0 to 20 mA/4 to 20 mA HART

The sensor can be ordered with terminals.

Connection methods available		Possible options for order code "Electrical connection"
Outputs	**Power supply**	
Terminals	Terminals	▪ Option **A**: coupling M20x1 ▪ Option **B**: thread M20x1 ▪ Option **C**: thread G ½" ▪ Option **D**: thread NPT ½"

Supply voltage

Order code "Power supply"	Terminal numbers	terminal voltage		Frequency range
Option **L** (wide range power unit)	1 (L+/L), 2 (L-/N)	DC 24 V	±25%	–
		AC 24 V	±25%	50/60 Hz, ±4 Hz
		AC 100 to 240 V	−15 to +10%	50/60 Hz, ±4 Hz

Signal transmission with current output 0 to 20 mA/4 to 20 mA HART and other outputs and inputs

Order code for "Output" and "Input"	Terminal numbers							
	Output 1		Output 2		Output 3		Input	
	26 (+)	27 (-)	24 (+)	25 (-)	22 (+)	23 (-)	20 (+)	21 (-)
Option **H**	Current output ▪ 4 to 20 mA HART (active) ▪ 0 to 20 mA (active)		Pulse/frequency output (passive)		Switch output (passive)		-	
Option **I**	Current output ▪ 4 to 20 mA HART (active) ▪ 0 to 20 mA (active)		Pulse/frequency/ switch output (passive)		Pulse/frequency/ switch output (passive)		Status input	
Option **J**	Current output ▪ 4 to 20 mA HART (active) ▪ 0 to 20 mA (active)		Fixed assignment: Certified pulse output (passive)		Switch output		Status input	

Transmitter: PROFIBUS DP

The sensor can be ordered with terminals.

Connection methods available		Possible options for order code "Electrical connection"
Outputs	Power supply	
Terminals	Terminals	▪ Option **A**: coupling M20x1 ▪ Option **B**: thread M20x1 ▪ Option **C**: thread G ½" ▪ Option **D**: thread NPT ½"

Supply voltage

Order code "Power supply"	Terminal numbers	terminal voltage		Frequency range
Option **L** (wide range power unit)	1 (L+/L), 2 (L-/N)	DC 24 V	±25%	–
		AC 24 V	±25%	50/60 Hz, ±4 Hz
		AC 100 to 240 V	−15 to +10%	50/60 Hz, ±4 Hz

PROFIBUS DP signal transmission

Order code for "Output" and "Input"	Terminal numbers	
	26 (RxD/TxD-P)	27 (RxD/TxD-N)
Option **L**	B	A
Order code for "Output": Option L: PROFIBUS DP, for use in non-hazardous areas and Zone 2/Div. 2		

Transmitter: Modbus RS485

The sensor can be ordered with terminals.

Connection methods available		Possible options for order code "Electrical connection"
Outputs	**Power supply**	
Terminals	Terminals	▪ Option **A**: coupling M20x1 ▪ Option **B**: thread M20x1 ▪ Option **C**: thread G ½" ▪ Option **D**: thread NPT ½"

Supply voltage

Order code "Power supply"	Terminal numbers	terminal voltage		Frequency range
Option **L** (wide range power unit)	1 (L+/L), 2 (L-/N)	DC 24 V	±25%	–
		AC 24 V	±25%	50/60 Hz, ±4 Hz
		AC 100 to 240 V	–15 to +10%	50/60 Hz, ±4 Hz

Signal transmission with Modbus RS485 and other outputs

Order code for "Output" and "Input"	Terminal numbers							
	26 (+)	27 (-)	24 (+)	25 (-)	22 (+)	23 (-)	20 (+)	21 (-)
Option **M**	Modbus B	Modbus A	-		-		-	
Option **O**	Current output 4 to 20 mA (active)		Pulse/frequency/ switch output (passive)		Pulse/frequency/ switch output (passive)		Modbus B	Modbus A
Option **P**	Current output 4 to 20 mA (active)		Pulse output certified (passive)		Pulse/frequency/ switch output (passive)		Modbus B	Modbus A

Transmitter: EtherNet/IP

The transmitter can be ordered with terminals or a device plug.

Connection methods available		Possible options for order code "Electrical connection"
Outputs	**Power supply**	
EtherNet/IP (RJ45 plug)	Terminals	Option **D**: thread NPT ½"
Device plug → 🖹 22	Terminals	▪ Option **L**: plug M12x1 + thread NPT ½" ▪ Option **N**: plug M12x1 + coupling M20 ▪ Option **P**: plug M12x1 + thread G ½" ▪ Option **U**: plug M12x1 + thread M20

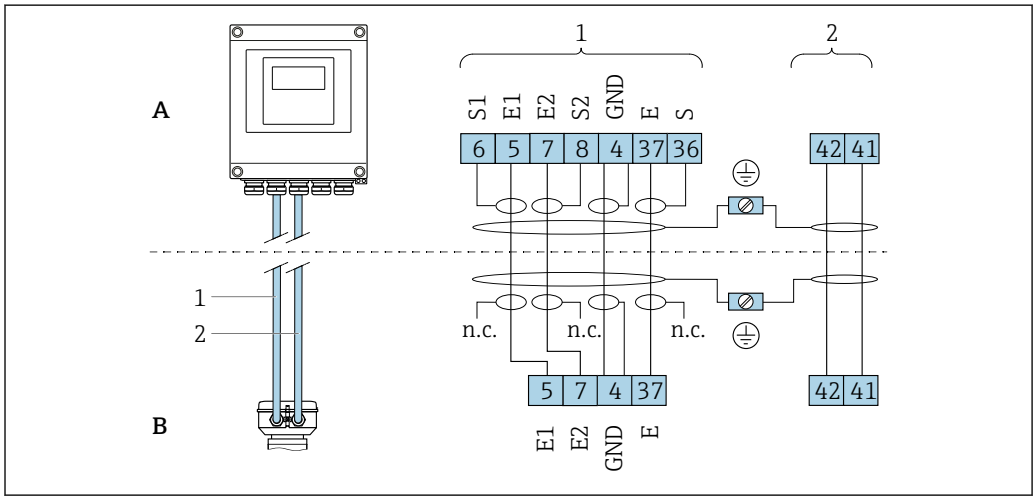
Supply voltage

Order code "Power supply"	Terminal numbers	terminal voltage		Frequency range
Option **L** (wide range power unit)	1 (L+/L), 2 (L-/N)	DC 24 V	±25%	–
		AC 24 V	±25%	50/60 Hz, ±4 Hz
		AC 100 to 240 V	–15 to +10%	50/60 Hz, ±4 Hz

EtherNet/IP signal transmission

Order code for "Output"	Connection via
Option **N**	EtherNet/IP: RJ45 or M12 plug

Remote version



2 *Remote version terminal assignment*

A Transmitter wall-mount housing
B Sensor connection housing
1 Electrode cable
2 Coil current cable
n.c. Not connected, insulated cable shields

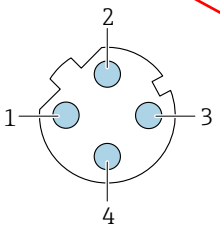
Terminal No. and cable colors: 6/5 = brown; 7/8 = white; 4 = green; 36/37 = yellow

Pin assignment, device plug

Order codes for the M12x1 plugs, see the "Order code for electrical connection" column: EtherNet/IP → 21

EtherNet/IP

Device plug for signal transmission (device side)



Pin		Assignment	Coding	Plug/socket
1	+	Tx	D	Socket
2	+	Rx		
3	-	Tx		
4	-	Rx		

Recommended plug:
- Binder, series 763, part no. 99 3729 810 04
- Phoenix, part no. 1543223 SACC-M12MSD-4Q
- The device plug is not permitted in the hazardous area, Class I Division 2. The device plug may only be used in the non-hazardous area (General Purpose).

Supply voltage

Transmitter

Order code for "Power supply"	terminal voltage		Frequency range
Option **L**	DC 24 V	±25%	–
	AC 24 V	±25%	50/60 Hz, ±4 Hz
	AC 100 to 240 V	−15 to +10%	50/60 Hz, ±4 Hz

Power consumption

Order code for "Output"	Maximum power consumption
Option **H**: 4-20mA HART, pulse/frequency output, switch output	30 VA/8 W
Option **I**: 4-20mA HART, 2 x pulse/frequency/switch output, status input	30 VA/8 W
Option **J**: 4-20mA HART, certified pulse output, switch output, status input	30 VA/8 W
Option **L**: PROFIBUS DP	30 VA/8 W
Option **M**: Modbus RS485	30 VA/8 W
Option **O**: Modbus RS485, 4-20mA, 2 x pulse/ frequency/switch output	30 VA/8 W
Option **P**: Modbus RS485, 4-20mA, certified pulse output, pulse/frequency/switch output	30 VA/8 W
Option **N**: EtherNet/IP	30 VA/8 W

Current consumption

Transmitter

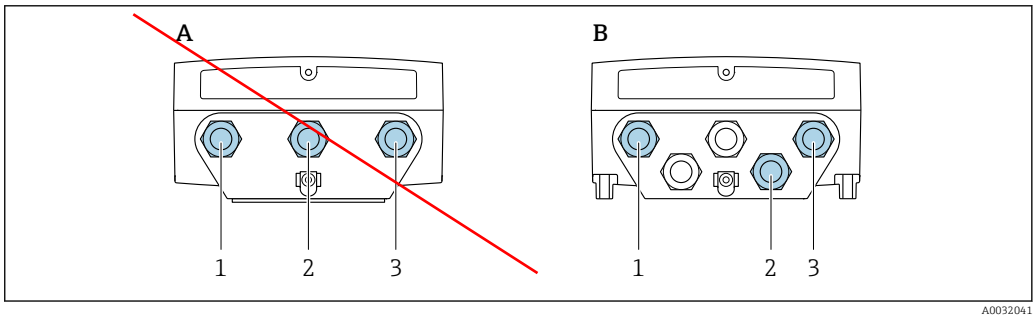
Order code for "Power supply"	Maximum Current consumption	Maximum switch-on current
Option **L**: AC 100 to 240 V	145 mA	25 A (< 5 ms)
Option **L**: AC/DC 24 V	350 mA	27 A (< 5 ms)

Power supply failure

- Totalizers stop at the last value measured.
- Depending on the device version, the configuration is retained in the device memoryor in the pluggable data memory (HistoROM DAT).
- Error messages (incl. total operated hours) are stored.

Electrical connection

Connecting the transmitter

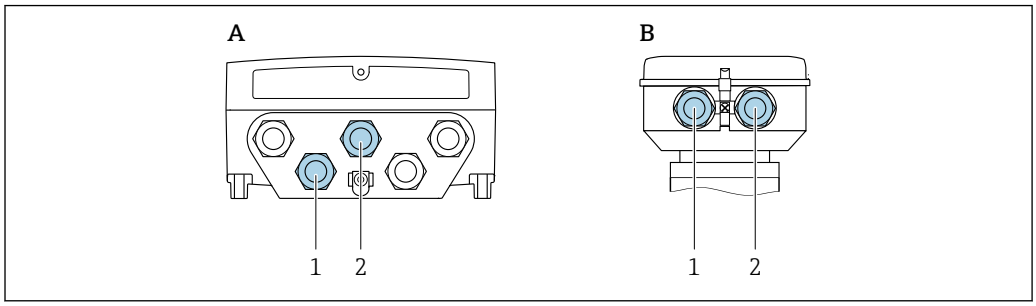


3 *Supply voltage and signal transmission connection*

A Compact version
B Remote version wall-mount housing
1 Cable entry for supply voltage
2 Cable entry for signal transmission
3 Cable entry for signal transmission

Remote version connection

Connecting cable



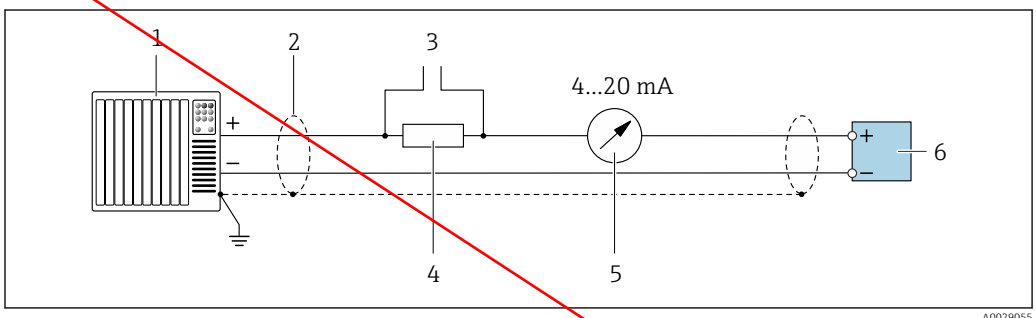
4 *Connecting cable connection: electrode and coil current cable*

A Transmitter wall-mount housing
B Sensor connection housing
1 Electrode cable
2 Coil current cable

- Fix the cable run or route it in an armored conduit.
  Cable movements can influence the measuring signal especially in the case of low fluid conductivities.
- Route the cable well clear of electrical machines and switching elements.
- Ensure potential equalization between the sensor and transmitter → 27.

Connection examples

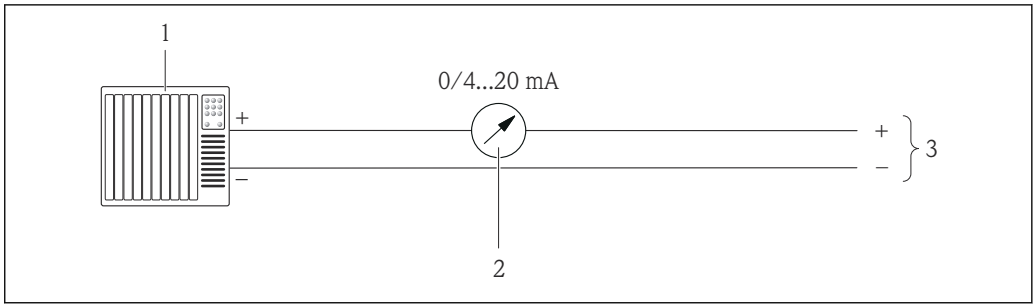
Current output 4 to 20 mA HART



5 *Connection example for 4 to 20 mA HART current output (active)*

1 Automation system with current input (e.g. PLC)
2 Cable shield provided at one end. The cable shield must be grounded at both ends to comply with EMC requirements; observe cable specifications → 31
3 Connection for HART operating devices → 95
4 Resistor for HART communication (≥ 250 Ω): observe maximum load → 13
5 Analog display unit: observe maximum load → 13
6 Transmitter

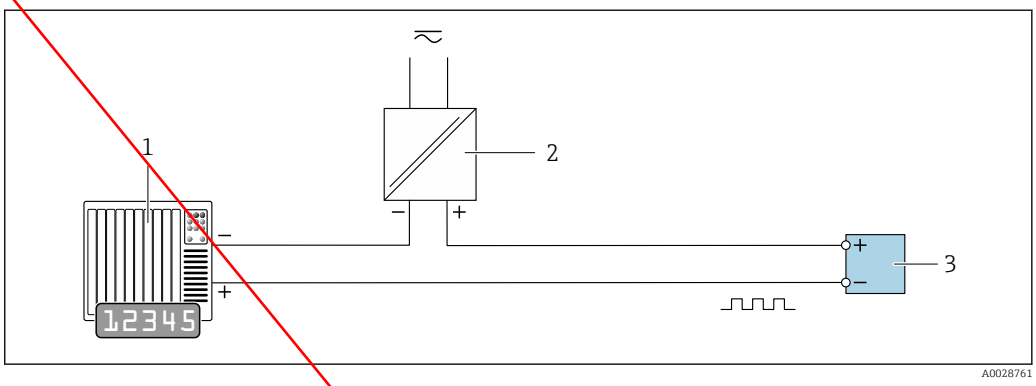
Current output 4 to 20 mA



6 *Connection example for 0 to 20 mA (active) and 4 to 20 mA (active) current output*

1 *Automation system with current input (e.g. PLC)*
2 *Analog display unit: observe maximum load*
3 *Transmitter*

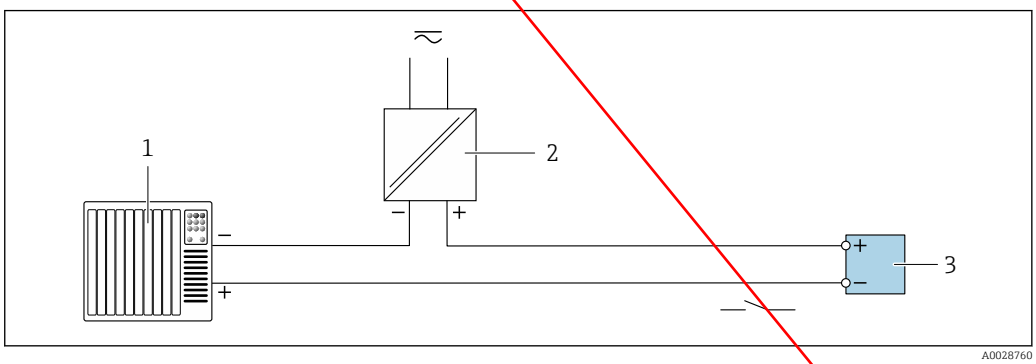
Pulse/frequency output



7 *Connection example for pulse/frequency output (passive)*

1 *Automation system with pulse/frequency input (e.g. PLC)*
2 *Power supply*
3 *Transmitter: Observe input values → 14*

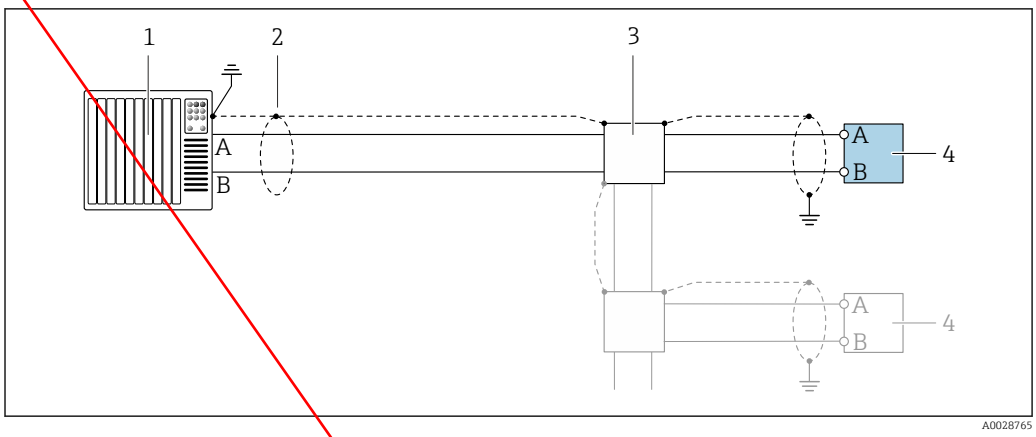
Switch output



8 *Connection example for switch output (passive)*

1 *Automation system with switch input (e.g. PLC)*
2 *Power supply*
3 *Transmitter: Observe input values → 14*

PROFIBUS DP

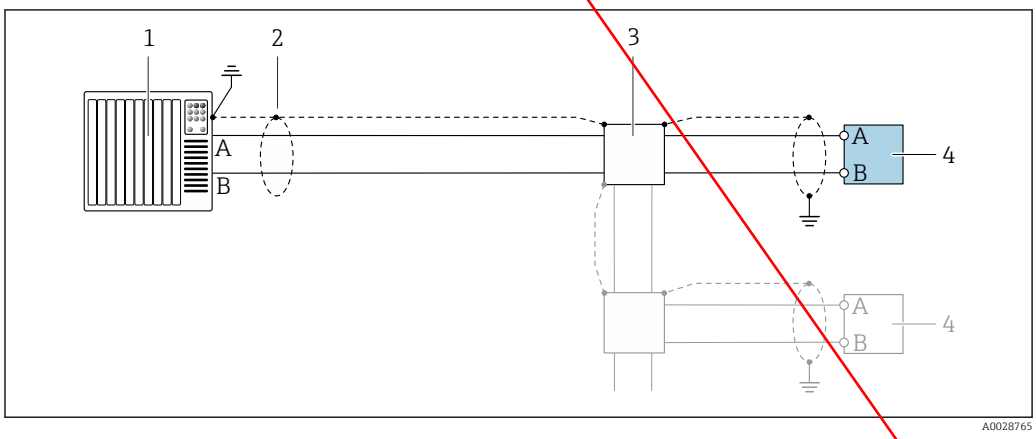


9 Connection example for PROFIBUS DP, non-hazardous area and Zone 2/Div. 2

1 Control system (e.g. PLC)
2 Cable shield provided at one end. The cable shield must be grounded at both ends to comply with EMC requirements; observe cable specifications
3 Distribution box
4 Transmitter

If baud rates > 1.5 MBaud an EMC cable entry must be used and the cable shield must continue as far as the terminal wherever possible.

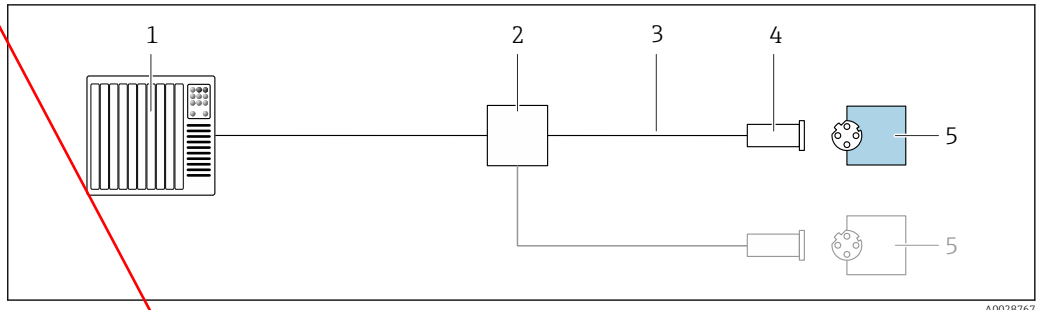
Modbus RS485



10 Connection example for Modbus RS485, non-hazardous area and Zone 2/Div. 2

1 Control system (e.g. PLC)
2 Cable shield provided at one end. The cable shield must be grounded at both ends to comply with EMC requirements; observe cable specifications
3 Distribution box
4 Transmitter

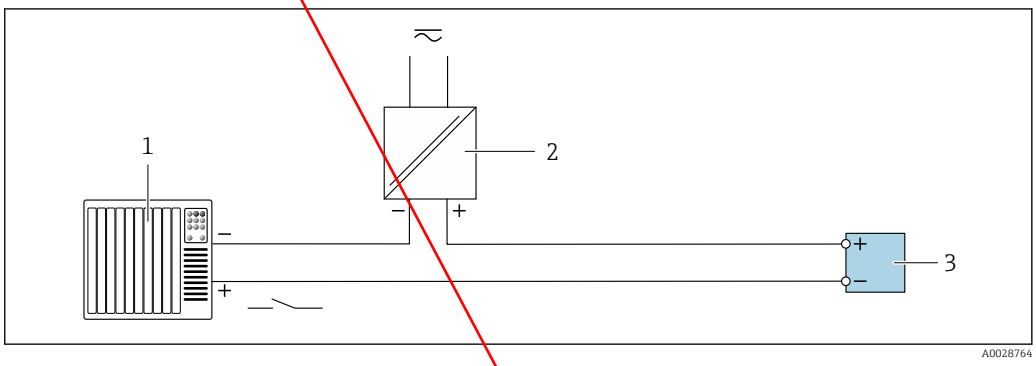
EtherNet/IP



11 Connection example for EtherNet/IP

1 Control system (e.g. PLC)
2 Ethernet switch
3 Observe cable specifications
4 Device plug
5 Transmitter

Status input



12 Connection example for status input

1 Automation system with status output (e.g. PLC)
2 Power supply
3 Transmitter

Potential equalization

Introduction

Correct potential equalization (equipotential bonding) is a prerequisite for stable and reliable flow measurement. Inadequate or incorrect potential equalization can result in device failure and present a safety hazard.

The following requirements must be observed to ensure correct, trouble-free measurement:
- The principle that the medium, the sensor and the transmitter must be at the same electrical potential applies.
- Take in-company grounding guidelines, materials and the grounding conditions and potential conditions of the pipe into consideration.
- Any necessary potential equalization connections must be established by ground cables with a minimum cross-section of 6 mm^2 (0.0093 in^2).
- For remote device versions, the ground terminal in the example always refers to the sensor and not to the transmitter.

You can order accessories like ground cables and ground disks from Endress+Hauser → 103

For devices intended for use in hazardous locations, observe the instructions in the Ex documentation (XA).

Abbreviations used

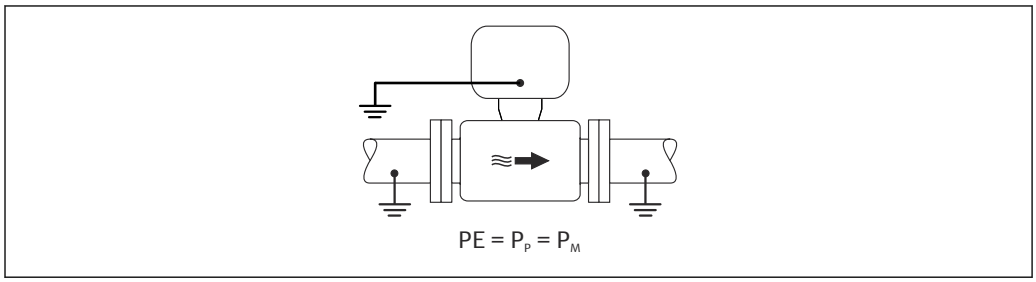
- PE (Protective Earth): potential at the protective earth terminals of the device
- P_P (Potential Pipe): potential of the pipe, measured at the flanges
- P_M (Potential Medium): potential of the medium

Connection examples for standard situations

Unlined and grounded metal pipe

- Potential equalization is via the measuring pipe.
- The medium is set to ground potential.

Starting conditions:
- Pipes are correctly grounded on both sides.
- Pipes are conductive and at the same electrical potential as the medium



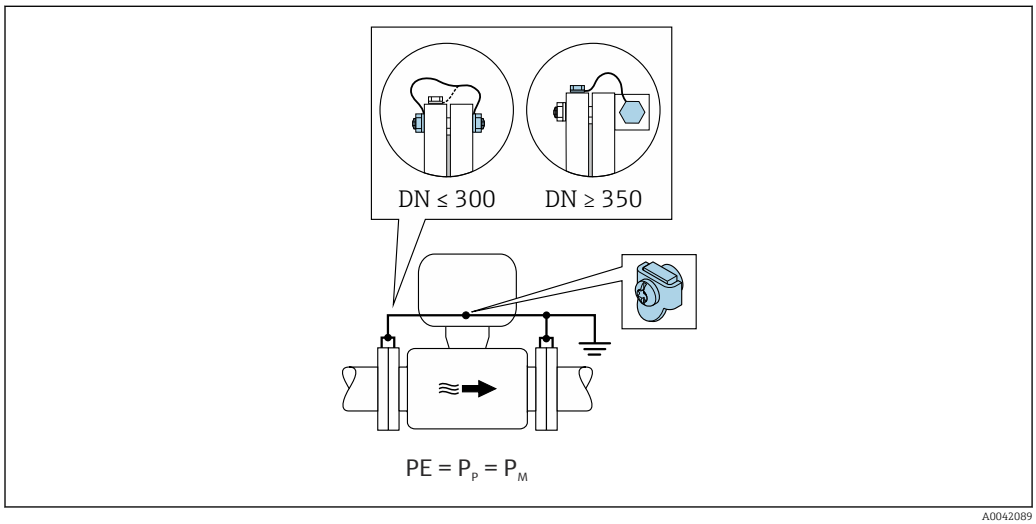
A0044854

▶ Connect the connection housing of the transmitter or sensor to ground potential by means of the ground terminal provided for this purpose.

Unlined metal pipe

- Potential equalization is via the ground terminal and pipe flanges.
- The medium is set to ground potential.

Starting conditions:
- Pipes are not sufficiently grounded.
- Pipes are conductive and at the same electrical potential as the medium



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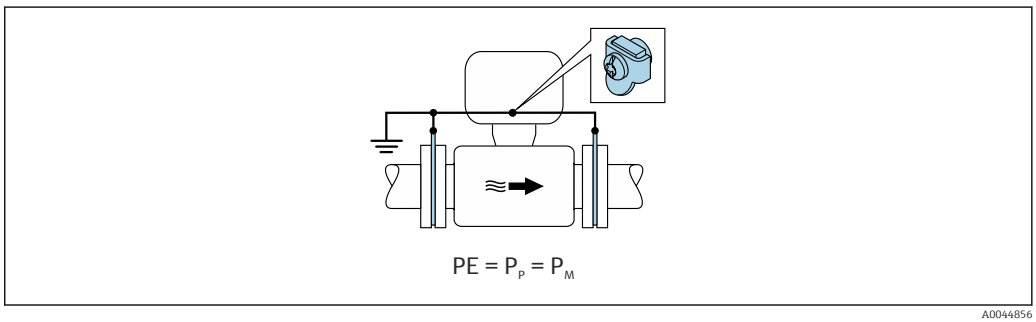
1. Connect both sensor flanges to the pipe flange via a ground cable and ground them.
2. Connect the connection housing of the transmitter or sensor to ground potential by means of the ground terminal provided for this purpose.

- For DN ≤ 300 (12"): Mount the ground cable directly on the conductive flange coating of the sensor with the flange screws.
- For DN ≥ 350 (14"): Mount the ground cable directly on the metal transport bracket. Observe screw tightening torques: see the Brief Operating Instructions for the sensor.

Plastic pipe or pipe with insulating liner

- Potential equalization is via the ground terminal and ground disks.
- The medium is set to ground potential.

Starting conditions:
- The pipe has an insulating effect.
- Low-impedance medium grounding close to the sensor is not guaranteed.
- Equalizing currents through the medium cannot be ruled out.



A0044856

1. Connect the ground disks to the ground terminal of the connection housing of the transmitter or sensor via the ground cable.
2. Connect the connection to ground potential.

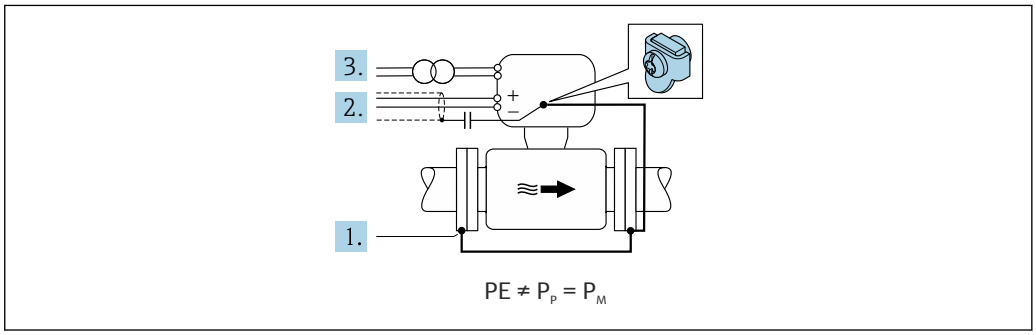
Connection example with the potential of the medium not equal to the protective ground

In these cases, the medium potential can differ from the potential of the device.

Metal, ungrounded pipe

The sensor and transmitter are installed in a way that provides electrical insulation from PE, e.g. applications for electrolytic processes or systems with cathodic protection.

Starting conditions:
- Unlined metal pipe
- Pipes with an electrically conductive liner



A0042253

1. Connect the pipe flanges and transmitter via the ground cable.
2. Route the shielding of the signal lines via a capacitor (recommended value 1.5µF/50V).
3. Device connected to power supply such that it is floating in relation to the protective earth (isolation transformer). This measure is not required in the case of 24V DC supply voltage without PE (= SELV power unit).

Connection examples with the potential of medium not equal to protective earth with the "Measurement isolated from ground" option

In these cases, the medium potential can differ from the potential of the device.

Introduction

The "Measurement isolated from ground" option enables the galvanic isolation of the measuring system from the device potential. This minimizes harmful equalizing currents caused by differences

in potential between the medium and the device. The "Measurement isolated from ground" option is optionally available: order code for "Sensor option", option CV

Operating conditions for the use of the "Measurement isolated from ground" option

Device version	Compact version and remote version (length of connecting cable ≤ 10 m)
Differences in voltage between medium potential and device potential	As small as possible, usually in the mV range
Alternating voltage frequencies in the medium or at ground potential (PE)	Below typical power line frequency in the country

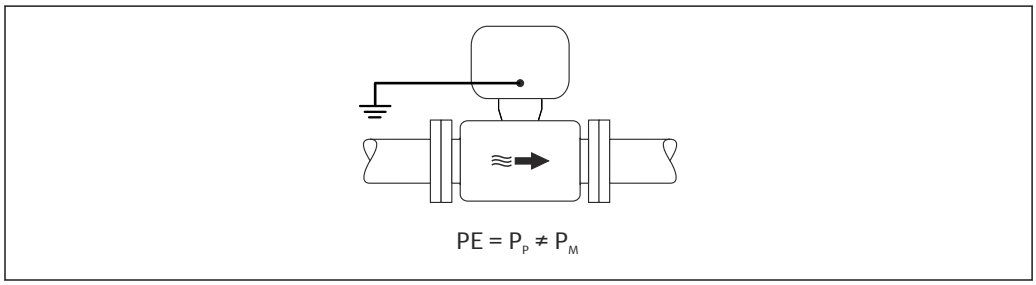
To achieve the specified conductivity measuring accuracy, a conductivity calibration is recommended when the device is installed.

A full pipe adjustment is recommended when the device is installed.

Plastic pipe

Sensor and transmitter are correctly grounded. A difference in potential can occur between the medium and protective earth. Potential equalization between P_M and PE via the reference electrode is minimized with the "Measurement isolated from ground" option.

Starting conditions:
- The pipe has an insulating effect.
- Equalizing currents through the medium cannot be ruled out.



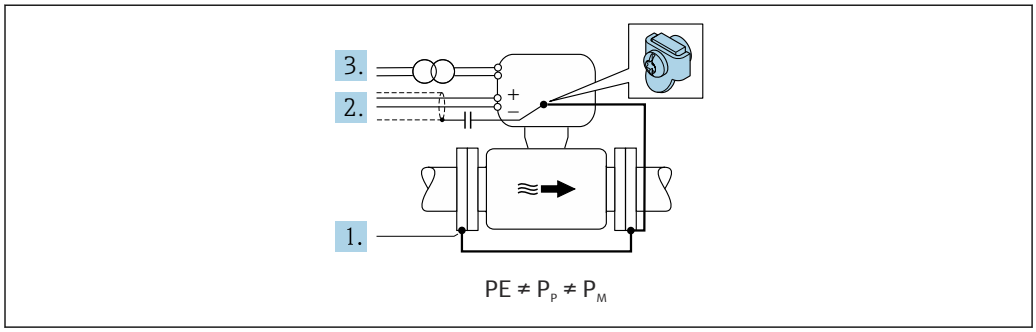
A0044855

1. Use the "Measurement isolated from ground" option, while observing the operating conditions for measurement isolated from ground.
2. Connect the connection housing of the transmitter or sensor to ground potential by means of the ground terminal provided for this purpose.

Metal, ungrounded pipe with insulating liner

The sensor and transmitter are installed in a way that provides electrical insulation from PE. The medium and pipe have different potentials. The "Measurement isolated from ground" option minimizes harmful equalizing currents between P_M and P_P via the reference electrode.

Starting conditions:
- Metal pipe with insulating liner
- Equalizing currents through the medium cannot be ruled out.



A0044857

1. Connect the pipe flanges and transmitter via the ground cable.
2. Route the shielding of the signal cables via a capacitor (recommended value 1.5µF/50V).
3. Device connected to power supply such that it is floating in relation to the protective earth (isolation transformer). This measure is not required in the case of 24V DC supply voltage without PE (= SELV power unit).
4. Use the "Measurement isolated from ground" option, while observing the operating conditions for measurement isolated from ground.

Terminals

Transmitter
- Supply voltage cable: plug-in spring terminals for wire cross-sections 0.5 to 2.5 mm² (20 to 14 AWG)
- Signal cable: plug-in spring terminals for wire cross-sections 0.5 to 2.5 mm² (20 to 14 AWG)
- Electrode cable: spring terminals for wire cross-sections 0.5 to 2.5 mm² (20 to 14 AWG)
- Coil current cable: spring terminals for wire cross-sections 0.5 to 2.5 mm² (20 to 14 AWG)

Sensor connection housing
Spring terminals for wire cross-sections 0.5 to 2.5 mm² (20 to 14 AWG)

Cable entries

Cable entry thread
- M20 x 1.5
- Via adapter:
  - NPT ½"
  - G ½"

Cable gland
- For standard cable: M20 × 1.5 with cable Φ 6 to 12 mm (0.24 to 0.47 in)
- For armored cable: M20 × 1.5 with cable Φ 9.5 to 16 mm (0.37 to 0.63 in)

If metal cable entries are used, use a grounding plate.

Cable specification

Permitted temperature range
- The installation guidelines that apply in the country of installation must be observed.
- The cables must be suitable for the minimum and maximum temperatures to be expected.

Power supply cable (incl. conductor for the inner ground terminal)

Standard installation cable is sufficient.

Signal cable

Current output 0/4 to 20 mA

Standard installation cable is sufficient.

Current output 4 to 20 mA HART

A shielded cable is recommended. Observe grounding concept of the plant.

Pulse/frequency/switch output

Standard installation cable is sufficient.

Status input

Standard installation cable is sufficient.

PROFIBUS DP

The IEC 61158 standard specifies two types of cable (A and B) for the bus line which can be used for every transmission rate. Cable type A is recommended.

Cable type	A
Characteristic impedance	135 to 165 Ω at a measuring frequency of 3 to 20 MHz
Cable capacitance	< 30 pF/m
Wire cross-section	> 0.34 mm² (22 AWG)

Cable type	Twisted pairs
Loop resistance	≤110 Ω/km
Signal damping	Max. 9 dB over the entire length of the cable cross-section
Shield	Copper braided shielding or braided shielding with foil shield. When grounding the cable shield, observe the grounding concept of the plant.

For further information on planning and installing PROFIBUS networks see:
Operating Instructions "PROFIBUS DP/PA: Guidelines for planning and commissioning" (BA00034S)

Modbus RS485

The EIA/TIA-485 standard specifies two types of cable (A and B) for the bus line which can be used for every transmission rate. Cable type A is recommended.

Cable type	A
Characteristic impedance	135 to 165 Ω at a measuring frequency of 3 to 20 MHz
Cable capacitance	< 30 pF/m
Wire cross-section	> 0.34 mm² (22 AWG)
Cable type	Twisted pairs
Loop resistance	≤110 Ω/km
Signal damping	Max. 9 dB over the entire length of the cable cross-section
Shield	Copper braided shielding or braided shielding with foil shield. When grounding the cable shield, observe the grounding concept of the plant.

EtherNet/IP

The standard ANSI/TIA/EIA-568-B.2 Annex specifies CAT 5 as the minimum category for a cable used for EtherNet/IP. CAT 5e and CAT 6 are recommended.

For more information on planning and installing EtherNet/IP networks, please refer to the "Media Planning and Installation Manual. EtherNet/IP" of ODVA Organization

Connecting cable for remote version

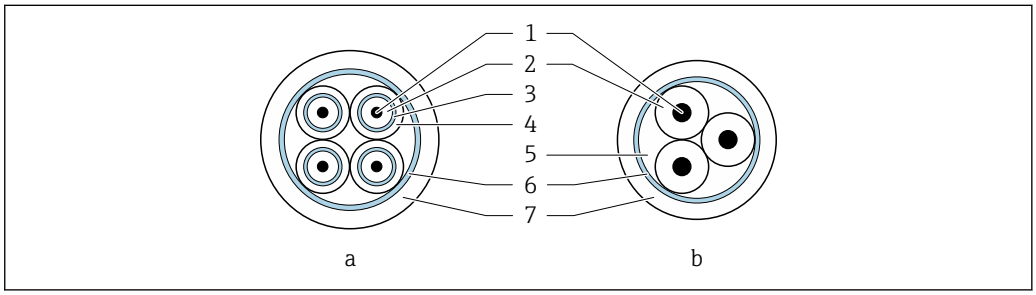
Electrode cable

Standard cable	3 ×0.38 mm² (20 AWG) with common, braided copper shield (ϕ ~9.5 mm (0.37 in)) and individual shielded cores
Cable for empty pipe detection (EPD)	4 ×0.38 mm² (20 AWG) with common, braided copper shield (ϕ ~9.5 mm (0.37 in)) and individual shielded cores
Conductor resistance	≤50 Ω/km (0.015 Ω/ft)
Capacitance: core/shield	≤420 pF/m (128 pF/ft)
Operating temperature	–20 to +80 °C (–4 to +176 °F)

Coil current cable

Standard cable	3 ×0.75 mm² (18 AWG) with common, braided copper shield (ϕ ~9 mm (0.35 in))
Conductor resistance	≤37 Ω/km (0.011 Ω/ft)
Capacitance: core/core, shield grounded	≤120 pF/m (37 pF/ft)

Operating temperature	–20 to +80 °C (–4 to +176 °F)
Test voltage for cable insulation	≤ AC 1433 V rms 50/60 Hz or ≥ DC 2026 V



13 *Cable cross-section*

a Electrode cable
b Coil current cable
1 Core
2 Core insulation
3 Core shield
4 Core jacket
5 Core reinforcement
6 Cable shield
7 Outer jacket

A connecting cable can be ordered from Endress+Hauser for IP68:
- Pre-terminated cables that are already connected to the sensor
- Pre-terminated cables, where the cables are connected by the customer onsite (incl. tools for sealing the connection compartment)

Armored connecting cable

Armored connecting cables with an additional, reinforcing metal braid should be used:
- When laying the cable directly in the ground
- Where there is a risk of damage from rodents
- Use as per IP68 degree of protection

Armored connecting cables with an additional, reinforcing metal braid can be ordered from Endress+Hauser → 103.

Operation in environments with strong electrical interference

The measuring system meets the general safety requirements → 102 and EMC specifications → 48.

Grounding is by means of the ground terminal provided for the purpose inside the connection housing. The stripped and twisted lengths of cable shield to the ground terminal must be as short as possible.

Performance characteristics

Reference operating conditions

- Error limits following DIN EN 29104, in future ISO 20456
- Water, typically +15 to +45 °C (+59 to +113 °F); 0.5 to 7 bar (73 to 101 psi)
- Data as indicated in the calibration protocol
- Accuracy based on accredited calibration rigs according to ISO 17025

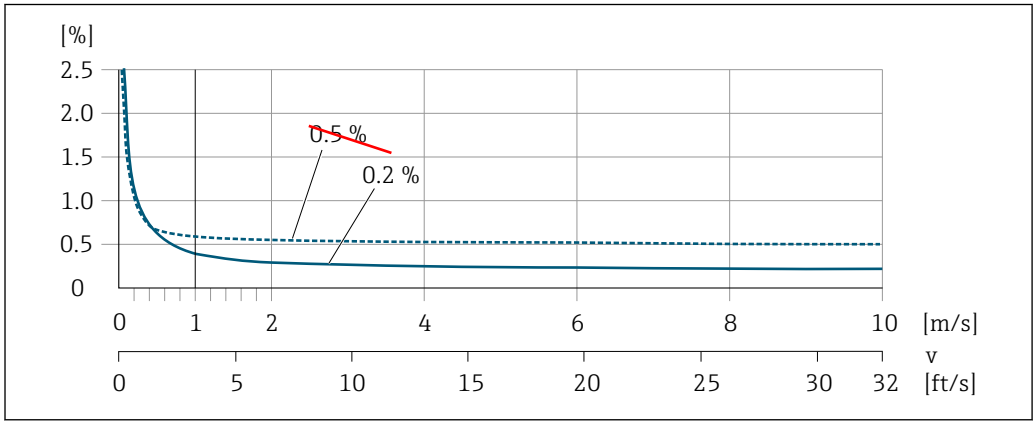
Maximum measured error

Error limits under reference operating conditions

Volume flow

- ±0.5 % o.r. ± 1 mm/s (0.04 in/s)
- Optional: ±0.2 % o.r. ± 2 mm/s (0.08 in/s)

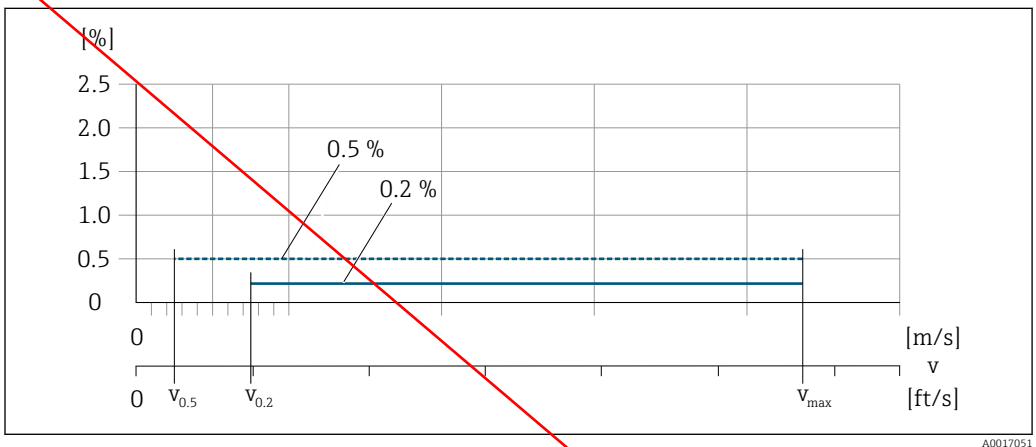
Fluctuations in the supply voltage do not have any effect within the specified range.



14 *Maximum measured error in % o.r.*

Flat Spec

For Flat Spec in the range $v_{0.5}$ ($v_{0.2}$) up to v_{max} the measured error is constant.



15 *Flat Spec in % o.r.*

Flat Spec flow values 0.5 %

Nominal diameter		$v_{0.5}$		v_{max}	
[mm]	[in]	[m/s]	[ft/s]	[m/s]	[ft/s]
25 to 600	1 to 24	0.5	1.64	10	32
50 to 300 [1)]	2 to 12	0.25	0.82	5	16

1) Order code for "Design", option C

Flat Spec flow values 0.2 %

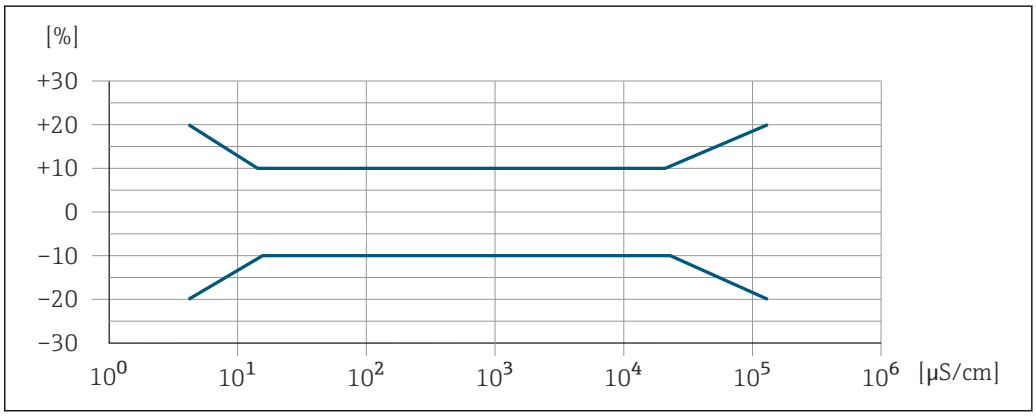
Nominal diameter		$v_{0.2}$		v_{max}	
[mm]	[in]	[m/s]	[ft/s]	[m/s]	[ft/s]
25 to 600	1 to 24	1.5	4.92	10	32
50 to 300 [1)]	2 to 12	0.6	1.97	4	13

1) Order code for "Design", option C

Electrical conductivity

The values apply for:
- Measurements at a reference temperature of 25 °C (77 °F)
  At different temperatures, attention must be paid to the temperature coefficient of the medium (typically 2.1 %/K)
- Device version: compact version - transmitter and sensor form a mechanical unit
- Devices installed in a metal pipe or in a non-metal pipe with ground disks
- Devices whose potential equalization was performed according to the instructions in the associated Operating Instructions

Conductivity [µS/cm]	Measured error [%] o. r.
5 to 20	± 20%
20 to 20 000	± 10%
20 000 to 100 000	± 20%



16 *Measured error*

Accuracy of outputs

The outputs have the following base accuracy specifications.

Current output

Accuracy	Max. ±5 µA

Pulse/frequency output

o.r. = of reading

Accuracy	Max. ±50 ppm o.r. (over the entire ambient temperature range)

Repeatability

o.r. = of reading

Volume flow
max. ±0.1 % o.r. ± 0.5 mm/s (0.02 in/s)

Electrical conductivity
Max. ±5 % o.r.

Influence of ambient temperature

Current output

o.r. = of reading

Temperature coefficient	Max. ±0.005 % o.r./°C

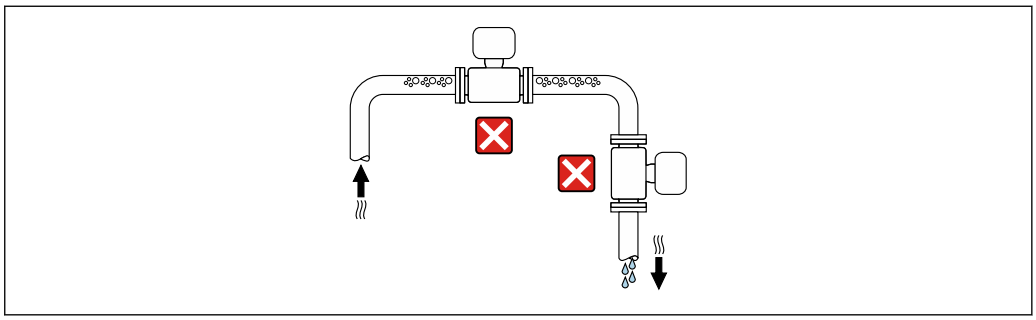
Pulse/frequency output

Temperature coefficient	No additional effect. Included in accuracy.

Installation

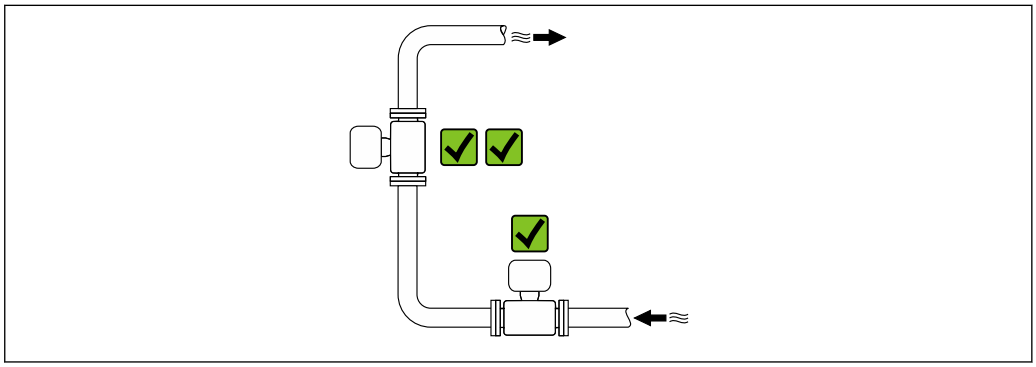
Mounting location

- Do not install the device at the highest point of the pipe.
- Do not install the device upstream from a free pipe outlet in a down pipe.



A0042131

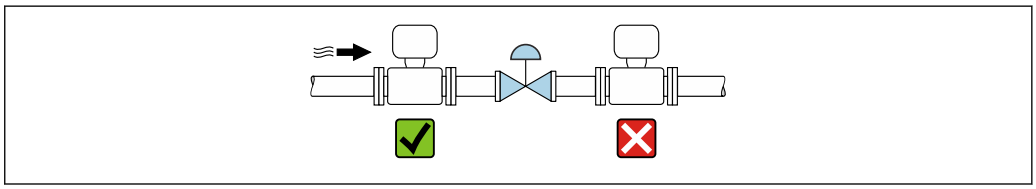
The device should ideally be installed in an ascending pipe.



A0042317

Installation near valves

Install the device in the direction of flow upstream from the valve.



A0041091

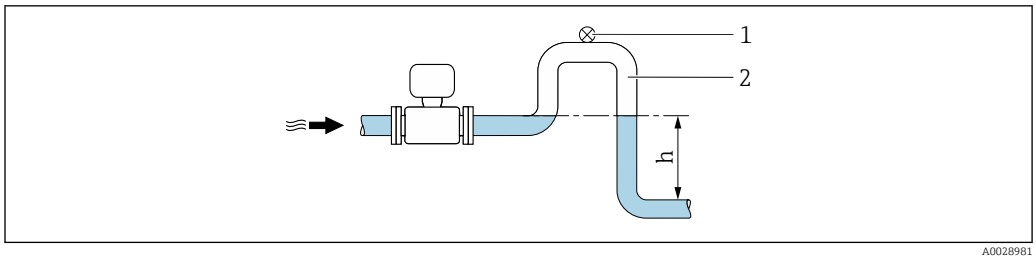
Installation upstream from a down pipe

NOTICE

Negative pressure in the measuring pipe can damage the liner!

▶ If installing upstream from down pipes with a length h ≥ 5 m (16.4 ft), install a siphon with a vent valve downstream from the device.

This arrangement prevents the stoppage of liquid flow and the formation of air pockets.

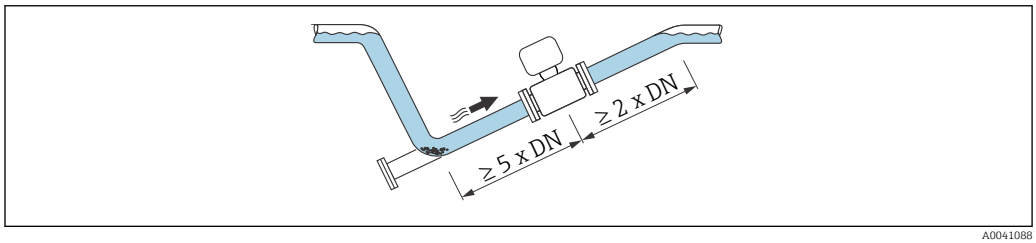


A0028981

1 Vent valve
2 Pipe siphon
h Length of down pipe

Installation with partially filled pipes

- Partially filled pipes with a gradient require a drain-type configuration.
- The installation of a cleaning valve is recommended.



A0041088

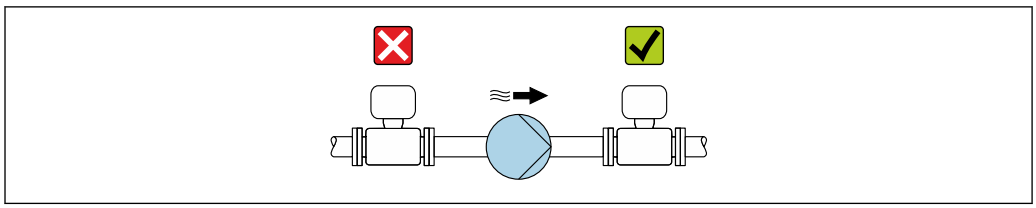
No inlet and outlet runs for devices with the order code for "Design": Option C, H, I, J or K.

Installation near pumps

NOTICE

Negative pressure in the measuring pipe can damage the liner!

- ▶ In order to maintain the system pressure, install the device in the flow direction downstream from the pump.
- ▶ Install pulsation dampers if reciprocating, diaphragm or peristaltic pumps are used.



A0041083

- Information on the liner's resistance to partial vacuum → 51
- Information on the measuring system's resistance to vibration and shock → 47

Installation of very heavy devices

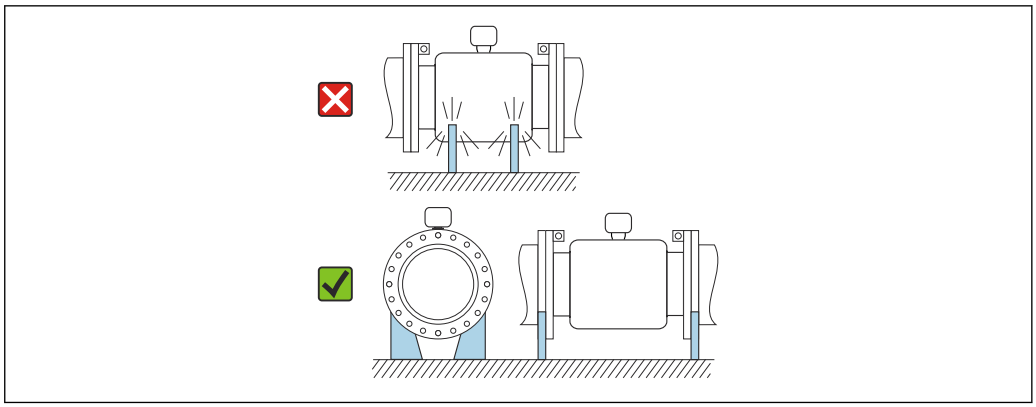
Support required for nominal diameters of DN ≥ 350 mm (14 in).

NOTICE

Damage to the device!

If incorrect support is provided, the sensor housing could buckle and the internal magnetic coils could be damaged.

- ▶ Only provide supports at the pipe flanges.



A0041087

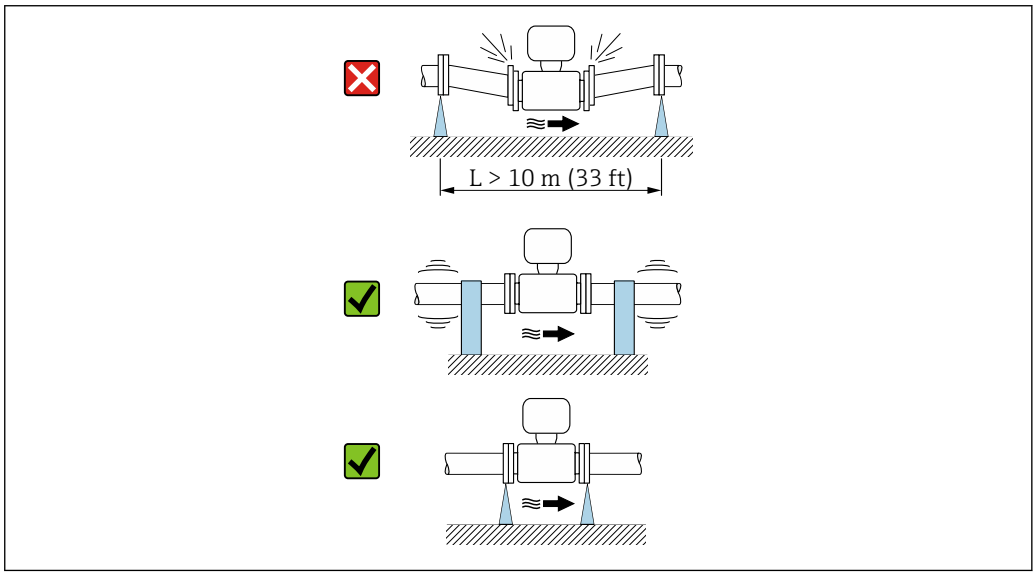
Installation in event of pipe vibrations

A remote version is recommended in the event of strong pipe vibrations.

NOTICE

Pipe vibrations can damage the device!

- Do not expose the device to strong vibrations.
- Support the pipe and fix it in place.
- Support the device and fix it in place.
- Mount the sensor and transmitter separately.

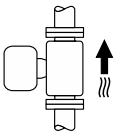
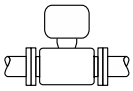
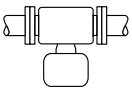
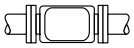


A0041092

Information on the measuring system's resistance to vibration and shock → 47

Orientation

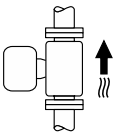
The direction of the arrow on the sensor nameplate helps you to install the sensor according to the flow direction (direction of medium flow through the piping).

Orientation		Recommendation
Vertical orientation	 A0015591	✓✓
Horizontal orientation, transmitter at top	 A0015589	✓✓ 1)
Horizontal orientation, transmitter at bottom	 A0015590	✓✓ 2) 3) ✗ 4)
Horizontal orientation, transmitter at side	 A0015592	✗

1) Applications with low process temperatures may decrease the ambient temperature. To maintain the minimum ambient temperature for the transmitter, this orientation is recommended.
2) Applications with high process temperatures may increase the ambient temperature. To maintain the maximum ambient temperature for the transmitter, this orientation is recommended.
3) To prevent the electronics module from overheating in the case of a sharp rise in temperature (e.g. CIP or SIP processes), install the device with the transmitter component pointing downwards.
4) With the empty pipe detection function switched on: empty pipe detection only works if the transmitter housing is pointing upwards.

Vertical

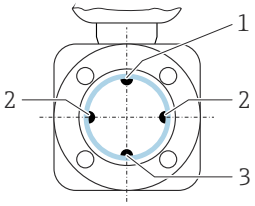
Optimum for self-emptying pipe systems and for use in conjunction with empty pipe detection.



A0015591

Horizontal

- Ideally, the measuring electrode plane should be horizontal. This prevents brief insulation of the measuring electrodes by entrained air bubbles.
- Empty pipe detection only works if the transmitter housing is pointing upwards as otherwise there is no guarantee that the empty pipe detection function will actually respond to a partially filled or empty measuring tube.



A0029344

1 EPD electrode for empty pipe detection
2 Measuring electrodes for signal detection
3 Reference electrode for potential equalization

Inlet and outlet runs

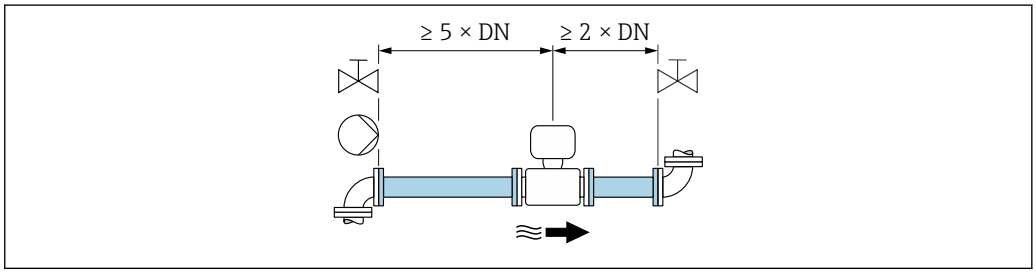
Installation with inlet and outlet runs

Installation requires inlet and outlet runs: devices with the order code for "Design", option D, E, F and G.

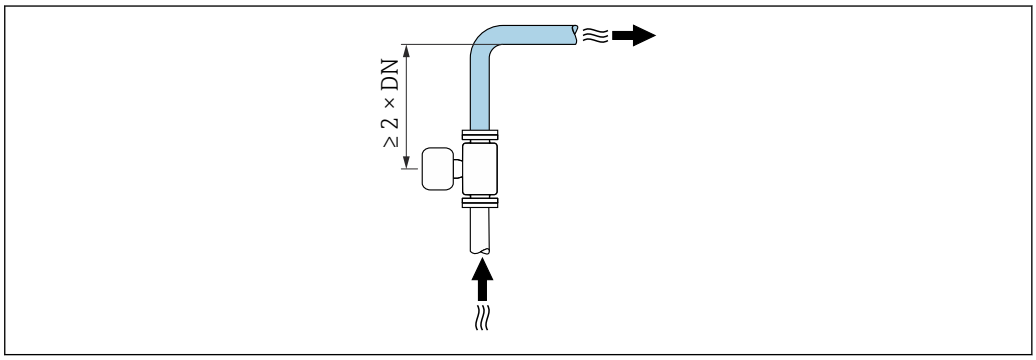
Installation with elbows, pumps or valves

To avoid a vacuum and to maintain the specified level of accuracy, install the device upstream from assemblies that produce turbulence (e.g. valves, T-sections) and downstream from pumps, wherever possible.

Maintain straight, unimpeded inlet and outlet runs.



A0028997



A0042132

Installation without inlet and outlet runs

Depending on the device design and installation location, the inlet and outlet runs can be reduced or omitted entirely.

Maximum measured error
When the device is installed with the inlet and outlet runs described, a maximum measured error of ±0.5 % of the reading ±1 mm/s (0.04 in/s) can be guaranteed.

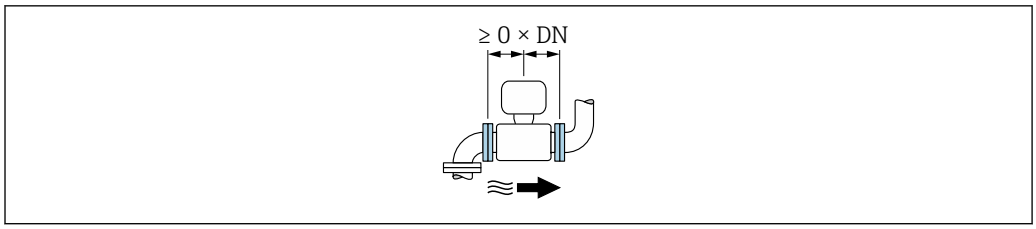
Devices and possible order options

Order code for "Design"		
Option	**Description**	**Design**
C	Fixed flange, constricted measuring tube, 0 x DN inlet/outlet runs	Constricted measuring tube [1]
H	Lap joint flange, 0 x DN inlet/outlet runs	Full Bore [2]
I	Fixed flange, 0 x DN inlet/outlet runs	
J	Fixed flange, short installed length, 0 x DN inlet/outlet runs	
K	Fixed flange, long installed length, 0 x DN inlet/outlet runs	

1) "Constricted measuring tube" stands for a reduction of the internal diameter of the measuring tube. The reduced internal diameter causes a higher flow velocity inside the measuring tube.
2) "Full Bore" stands for the full diameter of the measuring tube. There is no pressure loss with a full diameter.

Installation before or after bends

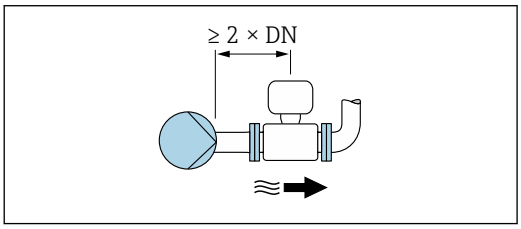
Installation without inlet and outlet runs is possible: devices with the order code for "Design", option C, H, I, J and K.



Installation downstream of pumps

Installation without inlet and outlet runs is possible: devices with the order code for "Design", option C, H and I.

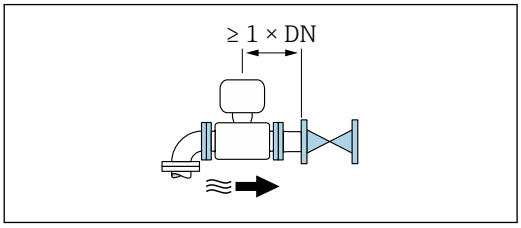
In the case of devices with the order code for "Design", option J and K, an inlet run of only ≥ 2 x DN must be taken into consideration.



Installation upstream of valves

Installation without inlet and outlet runs is possible: devices with the order code for "Design", option C, H and I.

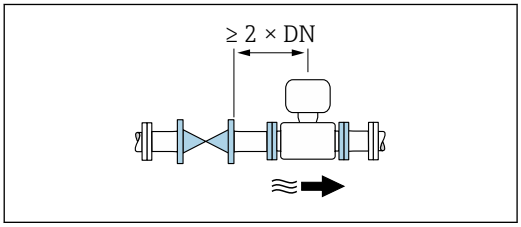
In the case of devices with the order code for "Design", option J and K, an outlet run of only ≥ 1 x DN must be taken into consideration.



Installation downstream of valves

Installation without inlet and outlet runs is possible if the valve is 100% open during operation: devices with the order code for "Design", option C, H and I.

In the case of devices with the order code for "Design", option J and K, an inlet run of only ≥ 2 x DN must be taken into consideration if the valve is 100% open during operation.



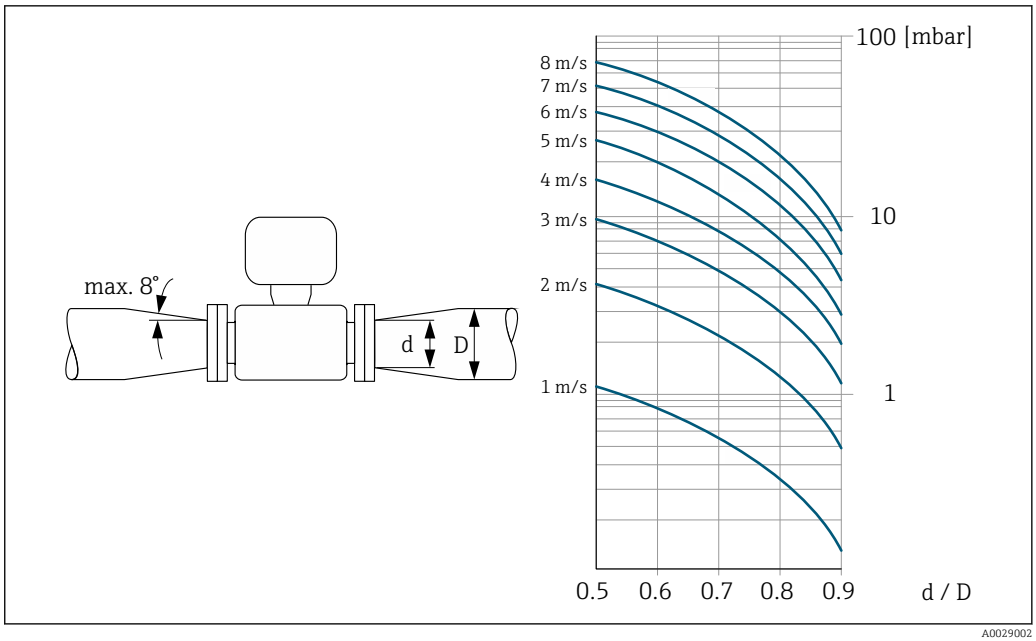
Adapters

Suitable adapters to DIN EN 545 (double-flange reducers) can be used to install the sensor in larger-diameter pipes. The resultant increase in the rate of flow improves measuring accuracy with very slow-moving fluids.

The nomogram shown here can be used to calculate the pressure loss caused by reducers and expanders:

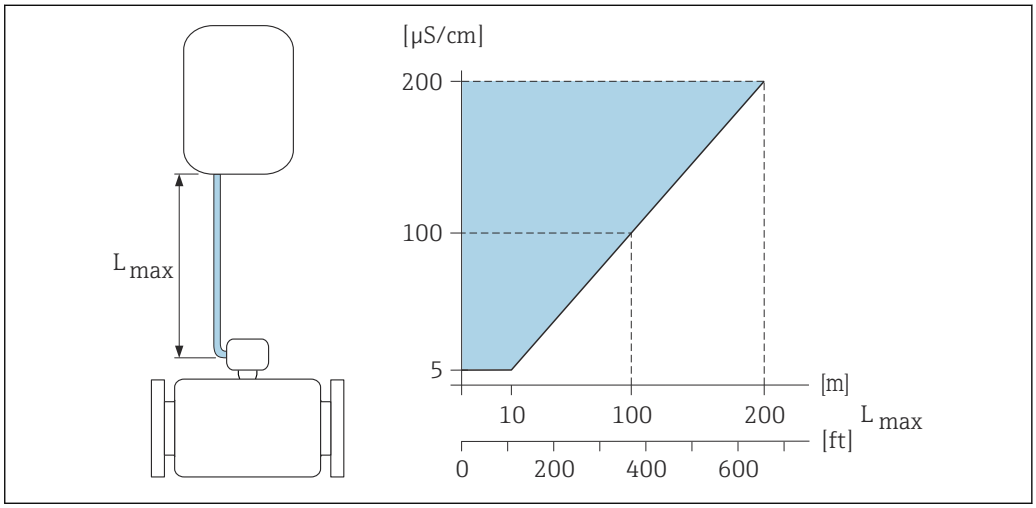
- Calculate the ratio of the diameters d/D.
- From the nomogram read off the pressure loss as a function of flow velocity (downstream from the reduction) and the d/D ratio.

The nomogram only applies to liquids with a viscosity similar to that of water.



Length of connecting cable

To obtain correct measurement results, observe the permitted connecting cable length of L_{max}. This length is determined by the conductivity of the fluid. If measuring liquids in general: 5 µS/cm



17 *Permitted length of connecting cable*

Colored area = permitted range
L_{max} = length of connecting cable in [m] ([ft])
[µS/cm] = fluid conductivity

Special mounting instructions

Display guard

To ensure that the optional display guard can be easily opened, maintain the following minimum head clearance: 350 mm (13.8 in)

Immersion in water

- Only the remote version of the device with IP68 protection, Type 6P is suitable for underwater use: order code for "Sensor option", options CB, CC, CD, CE and CQ.
- Pay attention to regional installation instructions.

NOTICE

If the maximum water depth and operating duration is exceeded, this can damage the device!

▶ Observe the maximum water depth and operating duration.

Order code for "Sensor option", options CB, CC

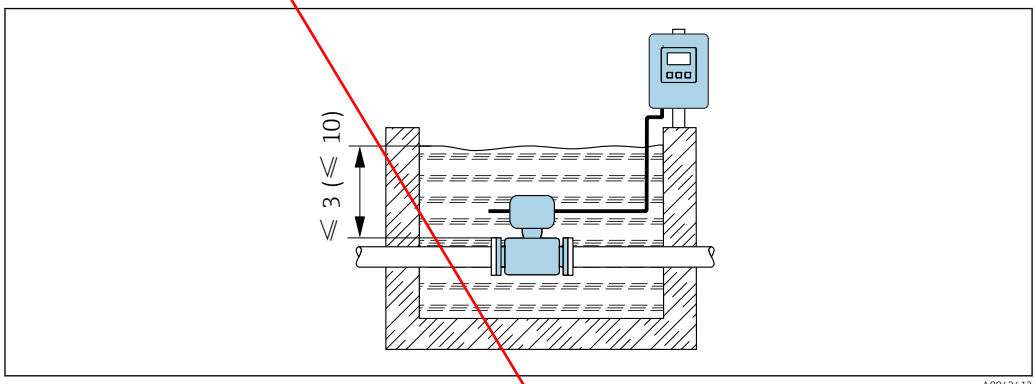
- For the operation of the device under water
- Operating duration at a maximum depth of:
  - 3 m (10 ft): permanent use
  - 10 m (30 ft): maximum 48 hours

Order code for "Sensor option", option CQ "Temporarily water-proof "

- For the temporary operation of the device under non-corrosive water
- Operating duration at a maximum depth of:
  3 m (10 ft): maximum 168 hours

Order code for "Sensor option", options CD, CE

- For the operation of the device under water and in saline water
- Operating duration at a maximum depth of:
  - 3 m (10 ft): permanent use
  - 10 m (30 ft): maximum 48 hours



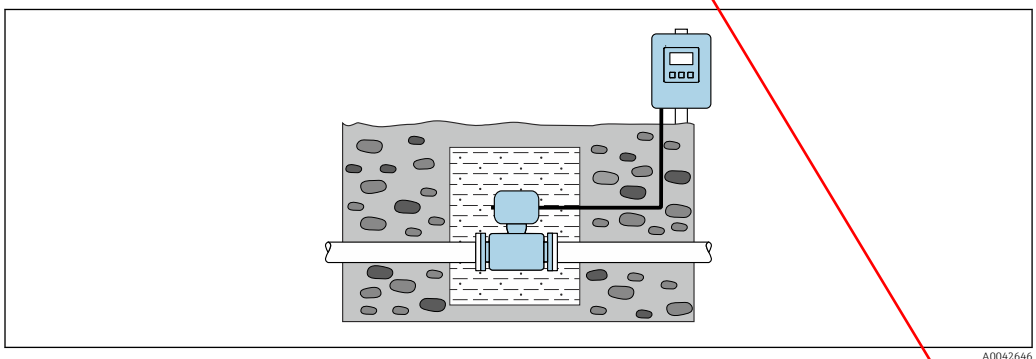
A0042412

Use in buried applications

- Only the remote version of the device with IP68 protection is suitable for use in buried applications: order code for "Sensor option", options CD and CE.
- Pay attention to regional installation instructions.

Order code for "Sensor option", options CD, CE

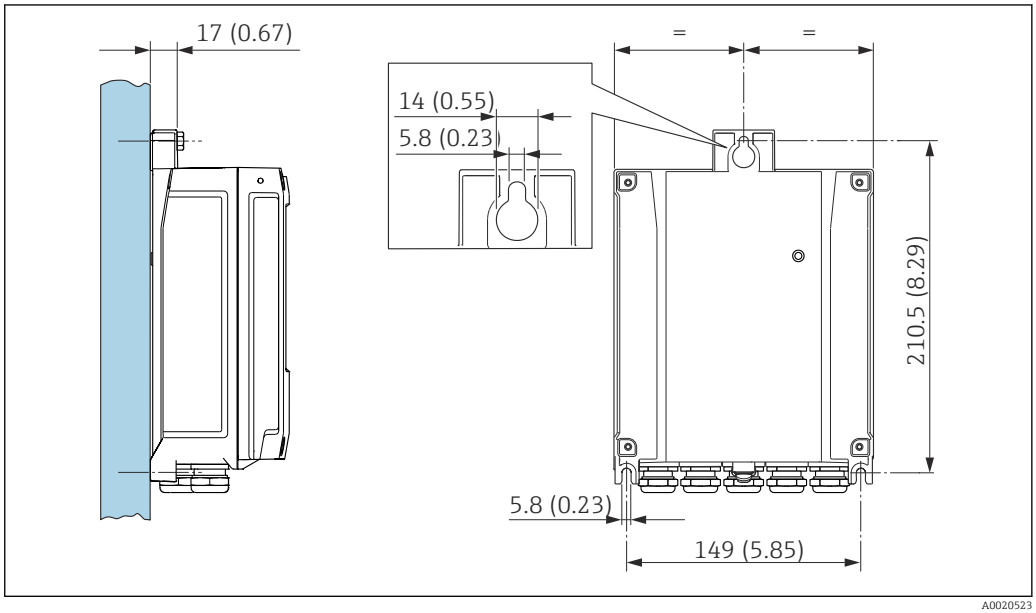
For the use of the device in buried applications.



A0042646

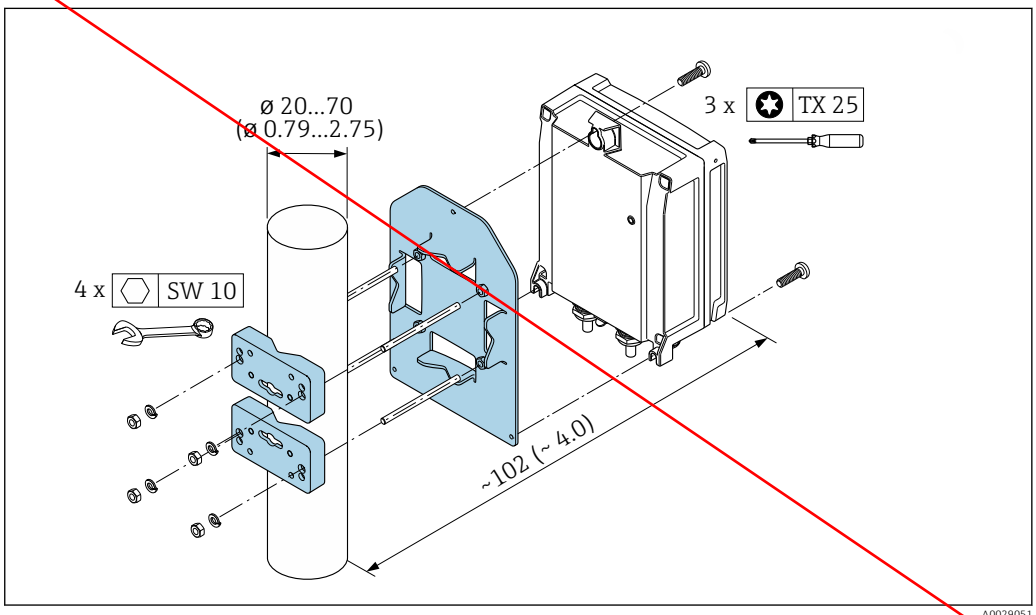
Mounting the transmitter housing

Wall mounting



18 *Engineering unit mm (in)*

Post mounting



19 *Engineering unit mm (in)*

Environment

Ambient temperature range

Transmitter	−40 to +60 °C (−40 to +140 °F)
Local display	−20 to +60 °C (−4 to +140 °F), the legibility of the local display may be impaired at temperatures outside the temperature range.

Sensor	▪ Process connection material, carbon steel: −10 to +60 °C (+14 to +140 °F) ▪ Process connection material, stainless steel: −40 to +60 °C (−40 to +140 °F) If both the ambient and the medium temperatures are high, mount the sensor separately from the transmitter.
Liner	Do not exceed or fall below the permitted temperature range of the liner → 48.

If operating outdoors:
- Install the measuring device in a shady location.
- Avoid direct sunlight, particularly in warm climatic regions.
- Avoid direct exposure to weather conditions.
- If the compact version of the device is insulated at low temperatures, the insulation must also include the device neck.
- Protect the display against impact.
- Protect the display from abrasion, e.g. caused by sand in desert areas.

Display guard available as an accessory → 103.

Temperature tables

Observe the interdependencies between the permitted ambient and fluid temperatures when operating the device in hazardous areas.

For detailed information on the temperature tables, see the separate document entitled "Safety Instructions" (XA) for the device.

Storage temperature

The storage temperature corresponds to the operating temperature range of the transmitter and the sensor → 45.

- Protect the measuring device against direct sunlight during storage in order to avoid unacceptably high surface temperatures.
- Select a storage location where moisture cannot collect in the measuring device as fungus or bacteria infestation can damage the liner.
- If protection caps or protective covers are mounted these should never be removed before installing the measuring device.

Atmosphere

If a plastic transmitter housing is permanently exposed to certain steam and air mixtures, this can damage the housing.

In cases of doubt, please contact the Sales Center.

Degree of protection

Transmitter

- IP66/67, type 4X enclosure
- When housing is open: IP20, type 1 enclosure
- Display module: IP20, type 1 enclosure

Sensor

Compact and remote version

IP66/67, type 4X enclosure

Optionally available for compact and remote version:

Order code for "Sensor option", option CA, C3
- IP66/67, type 4X enclosure
- Fully welded, with protective coating as per EN ISO 12944 C5-M
- For the operation of the device in corrosive environments

Optionally available for remote version:

Order code for "Sensor option", option CB, CC
- IP68, type 6P enclosure
- Fully welded, with protective coating as per EN ISO 12944 C5-M/Im1 and EN 60529
- For the operation of the device under water
- Operating duration at a maximum depth of:
  - 3 m (10 ft): permanent use
  - 10 m (30 ft): maximum 48 hours

Order code for "Sensor option", option CQ
- IP68, type 6P, temporarily waterproof
- Sensor with aluminum half-shell housing
- For the temporary operation of the device under non-corrosive water
- Operating duration at a maximum depth of:
  3 m (10 ft): maximum 168 hours

Order code for "Sensor option", option CD, CE
- IP68, type 6P enclosure
- Fully welded, with protective coating as per EN ISO 12944 Im2/Im3 and EN 60529
- For the operation of the device in buried applications
- For the operation of the device under water and in saline water
- Operating duration at a maximum depth of:
  - 3 m (10 ft): permanent use
  - 10 m (30 ft): maximum 48 hours

Vibration- and shock-resistance

Sinusoidal vibration according to IEC 60068-2-6

Compact version; order code for "Housing", option A "Compact, aluminum, coated"
- 2 to 8.4 Hz, 3.5 mm peak
- 8.4 to 2 000 Hz, 1 g peak

Compact version; order code for "Housing", option M "Compact, polycarbonate"
- 2 to 8.4 Hz, 7.5 mm peak
- 8.4 to 2 000 Hz, 2 g peak

Remote version; order code for "Housing", option N "Remote, polycarbonate" and option P "Remote, aluminum, coated"
- 2 to 8.4 Hz, 7.5 mm peak
- 8.4 to 2 000 Hz, 2 g peak

Vibration broad-band random, according to IEC 60068-2-64

Compact version; order code for "Housing", option A "Compact, aluminum, coated"
- 10 to 200 Hz, 0.003 g^2/Hz
- 200 to 2 000 Hz, 0.001 g^2/Hz
- Total: 1.54 g rms

Compact version; order code for "Housing", option M "Compact, polycarbonate"
- 10 to 200 Hz, 0.01 g^2/Hz
- 200 to 2 000 Hz, 0.003 g^2/Hz
- Total: 2.70 g rms

Remote version; order code for "Housing", option N "Remote, polycarbonate" and option P "Remote, aluminum, coated"
- 10 to 200 Hz, 0.01 g^2/Hz
- 200 to 2 000 Hz, 0.003 g^2/Hz
- Total: 2.70 g rms

Shock half-sine, according to IEC 60068-2-27

- Compact version; order code for "Housing", option A "Compact, aluminum, coated"
  6 ms 30 g
- Compact version; order code for "Housing", option M "Compact, polycarbonate"
  6 ms 50 g
- Remote version; order code for "Housing", option N "Remote, polycarbonate" and option P "Remote, aluminum, coated"
  6 ms 50 g

Rough handling shocks according to IEC 60068-2-31

Mechanical load

- Protect the transmitter housing against mechanical effects, such as shock or impact; the use of the remote version is sometimes preferable.
- Never use the transmitter housing as a ladder or climbing aid.

Electromagnetic compatibility (EMC)

- As per IEC/EN 61326 and NAMUR Recommendation 21 (NE 21)
- Complies with emission limits for industry as per EN 55011 (Class A)
- Device version with PROFIBUS DP: Complies with emission limits for industry as per EN 50170 Volume 2, IEC 61784

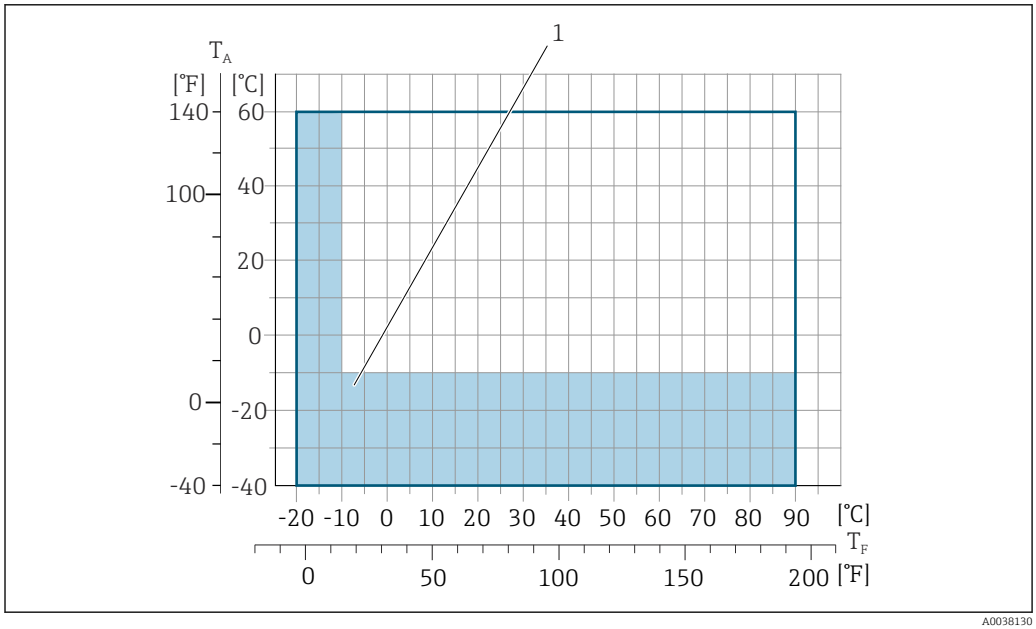
The following applies for PROFIBUS DP: If baud rates > 1.5 MBaud, an EMC cable entry must be used and the cable shield must continue as far as the terminal wherever possible.

Details are provided in the Declaration of Conformity.

Process

Medium temperature range

- ~~0 to +80 °C (+32 to +176 °F) for hard rubber, DN 50 to 3000 (2 to 120")~~
- ~~–20 to +50 °C (–4 to +122 °F) for polyurethane, DN 25 to 1200 (1 to 48")~~
- –20 to +90 °C (–4 to +194 °F) for PTFE, DN 25 to 300 (1 to 12")



T_A *Ambient temperature*
T_F *Medium temperature*
1 *Colored area: The ambient temperature range of –10 to –40 °C (+14 to –40 °F) and the medium temperature range of –10 to –20 °C (+14 to –4 °F) only apply for stainless flanges*

The permitted fluid temperature in custody transfer is 0 to +50 °C (+32 to +122 °F).

Conductivity

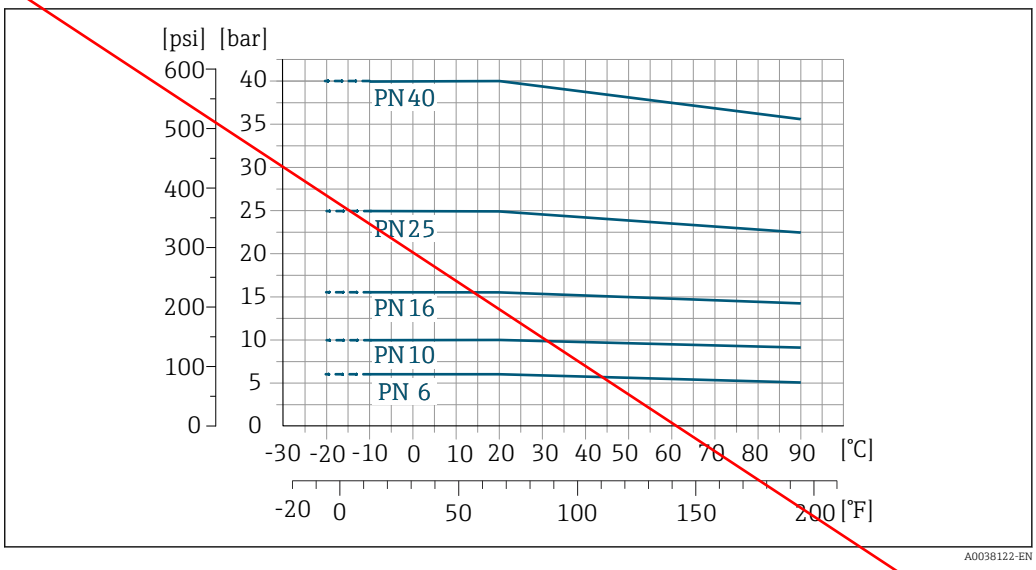
≥5 µS/cm for liquids in general.

- Note that in the case of the remote version, the requisite minimum conductivity additionally depends on the length of the connecting cable → 43.
- Maximum measured error for electrical conductivity → 35.

Pressure/temperature ratings

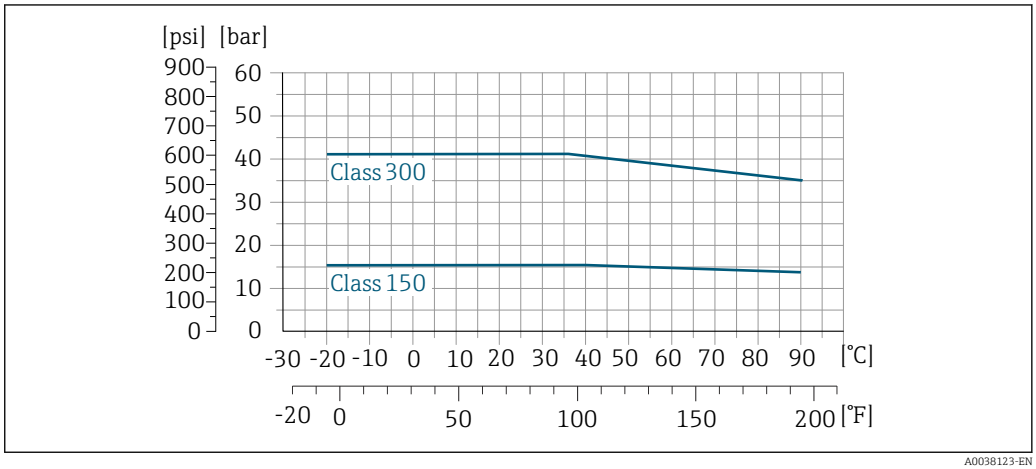
The following pressure/temperature diagrams apply to all pressure-bearing parts of the device and not just the process connection. The diagrams show the maximum permissible medium pressure depending on the specific medium temperature.

Process connection: fixed flange according to EN 1092-1 (DIN 2501)

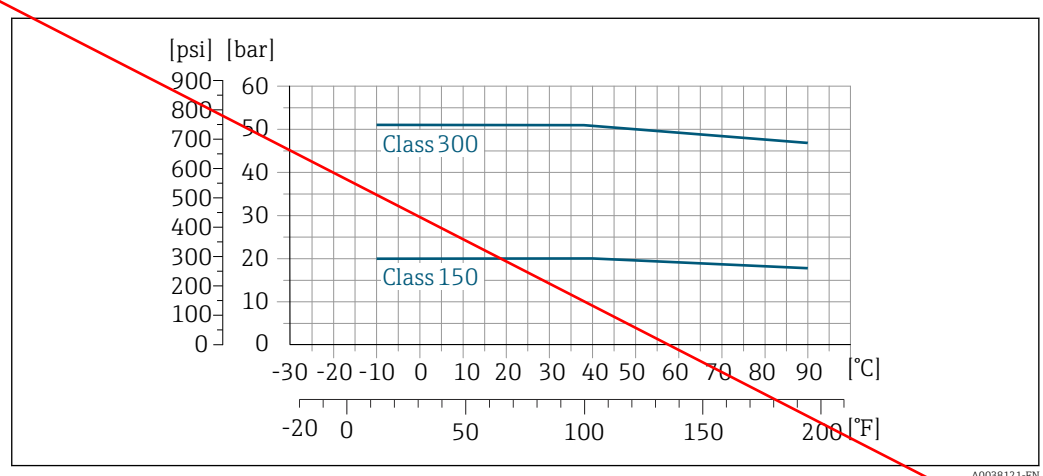


20 *Process connection material: stainless steel (−20 °C (−4 °F)); carbon steel (−10 °C (14 °F))*

Process connection: fixed flange according to ASME B16.5

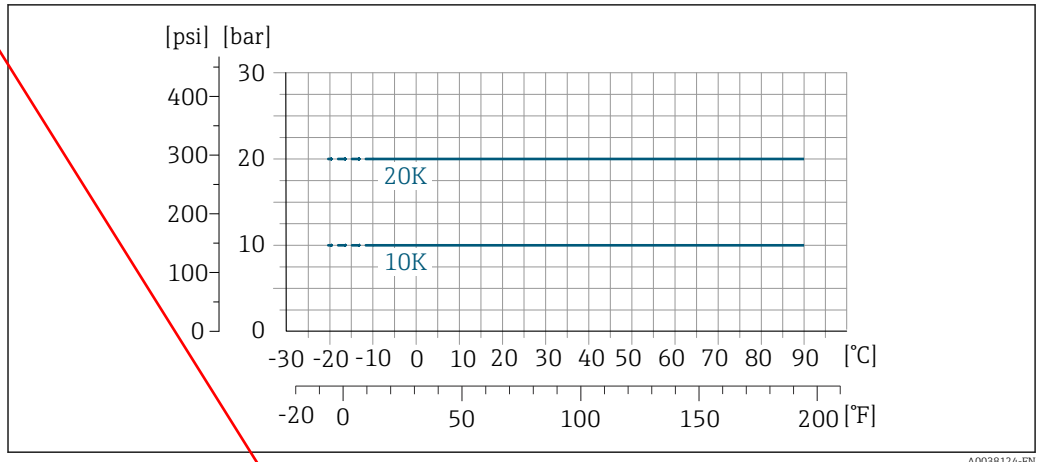


21 *Process connection material: stainless steel*



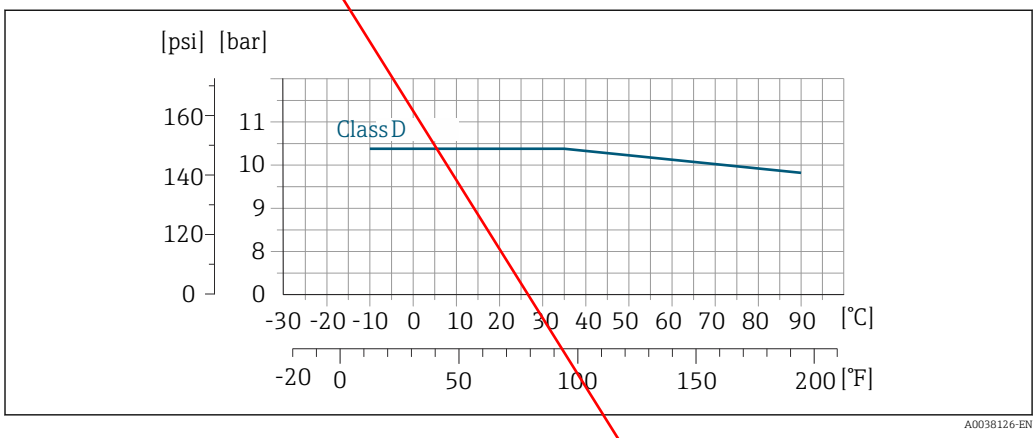
22 *Process connection material: carbon steel*

Process connection: fixed flange according to JIS B2220



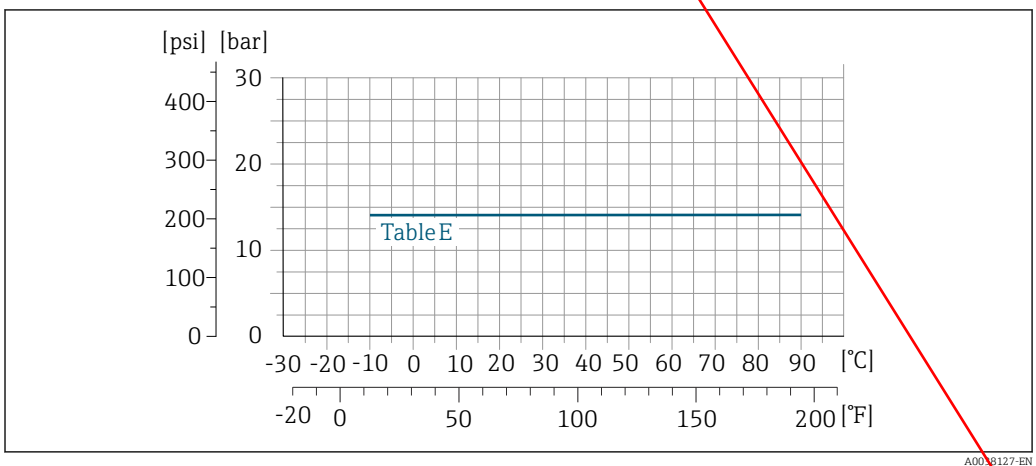
23 Process connection material: stainless steel (−20 °C (−4 °F)); carbon steel (−10 °C (14 °F))

Process connection: fixed flange according to AWWA C207



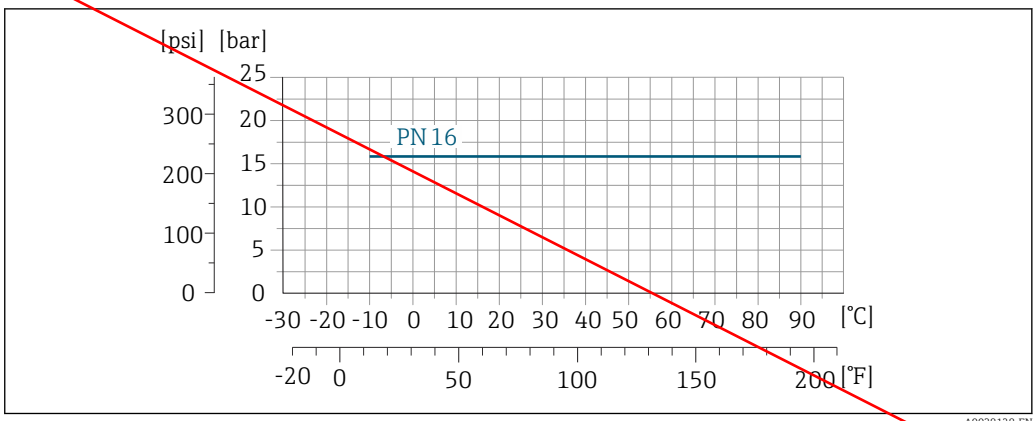
24 Process connection material: carbon steel

Process connection: fixed flange according to AS 2129



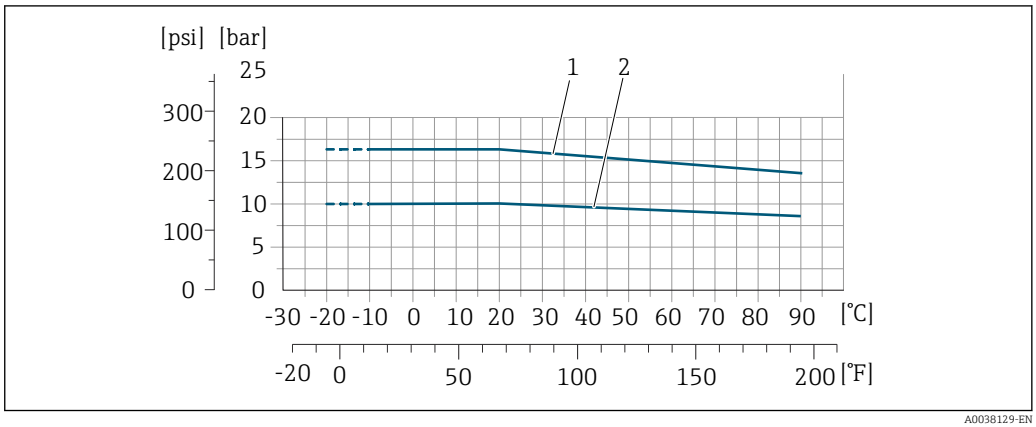
25 Process connection material: carbon steel

Process connection: fixed flange according to AS 4087



26 *Process connection material: carbon steel*

Process connection: lap joint flange/lap joint flange, stamped plate according to EN 1092-1 (DIN 2501) and ASME B16.5; DN 25 to 300 (1 to 12")



27 *Process connection material: stainless steel (−20 °C (−4 °F)); carbon steel (−10 °C (14 °F))*

1 *Lap joint flange PN16/ Class150*
2 *Lap joint flange, stamped plate PN10, lap joint flange PN10*

Pressure tightness

Liner: hard rubber

Nominal diameter		Limit values for absolute pressure in [mbar] ([psi]) for medium temperatures:		
[mm]	[in]	+25 °C (+77 °F)	+50 °C (+122 °F)	+80 °C (+176 °F)
50 … 3000	2 … 120	0 (0)	0 (0)	0 (0)

Liner: polyurethane

Nominal diameter		Limit values for absolute pressure in [mbar] ([psi]) for medium temperatures:	
[mm]	[in]	+25 °C (+77 °F)	+50 °C (+122 °F)
25 … 1200	1 … 48	0 (0)	0 (0)

Liner: PTFE

Nominal diameter		Limit values for absolute pressure in [mbar] ([psi]) for medium temperatures:	
[mm]	[in]	+25 °C (+77 °F)	+90 °C (+194 °F)
25	1	0 (0)	0 (0)
40	2	0 (0)	0 (0)

Nominal diameter		Limit values for absolute pressure in [mbar] ([psi]) for medium temperatures:	
[mm]	[in]	+25 °C (+77 °F)	+90 °C (+194 °F)
50	2	0 (0)	0 (0)
65	2 ½	0 (0)	40 (0.58)
80	3	0 (0)	40 (0.58)
100	4	0 (0)	135 (2.0)
125	5	135 (2.0)	240 (3.5)
150	6	135 (2.0)	240 (3.5)
200	8	200 (2.9)	290 (4.2)
250	10	330 (4.8)	400 (5.8)
300	12	400 (5.8)	500 (7.3)

Flow limit

The diameter of the pipe and the flow rate determine the nominal diameter of the sensor. The optimum velocity of flow is between 2 to 3 m/s (6.56 to 9.84 ft/s). Also match the velocity of flow (v) to the physical properties of the medium:

- v < 2 m/s (6.56 ft/s): for abrasive media (e.g. potter's clay, lime milk, ore slurry)
- v > 2 m/s (6.56 ft/s): for media producing buildup (e.g. wastewater sludge)

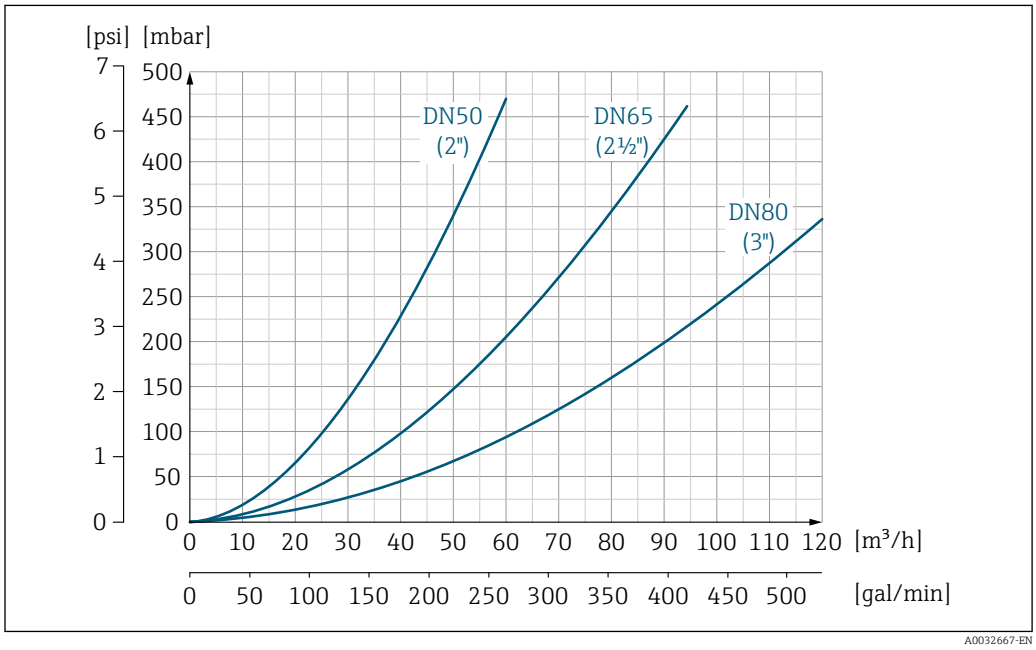
A necessary increase in the flow velocity can be achieved by reducing the sensor nominal diameter.

For an overview of the full scale values for the measuring range, see the "Measuring range" section → 8

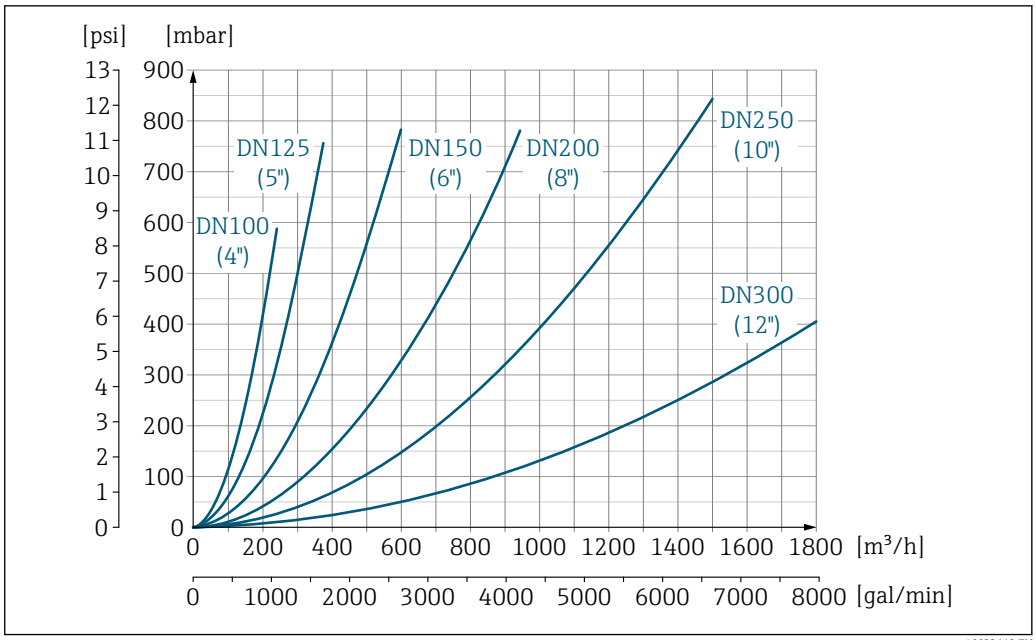
For custody transfer, the applicable approval determines the permitted measuring range.

Pressure loss

- No pressure loss occurs if the sensor is installed in a pipe with the same nominal diameter.
- Pressure losses for configurations incorporating adapters according to DIN EN 545 → 42



28 *Pressure loss DN 50 to 80 (2 to 3") for order code for "Design", option C "Fixed flange, constricted measuring tube", 0 x DN inlet/outlet runs"*



29 *Pressure loss DN 100 to 300 (4 to 12") for order code for "Design", option C "Fixed flange, constricted measuring tube", 0 x DN inlet/outlet runs"*

System pressure	Installation near pumps → 38
Vibrations	Installation in event of pipe vibrations → 39

Custody transfer mode

The measuring device is optionally tested in accordance with OIML R49 and has an EU type-examination certificate according to Measuring Instruments Directive 2014/32/EU for service subject to legal metrological control ("custody transfer") for cold water (Annex III).

The permitted medium temperature in these applications is 0 to +50 °C (+32 to +122 °F).

The device is used with a legally controlled totalizer on the local display and optionally with legally controlled outputs.

Measuring devices subject to legal metrological control totalize in both directions, i.e. all the outputs consider flow components in the positive (forward) and negative (reverse) flow direction.

Generally a measuring device subject to legal metrological control is secured against tampering by seals on the transmitter or sensor. These seals may normally only be opened by a representative of the competent authority for legal metrology controls.

After putting the device into circulation or after sealing the device, operation is only possible to a limited extent.

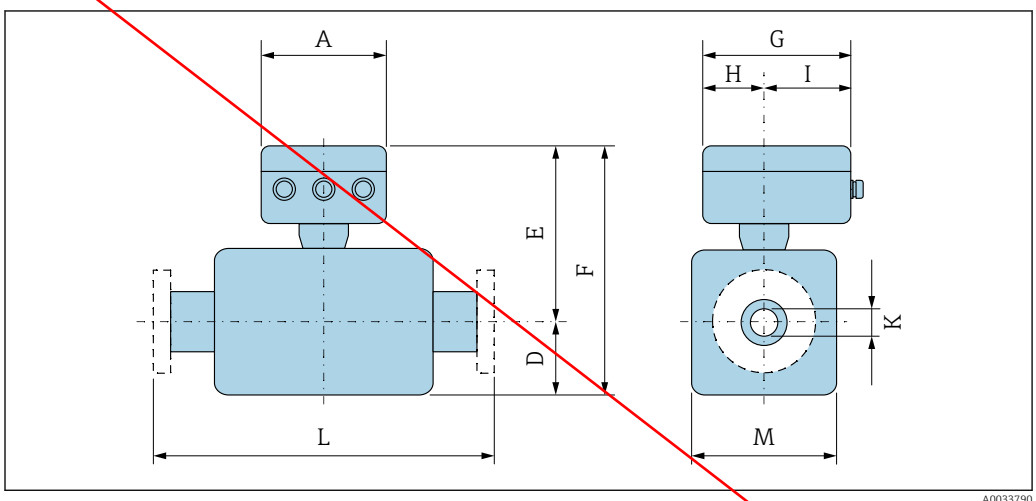
Detailed ordering information is available from your local Endress+Hauser sales center for national approvals (outside Europe) as cold water meters based on OIML R49.

Mechanical construction

Dimensions in SI units

Compact version

Order code for "Housing", option A "Compact, aluminum, coated" or option M "Compact, polycarbonate"



A0033790

A [mm]	G [1] [mm]	H [mm]	I [1] [mm]
167	193	90	103

1) Depending on the cable gland used: values up to + 30 mm

DN 25 to 300 mm (1 to 12 in): Sensor with aluminum half-shell housing

DN		Order code for "Design"								K	L
		Options D, E, H, I				Option C					
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]		
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
25	1	84	201	285	120	–	–	–	–	[2]	200
32	–	84	201	285	120	–	–	–	–	[2]	200
40	1 ½	84	201	285	120	–	–	–	–	[2]	200
50	2	84	201	285	120	84	201	285	120	[2]	200
65	–	109	226	335	180	84	201	285	120	[2]	200
80	3	109	226	335	180	84	201	285	120	[2]	200
100	4	109	226	335	180	109	226	335	180	[2]	250
125	–	150	266	416	260	109	226	335	180	[2]	250
150	6	150	266	416	260	109	226	335	180	[2]	300
200	8	180	291	471	324	150	266	416	260	[2]	350
250	10	205	316	521	400	150	266	416	260	[2]	450
300	12	230	341	571	460	180	291	471	324	[2]	500

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 90

DN 350 to 400 mm (14 to 16 in)

DN		Order code for "Design" Options E, I				K	L
		D [1]	E [1]	F [1]	M [1]		
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
350	14	282	379	679	564	[2]	550
375	15	308	423	731	616	[2]	600
400	16	308	423	731	616	[2]	600

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 90

DN 450 to 900 mm (18 to 36 in)

DN		Order code for "Design"								K	L	
		Options F, J				Options G, K						
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]			
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	
450	18	290	405	695	580	333	448	781	666	[2]	600 [3]	650 [4]
500	20	315	430	745	630	359	474	833	717	[2]	600 [3]	650 [4]
600	24	365	480	845	730	411	526	937	821	[2]	600 [3]	780 [4]
700	28	426	541	967	851	512	627	1139	1024	[2]	700 [3]	910 [4]
750	30	463	578	1041	926	512	627	1139	1024	[2]	750 [3]	975 [4]

DN		Order code for "Design"								K	L	
		Options F, J				Options G, K						
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]			
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	
800	32	482	597	1079	964	534	649	1183	1065	[2]	800 [3]	1040 [4]
900	36	532	647	1179	1064	610	725	1335	1218	[2]	900 [3]	1170 [4]

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 🖹 90
3) Order code for "Design", option F "Fixed flange, short installed length" and option J "Fixed flange, short installed length, 0 x DN inlet/outlet runs"
4) Order code for "Design", option G "Fixed flange, long installed length" and option K "Fixed flange, long installed length 0 x DN inlet/outlet runs"

DN 1000 to 2000 mm (40 to 78 in)

DN		Order code for "Design" Options F, G, J, K				K	L	
		D [1]	E [1]	F [1]	M [1]			
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	
1000	40	582	697	1279	1164	[2]	1000 [3]	1300 [4]
–	42	618	733	1351	1236	[2]	1050 [3]	1365 [4]
1200	48	696	811	1507	1392	[2]	1200 [3]	1560 [4]
–	54	809	924	1733	1617	[2]	1350 [3]	1755 [4]
1400	–	809	924	1733	1617	[2]	1400 [3]	1820 [4]
–	60	909	1024	1933	1817	[2]	1500 [3]	1950 [4]
1600	–	909	1024	1933	1817	[2]	1600 [3]	2080 [4]
–	66	960	1075	2035	1919	[2]	1650 [3]	2145 [4]
1800	72	1016	1131	2147	2032	[2]	1800 [3]	2340 [4]
–	78	1127	1242	2369	2254	[2]	2000 [3]	2600 [4]
2000	–	1127	1242	2369	2254	[2]	2000 [3]	2600 [4]

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 🖹 90
3) Order code for "Design", option F "Fixed flange, short installed length" and option J "Fixed flange, short installed length, 0 x DN inlet/outlet runs"
4) Order code for "Design", option G "Fixed flange, long installed length" and option K "Fixed flange, long installed length 0 x DN inlet/outlet runs"

DN 2200 to 3000 mm (84 to 120 in)

DN		Order code for "Design" Option F, J				K	L
		D [1]	E [1]	F [1]	M [1]		
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
–	84	1227	1342	2569	2454	[2]	2200
2200	–	1227	1342	2569	2454	[2]	2200
–	90	1332	1447	2779	2664	[2]	2400
2400	–	1332	1447	2783	2664	[2]	2400
–	96	1431	1546	2977	2861	[2]	2450

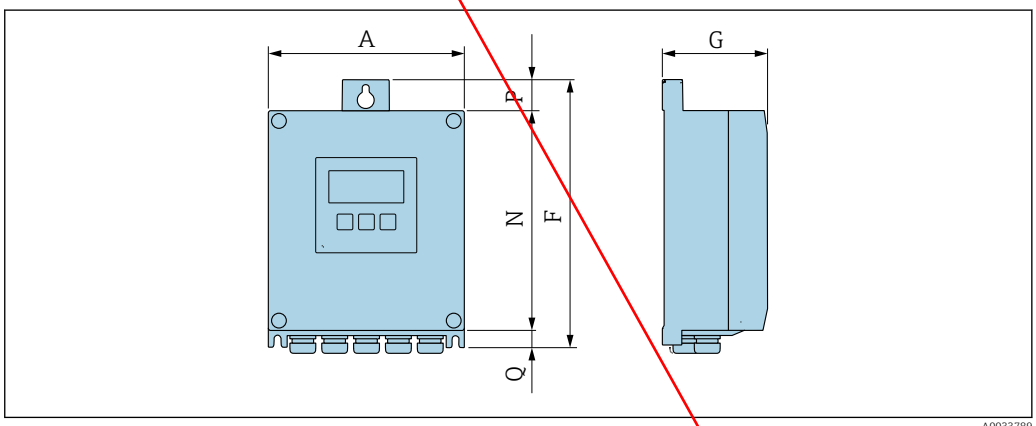
DN		Order code for "Design" Option F, J					
		D [1]	E [1]	F [1]	M [1]	K	L
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
–	102	1516	1631	3147	3032	[2]	2600
2600	–	1442	1557	2999	2883	[2]	2600
–	108	1602	1718	3320	3204	[2]	2750
2800	–	1547	1662	3209	3093	[2]	2800
–	114	1688	1803	3491	3375	[2]	2900
3000	–	1647	1762	3409	3293	[2]	3000
–	120	1774	1889	3663	3547	[2]	3050

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 90

Remote version

Transmitter remote version

Order code for "Housing", option N "Remote, polycarbonate" or option P "Remote, aluminum coated"



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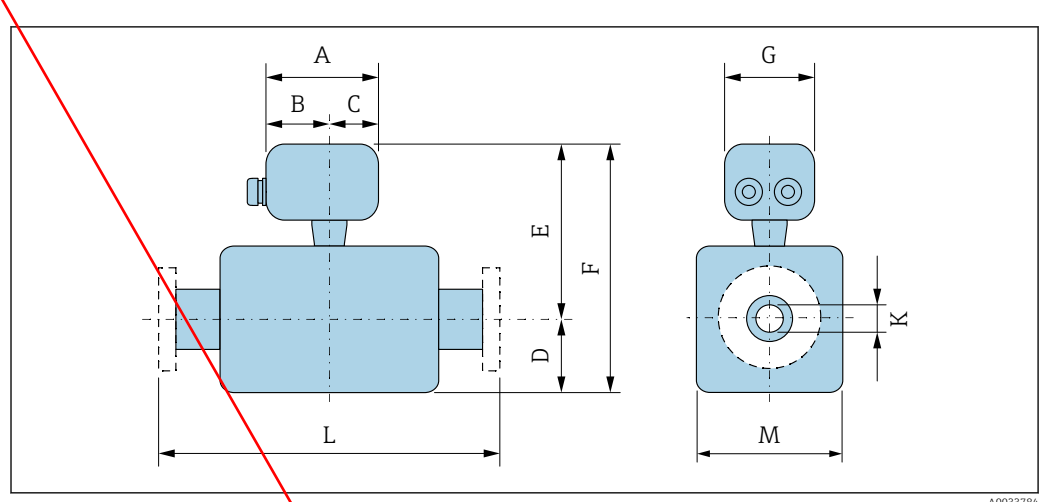
Order code for "Transmitter housing", option P "Remote, aluminum, coated"

A [mm]	F [mm]	G [mm]	N [mm]	P [mm]	Q [mm]
167	232	80	187	24	21

Order code for "Transmitter housing", option N "Remote, polycarbonate"

A [mm]	F [mm]	G [mm]	N [mm]	P [mm]	Q [mm]
177	234	90	197	17	22

Sensor connection housing



Aluminum, coated

A [mm]	B [mm]	C [mm]	G [mm]
148	94	54	136

Polycarbonate (only in conjunction with order code for "Sensor option", options CA...CE)

A [mm]	B [mm]	C [mm]	G [mm]
113	62	51	112

DN 25 to 300 mm (1 to 12 in): Sensor with aluminum half-shell housing

DN		Order code for "Design"									
		Options D, E, H, I				Option C					
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]	K	L
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
25	1	84	200	284	120	–	–	–	–	[2]	200
32	–	84	200	284	120	–	–	–	–	[2]	200
40	1 ½	84	200	284	120	–	–	–	–	[2]	200
50	2	84	200	284	120	84	200	284	120	[2]	200
65	–	109	225	334	180	84	200	284	120	[2]	200
80	3	109	225	334	180	84	200	284	120	[2]	200
100	4	109	225	334	180	109	225	334	180	[2]	250
125	–	150	265	415	260	109	225	334	180	[2]	250
150	6	150	265	415	260	109	225	334	180	[2]	300
200	8	180	290	470	324	150	265	415	260	[2]	350
250	10	205	315	520	400	150	265	415	260	[2]	450
300	12	230	340	570	460	180	290	470	324	[2]	500

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 90

DN 25 to 300 mm (1 to 12 in): Sensor with fully welded carbon steel housing

DN		Order code for "Design"									
		Option E				Option C					
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]	K	L
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
25	1	70	200	270	140	–	–	–	–	[2]	200
32	–	70	200	270	140	–	–	–	–	[2]	200
40	1 ½	70	200	270	140	–	–	–	–	[2]	200
50	2	70	200	270	140	70	200	270	140	[2]	200
65	–	82	225	307	165	70	200	270	140	[2]	200
80	3	87	225	312	175	70	200	270	140	[2]	200
100	4	100	225	325	200	82	225	307	165	[2]	250
125	–	113	265	378	226	87	225	312	175	[2]	250
150	6	134	265	399	269	100	225	325	200	[2]	300
200	8	160	290	450	320	113	265	378	226	[2]	350
250	10	193	315	508	387	134	265	399	269	[2]	450
300	12	218	340	558	437	160	290	450	320	[2]	500

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 90

DN 350 to 400 mm (14 to 16 in)

DN		Order code for "Design" Options E, I					
		D [1]	E [1]	F [1]	M [1]	K	L
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
350	14	282	379	679	564	[2]	550
375	15	308	423	731	616	[2]	550
400	16	308	423	731	616	[2]	600

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 90

DN 450 to 900 mm (18 to 36 in)

DN		Order code for "Design"										
		Options F, J				Options G, K						
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]	K	L	
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	
450	18	290	405	695	580	333	448	781	666	[2]	600 [3]	650 [4]
500	20	315	430	745	630	359	474	833	717	[2]	600 [3]	650 [4]
600	24	365	480	845	730	411	526	937	821	[2]	600 [3]	780 [4]
700	28	426	541	967	851	512	627	1139	1024	[2]	700 [3]	910 [4]
750	30	463	578	1041	926	512	627	1139	1024	[2]	750 [3]	975 [4]

DN		Order code for "Design"								K	L	
		Options F, J				Options G, K						
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]			
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	
800	32	482	597	1079	964	534	649	1183	1065	[2]	800 [3]	1040 [4]
900	36	532	647	1179	1064	610	725	1335	1218	[2]	900 [3]	1170 [4]

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 🖹 90
3) Order code for "Design", option F "Fixed flange, short installed length" and option J "Fixed flange, short installed length, 0 x DN inlet/outlet runs"
4) Order code for "Design", option G "Fixed flange, long installed length" and option K "Fixed flange, long installed length 0 x DN inlet/outlet runs"

DN 1000 to 2000 mm (40 to 78 in)

DN		Order code for "Design" Options F, G, J, K				K	L	
		D [1]	E [1]	F [1]	M [1]			
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	
1000	40	582	697	1279	1164	[2]	1000 [3]	1300 [4]
–	42	618	733	1351	1236	[2]	1050 [3]	1365 [4]
1200	48	696	811	1507	1392	[2]	1200 [3]	1560 [4]
–	54	809	924	1733	1617	[2]	1350 [3]	1755 [4]
1400	–	809	924	1733	1617	[2]	1400 [3]	1820 [4]
–	60	909	1024	1933	1817	[2]	1500 [3]	1950 [4]
1600	–	909	1024	1933	1817	[2]	1600 [3]	2080 [4]
–	66	960	1075	2035	1919	[2]	1650 [3]	2145 [4]
1800	72	1016	1131	2147	2032	[2]	1800 [3]	2340 [4]
–	78	1127	1242	2369	2254	[2]	2000 [3]	2600 [4]
2000	–	1127	1242	2369	2254	[2]	2000 [3]	2600 [4]

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Internal diameter depends on the liner, see the measuring tube specification → 🖹 90
3) Order code for "Design", option F "Fixed flange, short installed length" and option J "Fixed flange, short installed length, 0 x DN inlet/outlet runs"
4) Order code for "Design", option G "Fixed flange, long installed length" and option K "Fixed flange, long installed length 0 x DN inlet/outlet runs"

DN 2200 to 3000 mm (84 to 120 in)

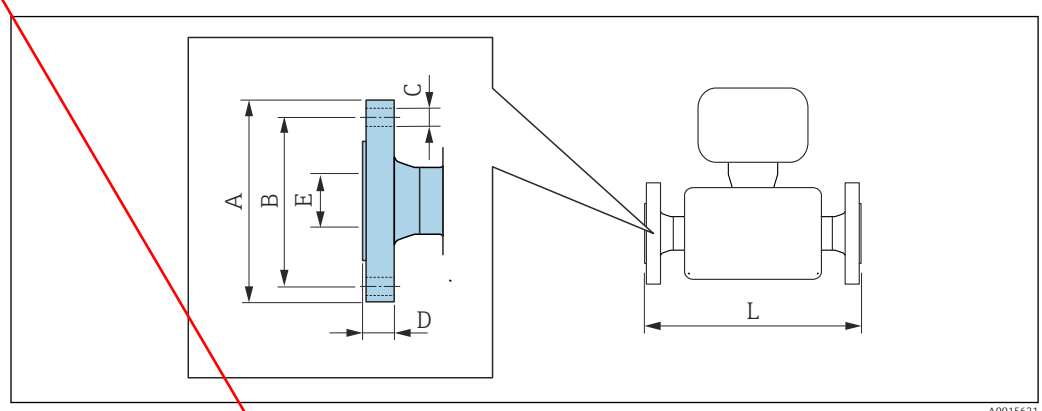
DN		Order code for "Design" Option F, J				K	L
		D [1]	E [1]	F [1]	M [1]		
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
–	84	1227	1342	2569	2454	[2]	2200
2200	–	1227	1342	2569	2454	[2]	2200
–	90	1332	1447	2779	2664	[2]	2400
2400	–	1332	1447	2783	2664	[2]	2400
–	96	1431	1546	2977	2861	[2]	2450

DN		Order code for "Design" Option F, J				K	L
		D [1]	E [1]	F [1]	M [1]		
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
–	102	1516	1631	3147	3032	[2]	2600
2600	–	1442	1557	2999	2883	[2]	2600
–	108	1602	1718	3320	3204	[2]	2750
2800	–	1547	1662	3209	3093	[2]	2800
–	114	1688	1803	3491	3375	[2]	2900
3000	–	1647	1762	3409	3293	[2]	3000
–	120	1774	1889	3663	3547	[2]	3050

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Internal diameter depends on the liner, see the measuring tube specification → 🖹 90

Flange connections

Fixed flange



A0015621

Flange in accordance with EN 1092-1 (DIN 2501 / DIN 2512N): PN 6 **Carbon steel:** *order code for "Process connection", option* **D1K** **Stainless steel:** *order code for "Process connection", option* **D1S**						
DN **[mm]**	**A** **[mm]**	**B** **[mm]**	**C** **[mm]**	**D** **[mm]**	**E** **[mm]**	**L** **[mm]**
350	490	445	12 × Ø22	22	1)	2)
400	540	495	16 × Ø22	22		
450	595	565	20 × Ø26	26		
500	645	600	20 × Ø22	24		
600	755	705	20 × Ø26	30		
700	860	810	24 × Ø26	30		
800	975	920	24 × Ø30	30		
900	1075	1020	24 × Ø30	34		
1000	1175	1120	28 × Ø30	38		
1200	1405	1340	32 × Ø33	42		
1400	1630	1560	36 × Ø36	56		
1600	1830	1760	40 × Ø36	63		
1800	2045	1970	44 × Ø39	69		
2000	2265	2180	48 × Ø42	74		
2200	2475	2390	52 × Ø42	81		
2400	2685	2600	56 × Ø42	87		
2600	2905	2810	60 × Ø48	91		
2800	3115	3020	64 × Ø48	101		
3000	3315	3220	68 × Ø48	102		
Surface roughness (flange): EN 1092-1 Form B1 (DIN 2526 Form C), Ra 6.3 to 12.5 µm						

1) Depends on the liner → 🖹 90
2) Total installed length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Flange in accordance with EN 1092-1 (DIN 2501 / DIN 2512N): PN 10
Carbon steel: *order code for "Process connection", option* **D2K**
Stainless steel: *order code for "Process connection", option* **D2S**

DN [mm]	A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	L [mm]
200	340	295	8 × Ø22	26	1)	2)
250	395	350	12 × Ø22	28		
300	445	400	12 × Ø22	28		
350	505	460	16 × Ø22	26		
400	565	515	16 × Ø26	26		
450	615	565	20 × Ø26	26		
500	670	620	20 × Ø26	28		
600	780	725	20 × Ø30	30		
700	895	840	24 × Ø30	35		
800	1015	950	24 × Ø33	38		
900	1115	1050	28 × Ø33	38		
1000	1230	1160	28 × Ø36	44		
1200	1455	1380	32 × Ø39	55		
1400	1675	1590	36 × Ø42	65		
1600	1915	1820	40 × Ø48	75		
1800	2115	2020	44 × Ø48	85		
2000	2325	2230	48 × Ø48	90		
2200	2550	2440	52 × Ø56	100		
2400	2760	2650	56 × Ø56	110		
2600	2960	2850	60 × Ø56	110		
2800	3180	3070	64 × Ø56	124		
3000	3405	3290	68 × Ø62	132		

Surface roughness (flange): EN 1092-1 Form B1 (DIN 2526 Form C), Ra 6.3 to 12.5 µm

1) Depends on the liner → 🖹 90
2) Total installed length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Flange in accordance with EN 1092-1 (DIN 2501 / DIN 2512N): PN 16
Carbon steel: *order code for "Process connection", option* **D3K**
Stainless steel: *order code for "Process connection", option* **D3S**

DN [mm]	A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	L [mm]
65	185	145	8 × Ø18	20	1)	2)
80	200	160	8 × Ø18	20		
100	220	180	8 × Ø18	22		
125	250	210	8 × Ø18	24		
150	285	240	8 × Ø22	24		
200	340	295	12 × Ø22	26		
250	405	355	12 × Ø26	32		
300	460	410	12 × Ø26	32		

Flange in accordance with EN 1092-1 (DIN 2501 / DIN 2512N): PN 16 **Carbon steel:** *order code for "Process connection", option* **D3K** **Stainless steel:** *order code for "Process connection", option* **D3S**						
DN [mm]	**A [mm]**	**B [mm]**	**C [mm]**	**D [mm]**	**E [mm]**	**L [mm]**
350	520	470	16 × Ø26	30		
400	580	525	16 × Ø30	32		
450	640	585	20 × Ø30	34		
500	715	650	20 × Ø33	36		
600	840	770	20 × Ø36	40		
700	910	840	24 × Ø36	40		
800	1025	950	24 × Ø39	41		
900	1125	1050	28 × Ø39	48		
1000	1255	1170	28 × Ø42	59		
1200	1485	1390	32 × Ø48	78		
1400	1685	1590	36 × Ø48	84		
1600	1930	1820	40 × Ø56	102		
1800	2130	2020	44 × Ø56	110		
2000	2345	2230	48 × Ø62	124		
Surface roughness (flange): EN 1092-1 Form B1 (DIN 2526 Form C), Ra 6.3 to 12.5 µm						

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Flange in accordance with EN 1092-1 (DIN 2501 / DIN 2512N): PN 25 **Carbon steel:** *order code for "Process connection", option* **D4K** **Stainless steel:** *order code for "Process connection", option* **D4S**						
DN [mm]	**A [mm]**	**B [mm]**	**C [mm]**	**D [mm]**	**E [mm]**	**L [mm]**
200	360	310	12 × Ø26	32	1)	2)
250	425	370	12 × Ø30	36		
300	485	430	16 × Ø30	40		
350	555	490	16 × Ø33	38		
400	620	550	16 × Ø36	40		
450	670	600	20 × Ø36	46		
500	730	660	20 × Ø36	48		
600	845	770	20 × Ø39	48		
700	960	875	24 × Ø42	50		
800	1085	990	24 × Ø48	53		
900	1185	1090	28 × Ø48	57		
1000	1320	1210	28 × Ø56	63		
Surface roughness (flange): EN 1092-1 Form B1 (DIN 2526 Form C), Ra 6.3 to 12.5 µm						

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Flange in accordance with EN 1092-1 (DIN 2501 / DIN 2512N): PN 40
Carbon steel: *order code for "Process connection", option* **D5K**
Stainless steel: *order code for "Process connection", option* **D5S**

DN [mm]	A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	L [mm]
25	115	85	4 × Ø14	16	1)	2)
32	140	100	4 × Ø18	18		
40	150	110	4 × Ø18	18		
50	165	125	4 × Ø18	20		
65	185	145	8 × Ø18	24		
80	200	160	8 × Ø18	26		
100	235	190	8 × Ø22	26		
125	270	220	8 × Ø26	28		
150	300	250	8 × Ø26	30		
Surface roughness (flange): EN 1092-1 Form B1 (DIN 2526 Form C), Ra 6.3 to 12.5 µm						

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Flange according to ASME B16.5, Class 150
Carbon steel: *order code for "Process connection", option* **A1K**
Stainless steel: *order code for "Process connection", option* **A1S**

DN		A	B	C	D	E	L
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
25	1	108	79.2	4 × Ø16	12.6	1)	2)
40	1 ½	127	98.6	4 × Ø16	15.9		
50	2	152.4	120.7	4 × Ø19.1	17.5		
80	3	190.5	152.4	4 × Ø19.1	22.3		
100	4	228.6	190.5	8 × Ø19.1	22.3		
150	6	279.4	241.3	8 × Ø22.4	23.8		
200	8	342.9	298.5	8 × Ø22.4	26.8		
250	10	406.4	362	12 × Ø25.4	29.6		
300	12	482.6	431.8	12 × Ø25.4	30.2		
350	14	535	476.3	12 × Ø28.6	35.4		
400	16	595	539.8	16 × Ø28.6	37		
450	18	635	577.9	16 × Ø31.8	40.1		
500	20	700	635	20 × Ø31.8	43.3		
600	24	815	749.3	20 × Ø34.9	48.1		
Surface roughness (flange): Ra 6.3 to 12.5 µm							

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Flange according to ASME B16.5, Class 300
Carbon steel: *order code for "Process connection", option* **A2K**
Stainless steel: *order code for "Process connection", option* **A2S**

DN		A	B	C	D	E	L
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
25	1	123.9	88.9	4 × Ø19.1	15.9	1)	2)
40	1 ½	155.4	114.3	4 × Ø22.4	19		
50	2	165.1	127	8 × Ø19.1	20.8		
80	3	209.6	168.1	8 × Ø22.4	26.8		
100	4	254	200.2	8 × Ø22.4	30.2		
150	6	317.5	269.7	12 × Ø22.4	35		
Surface roughness (flange): Ra 6.3 to 12.5 µm							

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Flange according to JIS B2220, 10K
Carbon steel: *order code for "Process connection", option* **N3K**
Stainless steel: *order code for "Process connection", option* **N3S**

DN [mm]	A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	L [mm]
50	155	120	4 × Ø19	16	1)	2)
65	175	140	4 × Ø19	18		
80	185	150	8 × Ø19	18		
100	210	175	8 × Ø19	18		
125	250	210	8 × Ø23	20		
150	280	240	8 × Ø23	22		
200	330	290	12 × Ø23	22		
250	400	355	12 × Ø25	24		
300	445	400	16 × Ø25	24		
Surface roughness (flange): Ra 6.3 to 12.5 µm						

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Flange according to JIS B2220, 20K
Carbon steel: *order code for "Process connection", option* **N4K**
Stainless steel: *order code for "Process connection", option* **N4S**

DN [mm]	A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	L [mm]
25	125	90	4 × Ø19	16	1)	2)
32	135	100	4 × Ø19	18		
40	140	105	4 × Ø19	18		
50	155	120	8 × Ø19	18		
65	175	140	8 × Ø19	20		
80	200	160	8 × Ø23	22		
100	225	185	8 × Ø23	24		

Flange according to JIS B2220, 20K
Carbon steel: *order code for "Process connection", option* **N4K**
Stainless steel: *order code for "Process connection", option* **N4S**

DN [mm]	A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	L [mm]
125	270	225	8 × Ø25	26		
150	305	260	12 × Ø25	28		
200	350	305	12 × Ø25	30		
250	430	380	12 × Ø27	34		
300	480	430	16 × Ø27	36		
Surface roughness (flange): Ra 6.3 to 12.5 µm						

1) Depends on the liner → 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Flange according to AWWA, Class D
Order code for "Process connection", option **W1K**

DN [mm]	DN [in]	A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	L [mm]
700	28	927	863.6	28 × Ø35	33.4	1)	2)
750	30	984	914.4	28 × Ø35	35.0		
800	32	1060	977.9	28 × Ø42	38.1		
900	36	1168	1085.9	32 × Ø42	41.3		
1000	40	1289	1200.2	36 × Ø42	41.3		
–	42	1346	1257.3	36 × Ø42	44.5		
1200	48	1511	1422.4	44 × Ø42	47.7		
–	54	1683	1593.9	44 × Ø48	54.0		
–	60	1855	1759.0	52 × Ø48	57.2		
–	66	2032	1930.4	52 × Ø48	63.5		
1800	72	2197	2095.5	60 × Ø48	66.7		
–	78	2362	2260.6	64 × Ø54	69.9		
–	84	2535	2425.7	64 × Ø54	73.1		
–	90	2705	2717.8	68 × Ø60	76.2		
–	96	2877	2755.9	68 × Ø60.3	82.55		
–	102	3048	2908.3	68 × Ø66.7	82.55		
–	108	3219	3067.0	68 × Ø66.7	85.73		
–	114	3391	3219.5	68 × Ø73	88.90		
–	120	3562	3371.8	68 × Ø73	88.90		
Surface roughness (flange): Ra 6.3 to 12.5 µm							

1) Depends on the liner → 🖹 90
2) Total length is independent of the process connections. Installed length according to DVGW → 🖹 54 (compact version) → 🖹 58 (remote version)

Flange according to AS 2129, Tab. E
Order code for "Process connection", option **M2K**

DN [mm]	A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	L [mm]
80	185	146	4 × Ø18	12	1)	2)
100	215	178	8 × Ø18	13		
150	280	235	8 × Ø22	17		
200	335	292	8 × Ø22	19		
250	405	356	12 × Ø22	22		
300	455	406	12 × Ø26	25		
350	525	470	12 × Ø26	30		
400	580	521	12 × Ø26	32		
450	640	584	16 × Ø26	35		
500	705	641	16 × Ø26	38		
600	825	756	16 × Ø33	48		
700	910	845	20 × Ø33	51		
750	995	927	20 × Ø36	54		
800	1060	984	20 × Ø36	54		
900	1175	1092	24 × Ø36	64		
1000	1255	1175	24 × Ø39	67		
1200	1490	1410	32 × Ø39	79		
Surface roughness (flange): Ra 6.3 to 12.5 µm						

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

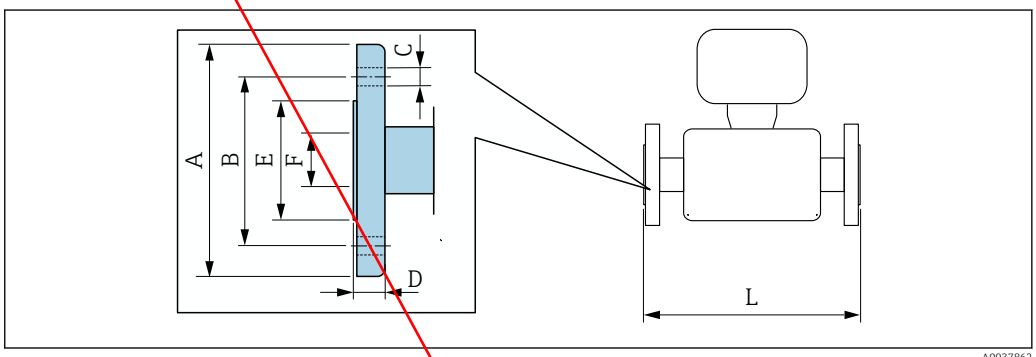
Flange according to AS 4087, PN 16
Order code for "Process connection", option **M3K**

DN [mm]	A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	L [mm]
80	185	146	4 × Ø18	12	1)	2)
100	215	178	4 × Ø18	13		
150	280	235	8 × Ø18	13		
200	335	292	8 × Ø18	19		
250	405	356	8 × Ø22	19		
300	455	406	12 × Ø22	23		
350	525	470	12 × Ø26	30		
375	550	495	12 × Ø26	30		
400	580	521	12 × Ø26	32		
450	640	584	12 × Ø26	30		
500	705	641	16 × Ø26	38		
600	825	756	16 × Ø30	48		
700	910	845	20 × Ø30	56		
750	995	927	20 × Ø33	56		
800	1060	984	20 × Ø36	56		

Flange according to AS 4087, PN 16 *Order code for "Process connection", option* **M3K**						
DN [mm]	**A [mm]**	**B [mm]**	**C [mm]**	**D [mm]**	**E [mm]**	**L [mm]**
900	1175	1092	24 × Ø36	66		
1000	1255	1175	24 × Ø36	66		
1200	1490	1410	32 × Ø36	76		
Surface roughness (flange): Ra 6.3 to 12.5 µm						

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Lap joint flange



A0037862

Lap joint flange in accordance with EN 1092-1 (DIN 2501 / DIN 2512N): PN 10 **Carbon steel:** *order code for "Process connection", option* **D22** **Stainless steel:** *order code for "Process connection", option* **D24**								
DN		**A**	**B**	**C**	**D**	**E**	**F**	**L**
[mm]	**[in]**	**[mm]**	**[mm]**	**[mm]**	**[mm]**	**[mm]**	**[mm]**	**[mm]**
200	8	340	295	8 × Ø22	24	264	1)	2)
250	10	395	350	12 × Ø22	26	317		
300	12	445	400	12 × Ø22	26	367		
Surface roughness (flange): Ra 6.3 to 12.5 µm								

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Lap joint flange in accordance with EN 1092-1 (DIN 2501 / DIN 2512N): PN 16 **Carbon steel:** *order code for "Process connection", option* **D32** **Stainless steel:** *order code for "Process connection", option* **D34**								
DN		**A**	**B**	**C**	**D**	**E**	**F**	**L**
[mm]	**[in]**	**[mm]**	**[mm]**	**[mm]**	**[mm]**	**[mm]**	**[mm]**	**[mm]**
25	1	115	85	4 × Ø14	16	49	1)	2)
32	-	140	100	4 × Ø18	18	65		
40	1 ½	150	110	4 × Ø18	18	71		
50	2	165	125	4 × Ø18	20	88		
65	-	185	145	8 × Ø18	20	103		
80	3	200	160	8 × Ø18	20	120		

Lap joint flange in accordance with EN 1092-1 (DIN 2501 / DIN 2512N): PN 16
Carbon steel: *order code for "Process connection", option* **D32**
Stainless steel: *order code for "Process connection", option* **D34**

DN		A	B	C	D	E	F	L
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
100	4	220	180	8 × Ø18	22	148		
125	-	250	210	8 × Ø18	22	177		
150	6	285	240	8 × Ø22	24	209		
200	8	340	295	12 × Ø22	26	264		
250	10	405	355	12 × Ø26	29	317		
300	12	460	410	12 × Ø26	32	367		
Surface roughness (flange): Ra 6.3 to 12.5 µm								

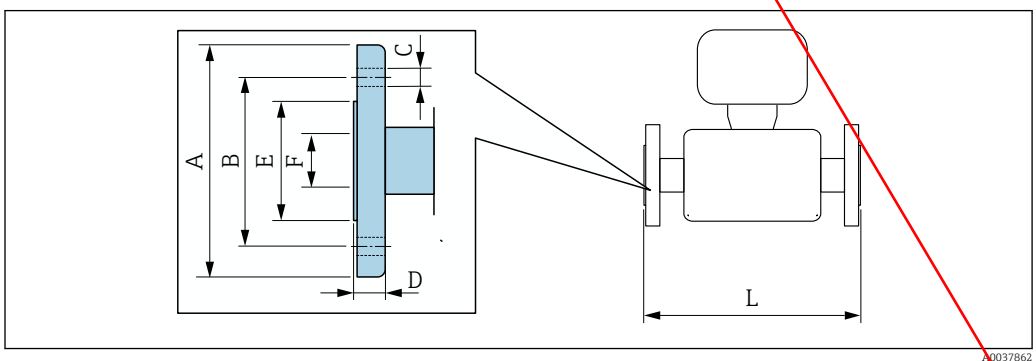
1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Lap joint flange according to ASME B16.5, Class 150
Carbon steel: *order code for "Process connection", option* **A12**
Stainless steel: *order code for "Process connection", option* **A14**

DN		A	B	C	D	E	F	L
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
25	1	110	80	4 × Ø16	14	49	1)	2)
40	1 ½	125	98	4 × Ø16	17.5	71		
50	2	150	121	4 × Ø19	19	88		
80	3	190	152	4 × Ø19	24	120		
100	4	230	190	8 × Ø19	24	148		
150	6	280	241	8 × Ø23	25	209		
200	8	345	298	8 × Ø23	29	264		
250	10	405	362	12 × Ø25	30	317		
300	12	485	432	12 × Ø25	32	378		
Surface roughness (flange): Ra 6.3 to 12.5 µm								

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Lap joint flange, stamped plate

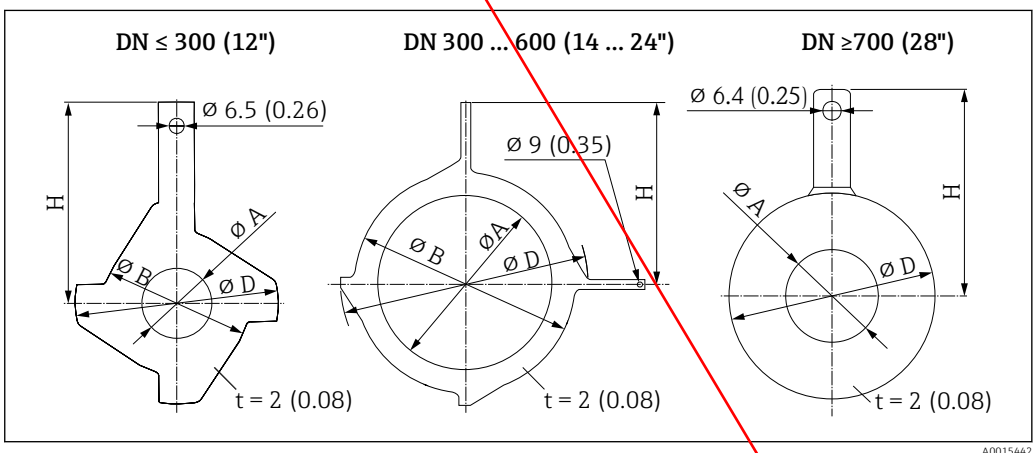


Lap joint flange, stamped plate in accordance with EN 1092-1 (DIN 2501 / DIN 2512N): PN 10 **Carbon steel:** *order code for "Process connection", option* **D21** **Stainless steel:** *order code for "Process connection", option* **D23**							
DN **[mm]**	**A** **[mm]**	**B** **[mm]**	**C** **[mm]**	**D** **[mm]**	**E** **[mm]**	**F** **[mm]**	**L** **[mm]**
25	115	85	4 x Ø13.5	16.5	49	1)	2)
32	140	100	4 x Ø17.5	17	65		
40	150	110	4 x Ø17.5	16.5	71		
50	165	125	4 x Ø17.5	18.5	88		
65	185	145	4 x Ø17.5	20	103		
80	200	160	8 x Ø17.5	23.5	120		
100	220	180	8 x Ø17.5	24.5	148		
125	250	210	8 x Ø17.5	24	177		
150	285	240	8 x Ø21.5	25	209		
200	340	295	8 x Ø21.5	27.5	264		
250	405	350	12 x Ø21.5	30.5	317		
300	445	400	12 x Ø21.5	34.5	367		
Surface roughness (flange): Ra 6.3 to 12.5 µm							

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

Accessories

Ground disks for flange connections



A0015442

DN		**Pressure rating**	**A**		**B**		**D**		**H**	
[mm]	**[inch]**		**[mm]**	**[inch]**	**[mm]**	**[inch]**	**[mm]**	**[inch]**	**[mm]**	**[inch]**
25	1"	1)	26	1.02	62	2.44	77.5	3.05	87.5	3.44
32	1 ¼"	1)	35	1.38	80	3.15	87.5	3.44	94.5	3.72
40	1 ½"	1)	41	1.61	82	3.23	101	3.98	103	4.06
50	2"	1)	52	2.05	101	3.98	115.5	4.55	108	4.25
65	2 ½"	1)	68	2.68	121	4.76	131.5	5.18	118	4.65
80	3"	1)	80	3.15	131	5.16	154.5	6.08	135	5.31

DN		Pressure rating	A		B		D		H	
[mm]	[inch]		[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]
100	4"	[1]	104	4.09	156	6.14	186.5	7.34	153	6.02
125	5"	[1]	130	5.12	187	7.36	206.5	8.13	160	6.30
150	6"	[1]	158	6.22	217	8.54	256	10.08	184	7.24
200	8"	[1]	206	8.11	267	10.51	288	11.34	205	8.07
250	10"	[1]	260	10.2	328	12.91	359	14.13	240	9.45
300	12"	PN 10 PN 16 Cl. 150	312	12.3	375	14.76	413	16.26	273	10.75
		PN 25 JIS 10K JIS 20K	310	12.2	375	14.76	404	15.91	268	10.55
350	14"	PN 6	420	16.5	420	16.54	479	18.86	365	14.37
		PN 10								
		PN 16								
375	15"	PN 16	461	18.2	461	18.2	523	20.6	395	15.6
400	16"	PN 6	470	18.5	470	18.50	542	21.34	395	15.55
		PN 10								
		PN 16								
450	18"	PN 6	525	20.7	525	20.67	583	22.95	417	16.42
		PN 10								
		PN 16								
500	20"	PN 6	575	22.6	575	22.64	650	25.59	460	18.11
		PN 10								
		PN 16								
600	24"	PN 6	676	26.6	676	26.61	766	30.16	522	20.55
		PN 10								
		PN 16								
700	28"	PN 6	697	27.4	–	–	786	30.94	460	18.11
		PN10	693	27.3	–	–	813	32.01	480	18.9
		PN16	687	27.1	–	–	807	31.77	490	19.29
		Cl, D	693	27.3	–	–	832	32.76	494	19.45
750	30"	Cl, D	743	29.3	–	–	833	32.8	523	20.59
800	32"	PN 6	799	31.5	–	–	893	35.16	520	20.47
		PN 10	795	31.3	–	–	920	36.22	540	21.26
		PN 16	789	31.1	–	–	914	35.98	550	21.65
		Cl, D	795	31.3	–	–	940	37.01	561	22.09
900	36"	PN 6	897	35.3	–	–	993	39.09	570	22.44
		PN 10	893	35.2	–	–	1020	40.16	590	23.23
		PN 16	886	34.9	–	–	1014	39.92	595	23.43
		Cl, D	893	35.2	–	–	1048	41.26	615	24.21
1000	40"	PN 6	999	39.3	–	–	1093	43.03	620	24.41
		PN 10	995	39.2	–	–	1127	44.37	650	25.59
		PN 16	988	38.9	–	–	1131	44.53	660	25.98

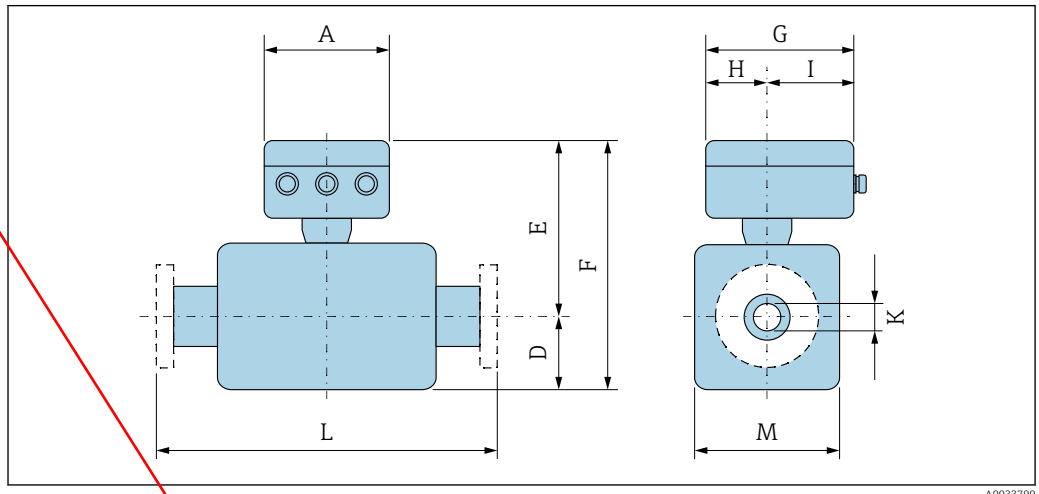
DN		Pressure rating	A		B		D		H	
[mm]	[inch]		[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]
		Cl, D	995	39.2	–	–	1163	45.79	675	26.57
–	42"	PN 6	1044	41.1	–	–	1220	48.03	704	27.72
1200	48"	PN 6	1203	47.4	–	–	1310	51.57	733	28.86
		PN 10	1196	47.1	–	–	1344	52.91	760	29.92
		PN 16	1196	47.1	–	–	1385	54.53	786	30.94
		Cl, D	1188	46.8	–	–	1345	52.95	775	30.51

1) In the case of DN 25 to 250, ground disks can be used for all the flange standards/pressure ratings which can be supplied in the standard version

Dimensions in US units

Compact version

Order code for "Housing", option A "Compact, aluminum, coated" or option M "Compact, polycarbonate"



A [in]	G [1] [in]	H [in]	I [1] [in]
6.57	7.60	3.54	4.06

1) Depending on the cable gland used: values up to + 1.18 in

DN 1 to 12 in (25 to 300 mm): Sensor with aluminum half-shell housing

DN		Order code for "Design"									
		Options D, E, H, I				Option C					
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]	K	L
[mm]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]
25	1	3.31	7.91	11.22	4.72	–	–	–	–	[2]	7.87
32	–	3.31	7.91	11.22	4.72	–	–	–	–	[2]	7.87
40	1 ½	3.31	7.91	11.22	4.72	–	–	–	–	[2]	7.87
50	2	3.31	7.91	11.22	4.72	3.31	7.91	11.22	4.72	[2]	7.87
65	–	4.29	8.9	13.19	7.09	3.31	7.91	11.22	4.72	[2]	7.87
80	3	4.29	8.9	13.19	7.09	3.31	7.91	11.22	4.72	[2]	7.87
100	4	4.29	8.9	13.19	7.09	4.29	8.9	13.19	7.09	[2]	9.84
125	–	5.91	10.47	16.38	10.24	4.29	8.9	13.19	7.09	[2]	9.84
150	6	5.91	10.47	16.38	10.24	4.29	8.9	13.19	7.09	[2]	11.81
200	8	7.09	11.46	18.54	12.76	5.91	10.47	16.38	10.24	[2]	13.78
250	10	8.07	12.44	20.51	15.75	5.91	10.47	16.38	10.24	[2]	17.72
300	12	9.06	13.43	22.48	18.11	7.09	11.46	18.54	12.76	[2]	19.69

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 90

DN 14 to 16 in (350 to 400 mm)

DN		Order code for "Design" Options E, I				K	L
		D [1]	E [1]	F [1]	M [1]		
[mm]	[in]	[in]	[in]	[in]	[in]	[in]	[in]
350	14	11.10	15.63	26.73	22.20	[2]	21.65
375	15	12.13	16.65	28.78	24.25	[2]	23.62
400	16	12.13	16.65	28.78	24.25	[2]	23.62

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 90

DN 18 to 36 in (450 to 900 mm)

DN		Order code for "Design" Options F, J				Options G, K				K	L	
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]			
[mm]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	
450	18	11.42	15.94	27.36	22.83	13.11	17.64	30.75	26.22	[2]	23.62 [3]	25.59 [4]
500	20	12.40	16.93	29.33	24.80	14.13	18.66	32.80	28.23	[2]	23.62 [2]	25.59 [4]
600	24	14.37	18.90	33.27	28.74	16.18	20.71	36.89	32.32	[2]	23.62 [2]	30.71 [4]
700	28	16.77	21.30	38.07	33.50	20.16	24.69	44.84	40.31	[2]	27.56 [2]	35.83 [4]
750	30	18.23	22.76	40.98	36.46	20.16	24.69	44.84	40.31	[2]	29.53 [2]	38.39 [4]
800	32	18.98	23.50	42.48	37.95	21.02	25.55	46.57	41.93	[2]	31.5 [2]	40.94 [4]
900	36	20.94	25.47	46.42	41.89	24.02	28.54	52.56	47.95	[2]	35.43 [2]	46.06 [4]

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 90
3) Order code for "Design", option F "Fixed flange, short installed length" and option J "Fixed flange, short installed length, 0 x DN inlet/outlet runs"
4) Order code for "Design", option G "Fixed flange, long installed length" and option K "Fixed flange, long installed length 0 x DN inlet/outlet runs"

DN 40 to 78 in (1000 to 2000 mm)

DN		Order code for "Design" Options F, G, J, K				K	L	
		D [1]	E [1]	F [1]	M [1]			
[mm]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	
1000	40	22.91	27.44	50.35	45.83	[2]	39.37 [3]	51.18 [4]
–	42	24.33	28.86	53.19	48.66	[2]	41.34 [3]	53.74 [4]
1200	48	27.40	31.93	59.33	54.80	[2]	47.24 [3]	61.42 [4]
–	54	31.85	36.38	68.23	63.66	[2]	53.15 [3]	69.09 [4]
1400	–	31.85	36.38	68.23	63.66	[2]	55.12 [3]	71.65 [4]
–	60	35.79	40.31	76.10	71.54	[2]	59.06 [3]	76.77 [4]
1600	–	35.79	40.31	76.10	71.54	[2]	62.99 [3]	81.89 [4]
–	66	37.80	42.32	80.12	75.55	[2]	64.96 [3]	84.45 [4]
1800	72	40.00	44.53	84.53	80.00	[2]	70.87 [3]	92.13 [4]

DN		Order code for "Design" Options F, G, J, K				K	L	
		D [1]	E [1]	F [1]	M [1]			
[mm]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	
–	78	44.37	48.90	93.27	88.74	[2]	78.74 [3]	102.36 [4]
2000	–	44.37	48.90	93.27	88.74	[2]	78.74 [3]	102.36 [4]

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 🖹 90
3) Order code for "Design", option F "Fixed flange, short installed length" and option J "Fixed flange, short installed length, 0 x DN inlet/outlet runs"
4) Order code for "Design", option G "Fixed flange, long installed length" and option K "Fixed flange, long installed length 0 x DN inlet/outlet runs"

DN 84 to 120 in (2200 to 3000 mm)

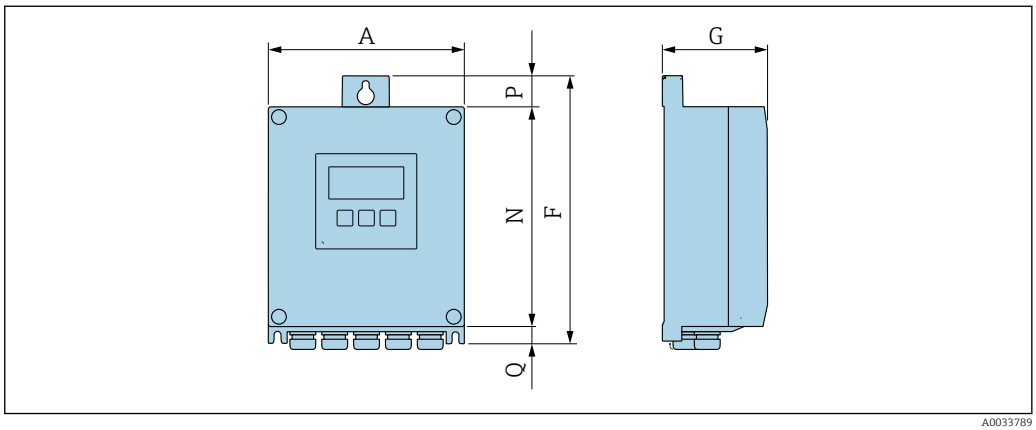
DN		Order code for "Design" Option F, J				K	L
		D [1]	E [1]	F [1]	M [1]		
[mm]	[in]	[in]	[in]	[in]	[in]	[in]	[in]
–	84	48.31	52.83	101.14	96.61	[2]	86.61
2200	–	48.31	52.83	101.14	96.61	[2]	86.61
–	90	52.44	56.97	109.41	104.88	[2]	94.49
2400	–	52.44	56.97	109.57	104.88	[2]	94.49
–	96	56.34	60.87	117.20	112.64	[2]	96.46
–	102	59.69	64.21	123.90	119.37	[2]	102.36
2600	–	56.77	61.30	118.07	113.50	[2]	102.36
–	108	63.07	67.64	130.71	126.14	[2]	108.27
2800	–	60.91	65.43	126.34	121.77	[2]	110.24
–	114	66.46	70.98	137.44	132.87	[2]	114.17
3000	–	64.84	69.37	134.21	129.65	[2]	118.11
–	120	69.84	74.37	144.21	139.65	[2]	120.08

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 🖹 90

Remote version

Transmitter remote version

Order code for "Housing", option N "Remote, polycarbonate" or option P "Remote, aluminum coated"



A0033789

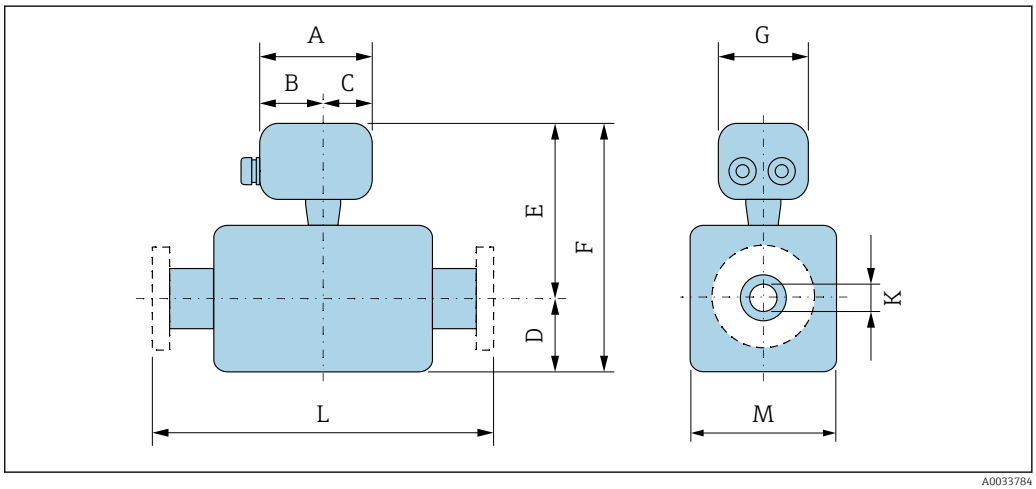
Order code for "Transmitter housing", option P "Remote, aluminum, coated"

A [in]	F [in]	G [in]	N [in]	P [in]	Q [in]
6.57	9.13	3.15	7.36	0.94	0.83

Order code for "Transmitter housing", option N "Remote, polycarbonate"

A [in]	F [in]	G [in]	N [in]	P [in]	Q [in]
6.97	9.21	3.54	7.76	0.67	0.87

Sensor connection housing



A0033784

Aluminum, coated

A [in]	B [in]	C [in]	G [in]
5.83	3.7	2.13	5.35

Polycarbonate (only in conjunction with order code for "Sensor option", options CA...CE)

A [in]	B [in]	C [in]	G [in]
4.45	2.44	2.01	4.41

DN 1 to 12 in (25 to 300 mm): Sensor with aluminum half-shell housing

DN		Order code for "Design"									
		Options D, E, H, I				Option C					
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]	K	L
[mm]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]
25	1	3.31	7.87	11.18	4.72	–	–	–	–	[2]	7.87
32	–	3.31	7.87	11.18	4.72	–	–	–	–	[2]	7.87
40	1 ½	3.31	7.87	11.18	4.72	–	–	–	–	[2]	7.87
50	2	3.31	7.87	11.18	4.72	3.31	7.87	11.18	4.72	[2]	7.87
65	–	4.29	8.86	13.15	7.09	3.31	7.87	11.18	4.72	[2]	7.87
80	3	4.29	8.86	13.15	7.09	3.31	7.87	11.18	4.72	[2]	7.87
100	4	4.29	8.86	13.15	7.09	4.29	8.86	13.15	7.09	[2]	9.84
125	–	5.91	10.43	16.34	10.24	4.29	8.86	13.15	7.09	[2]	9.84
150	6	5.91	10.43	16.34	10.24	4.29	8.86	13.15	7.09	[2]	11.81
200	8	7.09	11.42	18.5	12.76	5.91	10.43	16.34	10.24	[2]	13.78
250	10	8.07	12.4	20.47	15.75	5.91	10.43	16.34	10.24	[2]	17.72
300	12	9.06	13.39	22.44	18.11	7.09	11.42	18.5	12.76	[2]	19.69

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 🖹 90

DN 1 to 12 in (25 to 300 mm): Sensor with fully welded carbon steel housing

DN		Order code for "Design"									
		Option E				Option C					
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]	K	L
[mm]	[in]	[mm]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]
25	1	2.76	7.87	10.63	5.51	–	–	–	–	[2]	7.87
32	–	2.76	7.87	10.63	5.51	–	–	–	–	[2]	7.87
40	1 ½	2.76	7.87	10.63	5.51	–	–	–	–	[2]	7.87
50	2	2.76	7.87	10.63	5.51	2.76	7.87	10.63	5.51	[2]	7.87
65	–	3.23	8.86	12.09	6.5	2.76	7.87	10.63	5.51	[2]	7.87
80	3	3.43	8.86	12.28	6.89	2.76	7.87	10.63	5.51	[2]	7.87
100	4	3.94	8.86	12.8	7.87	3.23	8.86	12.09	6.5	[2]	9.84
125	–	4.45	10.43	14.88	8.9	3.43	8.86	12.28	6.89	[2]	9.84
150	6	5.28	10.43	15.71	10.59	3.94	8.86	12.8	7.87	[2]	11.81
200	8	6.3	11.42	17.72	12.6	4.45	10.43	14.88	8.9	[2]	13.78

DN		Order code for "Design"									
		Option E				Option C					
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]	K	L
[mm]	[in]	[mm]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]
250	10	7.6	12.4	20	15.24	5.28	10.43	15.71	10.59	[2]	17.72
300	12	8.58	13.39	21.97	17.2	6.3	11.42	17.72	12.6	[2]	19.69

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 90

DN 14 to 16 in (350 to 400 mm)

DN		Order code for "Design" Options E, I					
		D [1]	E [1]	F [1]	M [1]	K	L
[mm]	[in]	[in]	[in]	[in]	[in]	[in]	[in]
350	14	11.10	15.63	26.73	22.20	[2]	21.65
375	15	12.13	16.65	28.78	24.25	[2]	23.62
400	16	12.13	16.65	28.78	24.25	[2]	23.62

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 90

DN 18 to 36 in (450 to 900 mm)

DN		Order code for "Design"										
		Options F, J				Options G, K						
		D [1]	E [1]	F [1]	M [1]	D [1]	E [1]	F [1]	M [1]	K	L	
[mm]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	
450	18	11.42	15.94	27.36	22.83	13.11	17.64	30.75	26.22	[2]	23.62 [3]	25.59 [4]
500	20	12.40	16.93	29.33	24.80	14.13	18.66	32.80	28.23	[2]	23.62 [3]	25.59 [4]
600	24	14.37	18.90	33.27	28.74	16.18	20.71	36.89	32.32	[2]	23.62 [3]	30.71 [4]
700	28	16.77	21.30	38.07	33.50	20.16	24.69	44.84	40.31	[2]	27.56 [3]	35.83 [4]
750	30	18.23	22.76	40.98	36.46	20.16	24.69	44.84	40.31	[2]	29.53 [3]	38.39 [4]
800	32	18.98	23.50	42.48	37.95	21.02	25.55	46.57	41.93	[2]	31.5 [3]	40.94 [4]
900	36	20.94	25.47	46.42	41.89	24.02	28.54	52.56	47.95	[2]	35.43 [3]	46.06 [4]

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Depends on the liner → 90
3) Order code for "Design", option F "Fixed flange, short installed length" and option J "Fixed flange, short installed length, 0 x DN inlet/outlet runs"
4) Order code for "Design", option G "Fixed flange, long installed length" and option K "Fixed flange, long installed length 0 x DN inlet/outlet runs"

DN 40 to 78 in (1000 to 2000 mm)

DN		Order code for "Design" Options F, G, J, K				K	L	
[mm]	[in]	D [1] [in]	E [1] [in]	F [1] [in]	M [1] [in]	[in]	[in]	
1000	40	22.91	27.44	50.35	45.83	2)	39.37 3)	51.18 4)
–	42	24.33	28.86	53.19	48.66	2)	41.34 3)	53.74 4)
1200	48	27.40	31.93	59.33	54.80	2)	47.24 3)	61.42 4)
–	54	31.85	36.38	68.23	63.66	2)	53.15 3)	69.09 4)
1400	–	31.85	36.38	68.23	63.66	2)	55.12 3)	71.65 4)
–	60	35.79	40.31	76.10	71.54	2)	59.06 3)	76.77 4)
1600	–	35.79	40.31	76.10	71.54	2)	62.99 3)	81.89 4)
–	66	37.80	42.32	80.12	75.55	2)	64.96 3)	84.45 4)
1800	72	40.00	44.53	84.53	80.00	2)	70.87 3)	92.13 4)
–	78	44.37	48.90	93.27	88.74	2)	78.74 3)	102.36 4)
2000	–	44.37	48.90	93.27	88.74	2)	78.74 3)	102.36 4)

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Internal diameter depends on the liner, see the measuring tube specification → 🖹 90
3) Order code for "Design", option F "Fixed flange, short installed length" and option J "Fixed flange, short installed length, 0 x DN inlet/outlet runs"
4) Order code for "Design", option G "Fixed flange, long installed length" and option K "Fixed flange, long installed length 0 x DN inlet/outlet runs"

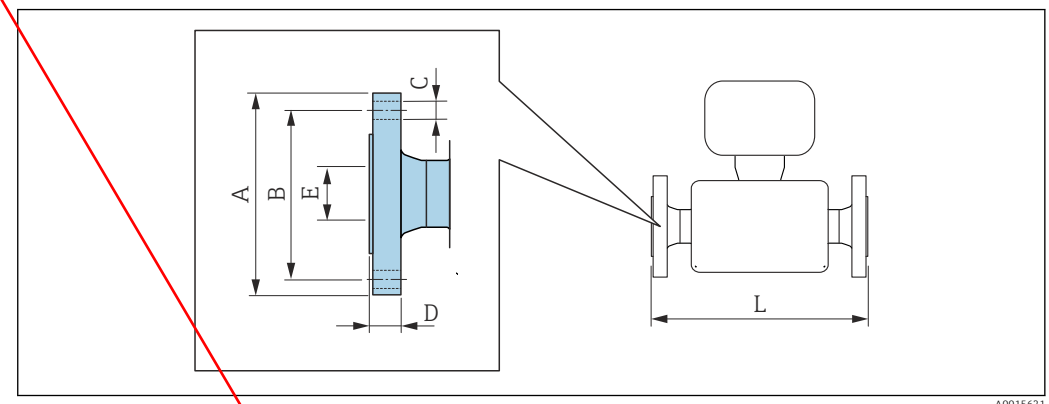
DN 84 to 120 in (2200 to 3000 mm)

DN		Order code for "Design" Option F, J				K	L
[mm]	[in]	D [1] [in]	E [1] [in]	F [1] [in]	M [1] [in]	[in]	[in]
–	84	48.31	52.83	101.14	96.61	2)	86.61
2200	–	48.31	52.83	101.14	96.61	2)	86.61
–	90	52.44	56.97	109.41	104.88	2)	94.49
2400	–	52.44	56.97	109.57	104.88	2)	94.49
–	96	56.34	60.87	117.20	112.64	2)	96.46
–	102	59.69	64.21	123.90	119.37	2)	102.36
2600	–	56.77	61.30	118.07	113.50	2)	102.36
–	108	63.07	67.64	130.71	126.14	2)	108.27
2800	–	60.91	65.43	126.34	121.77	2)	110.24
–	114	66.46	70.98	137.44	132.87	2)	114.17
3000	–	64.84	69.37	134.21	129.65	2)	118.11
–	120	69.84	74.37	144.21	139.65	2)	120.08

1) The dimensions are reference values. They may vary depending on the pressure rating, design and order option.
2) Internal diameter depends on the liner, see the measuring tube specification → 🖹 90

Flange connections

Fixed flange



A0015621

Flange according to ASME B16.5, Class 150 **Carbon steel:** *order code for "Process connection", option* **A1K** **Stainless steel:** *order code for "Process connection", option* **A1S**							
DN		**A**	**B**	**C**	**D**	**E**	**L**
[mm]	**[in]**	**[in]**	**[in]**	**[in]**	**[in]**	**[in]**	**[in]**
25	1	4.25	3.12	4 × Ø0.63	0.5	1)	2)
40	1 ½	5	3.88	4 × Ø0.63	0.63		
50	2	6	4.75	4 × Ø0.75	0.69		
80	3	7.5	6	4 × Ø0.75	0.88		
100	4	9	7.5	8 × Ø0.75	0.88		
150	6	11	9.5	8 × Ø0.88	0.94		
200	8	13.5	11.75	8 × Ø0.88	1.06		
250	10	16	14.25	12 × Ø1	1.17		
300	12	19	17	12 × Ø1	1.19		
350	14	21.06	18.75	12 × Ø1.13	1.39		
400	16	23.43	21.25	16 × Ø1.13	1.46		
450	18	25	22.75	16 × Ø1.25	1.58		
500	20	27.56	25	20 × Ø1.25	1.7		
600	24	32.09	29.5	20 × Ø1.37	1.89		
Surface roughness (flange): Ra 250 to 492 µm							

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 74 (compact version) → 🖹 77 (remote version)

Flange according to ASME B16.5, Class 300 **Carbon steel:** *order code for "Process connection", option* **A2K** **Stainless steel:** *order code for "Process connection", option* **A2S**							
DN		**A**	**B**	**C**	**D**	**E**	**L**
[in]	**[mm]**	**[in]**	**[in]**	**[in]**	**[in]**	**[in]**	**[in]**
1	25	4.88	3.5	4 × Ø0.75	0.63	1)	2)
1 ½	40	6.12	4.5	4 × Ø0.88	0.75		
2	50	6.5	5	8 × Ø0.75	0.82		

Flange according to ASME B16.5, Class 300
Carbon steel: *order code for "Process connection", option* **A2K**
Stainless steel: *order code for "Process connection", option* **A2S**

DN		A	B	C	D	E	L
[in]	[mm]	[in]	[in]	[in]	[in]	[in]	[in]
3	80	8.25	6.62	8 × Ø0.88	1.06		
4	100	10	7.88	8 × Ø0.88	1.19		
6	150	12.5	10.62	12 × Ø0.88	1.38		
Surface roughness (flange): Ra 250 to 492 µm							

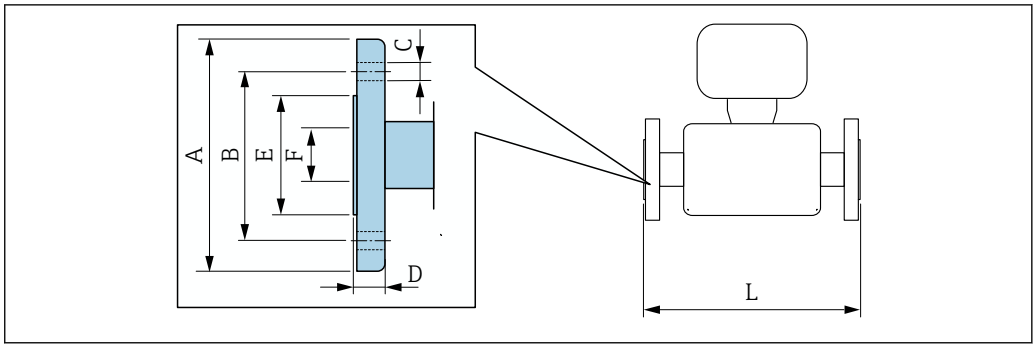
1) Depends on the liner → 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 74 (compact version) → 🖹 77 (remote version)

Flange according to AWWA, Cl. D
Order code for "Process connection", option **W1K**

DN		A	B	C	D	E	L
[in]	[mm]	[in]	[in]	[in]	[in]	[in]	[in]
28	700	36.50	34.00	28 × Ø1.38	1.31	1)	2)
30	–	38.74	36.00	28 × Ø1.38	1.38		
32	800	41.73	38.50	28 × Ø1.65	1.50		
36	900	45.98	42.75	32 × Ø1.65	1.63		
40	1000	50.75	47.25	36 × Ø1.65	1.63		
42	–	52.99	49.50	36 × Ø1.65	1.75		
48	1200	59.49	56.00	44 × Ø1.65	1.88		
54	–	66.26	62.75	44 × Ø1.89	2.13		
60	–	73.03	69.25	52 × Ø1.89	2.25		
66	–	80.00	76.00	52 × Ø1.89	2.50		
72	1800	86.50	82.50	60 × Ø1.89	2.63		
78	–	92.99	89.00	64 × Ø2.13	2.75		
84	–	99.80	95.50	64 × Ø2.13	2.88		
90	–	106.50	107.00	68 × Ø2.36	3.00		
96	–	113.27	108.50	68 × Ø2.37	3.25		
102	–	120.00	114.50	68 × Ø2.63	3.25		
108	–	126.73	120.75	68 × Ø2.63	3.38		
114	–	133.50	126.75	68 × Ø2.87	3.50		
120	–	140.24	132.75	68 × Ø2.87	3.50		
Surface roughness (flange): Ra 250 to 492 µin							

1) Depends on the liner → 🖹 90
2) Total length is independent of the process connections. Installed length according to DVGW → 🖹 74 (compact version) → 🖹 77 (remote version)

Lap joint flange



A0037862

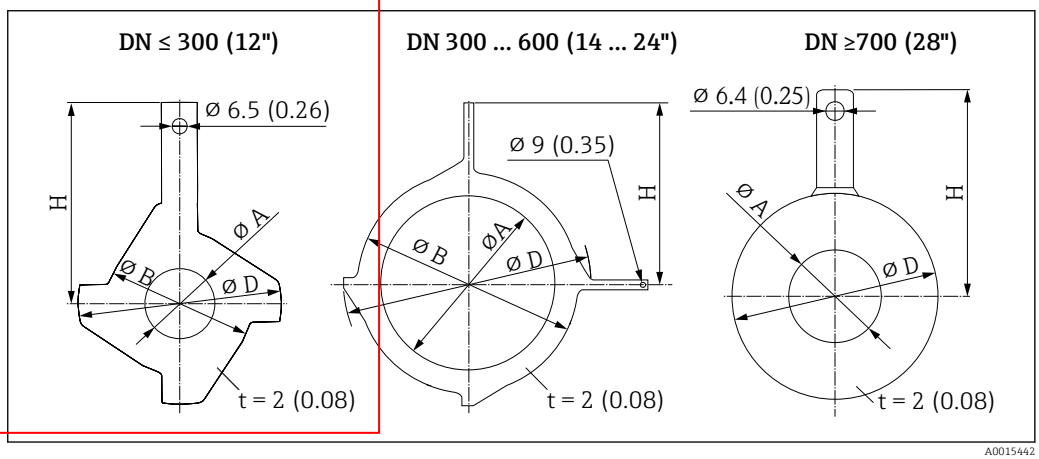
Lap joint flange according to ASME B16.5, Class 150
Carbon steel: *order code for "Process connection", option* **A12**
Stainless steel: *order code for "Process connection", option* **A14**

DN		A	B	C	D	E	F	L
[mm]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]
25	1	4.33	3.15	4 × Ø0.63	0.55	1.93	1)	2)
40	1 ½	4.92	3.86	4 × Ø0.63	0.69	2.8		
50	2	5.91	4.76	4 × Ø0.75	0.75	3.46		
80	3	7.48	5.98	4 × Ø0.75	0.94	4.72		
100	4	9.06	7.48	8 × Ø0.75	0.94	5.83		
150	6	11.02	9.49	8 × Ø0.91	0.98	8.23		
200	8	13.58	11.73	8 × Ø0.91	1.14	10.39		
250	10	15.94	14.25	12 × Ø0.98	1.18	12.48		
300	12	19.09	17.01	12 × Ø0.98	1.26	14.88		
Surface roughness (flange): Ra 248 to 492 µin								

1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 74 (compact version) → 🖹 77 (remote version)

Accessories

Ground disks for flange connections



A0015442

DN		Pressure rating	A		B		D		H	
[mm]	[inch]		[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]
25	1"	1)	26	1.02	62	2.44	77.5	3.05	87.5	3.44
32	1 ¼"	1)	35	1.38	80	3.15	87.5	3.44	94.5	3.72
40	1 ½"	1)	41	1.61	82	3.23	101	3.98	103	4.06
50	2"	1)	52	2.05	101	3.98	115.5	4.55	108	4.25
65	2 ½"	1)	68	2.68	121	4.76	131.5	5.18	118	4.65
80	3"	1)	80	3.15	131	5.16	154.5	6.08	135	5.31
100	4"	1)	104	4.09	156	6.14	186.5	7.34	153	6.02
125	5"	1)	130	5.12	187	7.36	206.5	8.13	160	6.30
150	6"	1)	158	6.22	217	8.54	256	10.08	184	7.24
200	8"	1)	206	8.11	267	10.51	288	11.34	205	8.07
250	10"	1)	260	10.2	328	12.91	359	14.13	240	9.45
300	12"	PN 10 PN 16 Cl. 150	312	12.3	375	14.76	413	16.26	273	10.75
		PN 25 JIS 10K JIS 20K	310	12.2	375	14.76	404	15.91	268	10.55
350	14"	PN 6	420	16.5	420	16.54	479	18.86	365	14.37
		PN 10								
		PN 16								
375	15"	PN 16	461	18.2	461	18.2	523	20.6	395	15.6
400	16"	PN 6	470	18.5	470	18.50	542	21.34	395	15.55
		PN 10								
		PN 16								
450	18"	PN 6	525	20.7	525	20.67	583	22.95	417	16.42
		PN 10								
		PN 16								
500	20"	PN 6	575	22.6	575	22.64	650	25.59	460	18.11
		PN 10								
		PN 16								
600	24"	PN 6	676	26.6	676	26.61	766	30.16	522	20.55
		PN 10								
		PN 16								
700	28"	PN 6	697	27.4	–	–	786	30.94	460	18.11
		PN10	693	27.3	–	–	813	32.01	480	18.9
		PN16	687	27.1	–	–	807	31.77	490	19.29
		Cl, D	693	27.3	–	–	832	32.76	494	19.45
750	30"	Cl, D	743	29.3	–	–	833	32.8	523	20.59
800	32"	PN 6	799	31.5	–	–	893	35.16	520	20.47
		PN 10	795	31.3	–	–	920	36.22	540	21.26
		PN 16	789	31.1	–	–	914	35.98	550	21.65
		Cl, D	795	31.3	–	–	940	37.01	561	22.09
900	36"	PN 6	897	35.3	–	–	993	39.09	570	22.44

DN		Pressure rating	A		B		D		H	
[mm]	[inch]		[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]
		PN 10	893	35.2	–	–	1020	40.16	590	23.23
		PN 16	886	34.9	–	–	1014	39.92	595	23.43
		Cl, D	893	35.2	–	–	1048	41.26	615	24.21
1000	40"	PN 6	999	39.3	–	–	1093	43.03	620	24.41
		PN 10	995	39.2	–	–	1127	44.37	650	25.59
		PN 16	988	38.9	–	–	1131	44.53	660	25.98
		Cl, D	995	39.2	–	–	1163	45.79	675	26.57
–	42"	PN 6	1044	41.1	–	–	1220	48.03	704	27.72
1200	48"	PN 6	1203	47.4	–	–	1310	51.57	733	28.86
		PN 10	1196	47.1	–	–	1344	52.91	760	29.92
		PN 16	1196	47.1	–	–	1385	54.53	786	30.94
		Cl, D	1188	46.8	–	–	1345	52.95	775	30.51

1) In the case of DN 25 to 250, ground disks can be used for all the flange standards/pressure ratings which can be supplied in the standard version

Weight

All values (weight exclusive of packaging material) refer to devices with flanges of the standard pressure rating.
The weight may be lower than indicated depending on the pressure rating and design.

Weight in SI units

Order code for "Design", option C, D, E, H, I : DN 25 to 400 mm (1 to 16 in)			
Nominal diameter		Reference values EN (DIN), AS, JIS	
[mm]	[in]	Pressure rating	[kg]
25	1	PN 40	10
32	–	PN 40	11
40	1 ½	PN 40	12
50	2	PN 40	13
65	–	PN 16	13
80	3	PN 16	15
100	4	PN 16	18
125	–	PN 16	25
150	6	PN 16	31
200	8	PN 10	52
250	10	PN 10	81
300	12	PN 10	95
350	14	PN 6	106
375	15	PN 6	121
400	16	PN 6	121

Order code for "Design", option F, J: DN 450 to 2 000 mm (18 to 78 in)			
Nominal diameter		Reference values EN (DIN) (PN16)	AS (PN 16)
[mm]	[in]	[kg]	[kg]
450	18	142	138
500	20	182	186
600	24	227	266
700	28	291	369
–	30	–	447
800	32	353	524
900	36	444	704
1000	40	566	785
–	42	–	–
1200	48	843	1229
–	54	–	–
1400	–	1204	–
–	60	–	–
1600	–	1845	–
–	66	–	–

Order code for "Design", option F, J: DN 450 to 2 000 mm (18 to 78 in)			
Nominal diameter		Reference values	
		EN (DIN) (PN16)	AS (PN 16)
[mm]	[in]	[kg]	[kg]
1800	72	2 357	–
–	78	2 929	–
2000	–	2 929	–

Order code for "Design", option F, J: DN 2 200 to 3 000 mm (84 to 120 in)		
Nominal diameter		Reference values
		EN (DIN) (PN6)
[mm]	[in]	[kg]
–	84	–
2200	–	3 422
–	90	–
2400	–	4 094
–	96	–
–	102	–
2600	–	7 601.5
–	108	–
2800	–	9 466.5
–	114	–
3000	–	11 911
–	120	–

Order code for "Design", option G, K: DN 450 to 2 000 mm (18 to 78 in)		
Nominal diameter		Reference values
		EN (DIN) (PN 6)
[mm]	[in]	[kg]
450	18	161
500	20	156
600	24	208
700	28	304
–	30	–
800	32	357
900	36	485
1000	40	589
–	42	–
1200	48	850
–	54	850
1400	–	1 300
–	60	–
1600	–	1 845

Order code for "Design", option G, K: DN 450 to 2 000 mm (18 to 78 in)		
Nominal diameter		Reference values EN (DIN) (PN 6)
[mm]	[in]	[kg]
–	66	–
1800	72	2 357
–	78	2 929
2000	–	2 929

Weight in US units

Order code for "Design", option C, D, E, H, I: DN 1 to 16 in (25 to 400 mm)		
Nominal diameter		Reference values ASME (Class 150)
[mm]	[in]	[lb]
25	1	11
32	–	–
40	1 ½	15
50	2	20
65	–	–
80	3	31
100	4	42
125	–	–
150	6	73
200	8	115
250	10	198
300	12	284
350	14	379
375	15	–
400	16	448

Order code for "Design", option F, J: DN 18 to 120 in (450 to 3 000 mm)		
Nominal diameter		Reference values ASME (Class 150), AWWA (Class D)
[mm]	[in]	[lb]
450	18	421
500	20	503
600	24	666
700	28	587
–	30	701
800	32	845
900	36	1036
1000	40	1294
–	42	1477
1200	48	1987

Order code for "Design", option F, J: DN 18 to 120 in (450 to 3 000 mm)		
Nominal diameter		Reference values ASME (Class 150), AWWA (Class D)
[mm]	[in]	[lb]
–	54	2 807
1400	–	–
–	60	3 515
1600	–	–
–	66	4 699
1800	72	5 662
–	78	6 864
2000	–	6 864
–	84	8 280
2200	–	–
–	90	10 577
2400	–	–
–	96	15 574.6
–	102	18 023.9
2600	–	–
–	108	20 783.0
2800	–	–
–	114	24 060.2
3000	–	–
–	120	27 724.3

Order code for "Design", option G, K: DN 18 to 78 in (450 to 2 000 mm)		
Nominal diameter		Reference values ASME (Class 150), AWWA (Class D)
[mm]	[in]	[lb]
450	18	562
500	20	628
600	24	893
700	28	882
–	30	1 014
800	32	1 213
900	36	1 764
1000	40	1 984
–	42	2 426
1200	48	3 087
–	54	4 851
1400	–	–
–	60	5 954
1600	–	–
–	66	8 158

Order code for "Design", option G, K: DN 18 to 78 in (450 to 2000 mm)		
Nominal diameter		Reference values ASME (Class 150), AWWA (Class D)
[mm]	[in]	[lb]
1800	72	9040
–	78	10 143
2000	–	–

Measuring tube specification

The values are reference values and can vary depending on the pressure rating, design and order option.

Nominal diameter		Pressure rating				Measuring tube internal diameter					
		EN (DIN)	ASME AWWA	AS 2129 AS 4087	JIS	Hard rubber		Polyurethane		PTFE	
[mm]	[in]					[mm]	[in]	[mm]	[in]	[mm]	[in]
25	1	PN 40	Class 150	–	20K	–	–	24	0.93	25	1.00
32	–	PN 40	–	–	20K	–	–	32	1.28	34	1.34
40	1 ½	PN 40	Class 150	–	20K	–	–	38	1.51	40	1.57
50	2	PN 40	Class 150	Table E, PN 16	10K	50	1.98	50	1.98	52	2.04
50 [1]	2	PN 40	Class 150	Table E, PN 16	10K	32	1.26	–	–	–	–
65	–	PN 16	–	–	10K	66	2.60	66	2.60	68	2.67
65 [1]	–	PN 16	–	–	10K	38	1.50	–	–	–	–
80	3	PN 16	Class 150	Table E, PN 16	10K	79	3.11	79	3.11	80	3.15
80 [1]	3	PN 16	Class 150	Table E, PN 16	10K	50	1.97	–	–	–	–
100	4	PN 16	Class 150	Table E, PN 16	10K	101	3.99	104	4.11	104	4.09
100 [1]	4	PN 16	Class 150	Table E, PN 16	10K	66	2.60	–	–	–	–
125	–	PN 16	–	–	10K	127	4.99	130	5.11	129	5.08
125 [1]	–	PN 16	–	–	10K	79	3.11	–	–	–	–
150	6	PN 16	Class 150	Table E, PN 16	10K	155	6.11	158	6.23	156	6.15
150 [1]	6	PN 16	Class 150	Table E, PN 16	10K	102	4.02	–	–	–	–
200	8	PN 10	Class 150	Table E, PN 16	10K	204	8.02	207	8.14	202	7.96
200 [1]	8	PN 16	Class 150	Table E, PN 16	10K	127	5.00	–	–	–	–
250	10	PN 10	Class 150	Table E, PN 16	10K	258	10.14	261	10.26	256	10.09
250 [1]	10	PN 16	Class 150	Table E, PN 16	10K	156	6.14	–	–	–	–
300	12	PN 10	Class 150	Table E, PN 16	10K	309	12.15	312	12.26	306	12.03
300 [1]	12	PN 16	Class 150	Table E, PN 16	10K	204	8.03	–	–	–	–
350	14	PN 10	Class 150	Table E, PN 16	10K	337	13.3	340	13.4	–	–
375	15	–	–	PN 16	10K	389	15.3	392	15.4	–	–
400	16	PN 10	Class 150	Table E, PN 16	10K	387	15.2	390	15.4	–	–
450	18	PN 10	Class 150	–	10K	436	17.2	439	17.3	–	–
500	20	PN 10	Class 150	Table E, PN 16	10K	487	19.2	490	19.3	–	–
600	24	PN 10	Class 150	Table E, PN 16	10K	585	23.0	588	23.1	–	–
700	28	PN 10	Class D	Table E, PN 16	10K	694	27.3	697	27.4	–	–
750	30	–	Class D	Table E, PN 16	10K	743	29.3	746	29.4	–	–
800	32	PN 10	Class D	Table E, PN 16	–	794	31.3	797	31.4	–	–

Nominal diameter		Pressure rating				Measuring tube internal diameter					
		EN (DIN)	ASME AWWA	AS 2129 AS 4087	JIS	Hard rubber		Polyurethane		PTFE	
[mm]	[in]					[mm]	[in]	[mm]	[in]	[mm]	[in]
900	36	PN 10	Class D	Table E, PN 16	–	895	35.2	898	35.4	–	–
1000	40	PN 6	Class D	Table E, PN 16	–	991	39.0	994	39.1	–	–
–	42	–	Class D	–	–	1043	41.1	1043	41.1	–	–
1200	48	PN 6	Class D	Table E, PN 16	–	1191	46.9	1197	47.1	–	–
–	54	–	Class D	–	–	1339	52.7	–	–	–	–
1400	–	PN 6	–	–	–	1402	55.2	–	–	–	–
–	60	–	Class D	–	–	1492	58.7	–	–	–	–
1600	–	PN 6	–	–	–	1600	63.0	–	–	–	–
–	66	–	Class D	–	–	1638	64.5	–	–	–	–
1800	72	PN 6	–	–	–	1786	70.3	–	–	–	–
–	78	–	Class D	–	–	1989	78.3	–	–	–	–
2000	–	PN 6	–	–	–	1989	78.3	–	–	–	–
–	84	–	Class D	–	–	2099	84.0	–	–	–	–
2200	–	PN 6	–	–	–	2194	87.8	–	–	–	–
–	90	–	Class D	–	–	2246	89.8	–	–	–	–
2400	–	PN 6	–	–	–	2391	94.1	–	–	–	–
–	96	–	Class D	–		2382	93.8	–	–	–	–
–	102	–	Class D	–		2533	99.7	–	–	–	–
2600	–	PN 6	–	–		2580	101.6	–	–	–	–
–	108	–	Class D	–		2683	105.6	–	–	–	–
2800	–	PN 6	–	–		2780	109.5	–	–	–	–
–	114	–	Class D	–		2832	111.5	–	–	–	–
3000	–	PN 6	–	–		2976	117.2	–	–	–	–
–	120	–	Class D	–		2980	117.3	–	–	–	–

1) Order code for "Design", option C

Materials

Transmitter housing

Compact version

- Order code for "Housing", option **A** "Compact, alu, coated": Aluminum, AlSi10Mg, coated
- Order code for "Housing", option **M**: polycarbonate plastic
- Window material:
  - For order code for "Housing", option **A**: glass
  - For order code for "Housing", option **M**: plastic

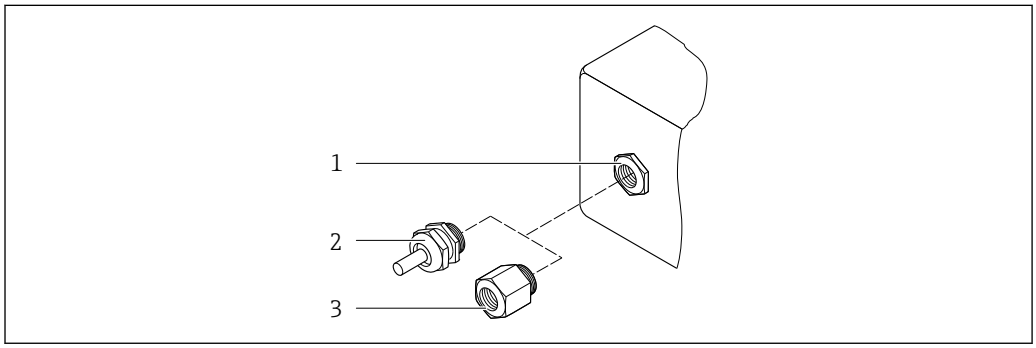
Remote version (wall-mount housing)

- Order code for "Housing", option **P** "Remote, alu, coated": Aluminum, AlSi10Mg, coated
- Order code for "Housing", option **N**: polycarbonate plastic
- Window material:
  - For order code for "Housing", option **P**: glass
  - For order code for "Housing", option **N**: plastic

Sensor connection housing

- Aluminum, AlSi10Mg, coated
- Polycarbonate plastic (only in conjunction with order code for "Sensor option", options CA, C3, CB, CC, CD, CD)

Cable entries/cable glands



30 *Possible cable entries/cable glands*

1 *Female thread M20 × 1.5*
2 *Cable gland M20 × 1.5*
3 *Adapter for cable entry with female thread G ½" or NPT ½"*

Compact and remote versions and sensor connection housing

Cable entry/cable gland	Material
Cable gland M20 × 1.5	▪ Plastic ▪ Nickel-plated brass
Remote version: cable gland M20 × 1.5 Option of armored connecting cable	▪ Sensor connection housing: Nickel-plated brass ▪ Transmitter wall-mount housing: Plastic
Adapter for cable entry with female thread G ½" or NPT ½"	Nickel-plated brass

Device plug

Electrical connection	Material
Plug M12x1	▪ Socket: Stainless steel, 1.4404 (316L) ▪ Contact housing: Polyamide ▪ Contacts: Gold-plated brass

Remote version connecting cable

UV rays can impair the cable outer sheath. Protect the cable from exposure to sun as much as possible.

Electrode and coil current cable:
- Standard cable: PVC cable with copper shield
- Armored cable: PVC cable with copper shield and additional steel wire braided jacket

Sensor housing

- DN 25 to 300 (1 to 12")
  - Aluminum half-shell housing, aluminum, AlSi10Mg, coated
  - Fully welded carbon steel housing with protective varnish
- DN 350 to 3000 (14 to 120")
  Fully welded carbon steel housing with protective varnish

Measuring tubes

- DN 25 to 600 (1 to 24")
  Stainless steel: 1.4301, 1.4306, 304, 304L
- DN 700 to 3000 (28 to 120")
  Stainless steel: 1.4301, 304

Liner

- DN 25 to 300 (1 to 12"): PTFE
- DN 25 to 1200 (1 to 48"): polyurethane
- DN 50 to 3000 (2 to 120"): hard rubber

Electrodes

- Stainless steel, 1.4435 (316L)
- Alloy C22, 2.4602 (UNS N06022)
- Tantalum

Process connections

For flanges made of carbon steel:
- DN ≤ 300 (12"): with Al/Zn protective coating or protective varnish
- DN ≥ 350 (14"): protective varnish

All carbon steel lap joint flanges are supplied with a hot-dip galvanized finish.

EN 1092-1 (DIN 2501)

Fixed flange
- Carbon steel:
  - DN ≤ 300: S235JRG2, S235JR+N, P245GH, A105, E250C
  - DN 350 to 3000: P245GH, S235JRG2, A105, E250C
- Stainless steel:
  - DN ≤ 300: 1.4404, 1.4571, F316L
  - DN 350 to 600: 1.4571, F316L, 1.4404
  - DN 700 to 1000: 1.4404, F316L

Lap joint flange
- Carbon steel DN ≤ 300: S235JRG2, A105, E250C
- Stainless steel DN ≤ 300: 1.4306,1.4404, 1.4571, F316L

Lap joint flange, stamped plate
- Carbon steel DN ≤ 300: S235JRG2 similar to S235JR+AR or 1.0038
- Stainless steel DN ≤ 300: 1.4301 similar to 304

ASME B16.5

Fixed flange, lap joint flange
- Carbon steel: A105
- Stainless steel: F316L

JIS B2220

- Carbon steel: A105, A350 LF2
- Stainless steel: F316L

AWWA C207

Carbon steel: A105, P265GH, A181 Class 70, E250C, S275JR

AS 2129

Carbon steel: A105, E250C, P235GH, P265GH, S235JRG2

AS 4087

Carbon steel: A105, P265GH, S275JR

Seals

As per DIN EN 1514-1, form IBC

Accessories

Display guard

Stainless steel, 1.4301 (304L)

Ground disks

- Stainless steel, 1.4435 (316L)
- Alloy C22, 2.4602 (UNS N06022)
- Tantalum

Fitted electrodes

Measurement, reference and empty pipe detection electrodes available as standard with:
- 1.4435 (316L)
- Alloy C22, 2.4602 (UNS N06022)
- Tantalum

Process connections

- EN 1092-1 (DIN 2501)
- ASME B16.5
- JIS B2220
- AS 2129 Table E
- AS 4087 PN 16
- AWWA C207 Class D

For information on the different materials used in the process connections → 93

Surface roughness

Electrodes with 1.4435 (316L); Alloy C22, 2.4602 (UNS N06022); tantalum: < 0.5 µm (19.7 µin)

(All data relate to parts in contact with medium)

Human interface

Operating concept

Operator-oriented menu structure for user-specific tasks
- Commissioning
- Operation
- Diagnostics
- Expert level

Fast and safe commissioning
- Guided menus ("Make-it-run" wizards) for applications
- Menu guidance with brief descriptions of the individual parameter functions
- Access to the device via Web server
- WLAN access to the device via mobile handheld terminal, tablet or smart phone

Reliable operation
- Operation in local language
- Uniform operating philosophy applied to device and operating tools
- If replacing electronic modules, transfer the device configuration via the integrated memory (HistoROM backup) which contains the process and measuring device data and the event logbook. No need to reconfigure.

Efficient diagnostic behavior increases measurement availability
- Troubleshooting measures can be called up via the device and in the operating tools
- Diverse simulation options, logbook for events that occur and optional line recorder functions

Languages

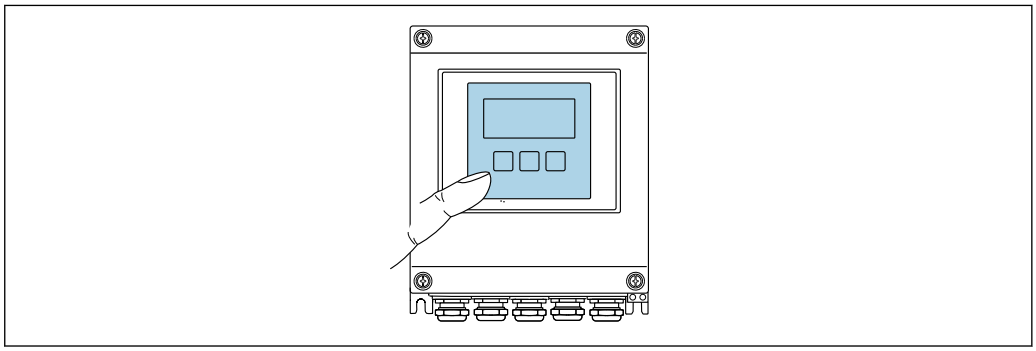
Can be operated in the following languages:
- Via local operation:
  English, German, French, Spanish, Italian, Dutch, Portuguese, Polish, Russian, Turkish, Chinese, Japanese, Bahasa (Indonesian), Vietnamese, Czech, Swedish
- Via "FieldCare", "DeviceCare" operating tool:
  English, German, French, Spanish, Italian, Chinese, Japanese
- Via Web browser (only available for device versions with HART, PROFIBUS DP and EtherNet/IP):
  English, German, French, Spanish, Italian, Dutch, Portuguese, Polish, Russian, Turkish, Chinese, Japanese, Bahasa (Indonesian), Vietnamese, Czech, Swedish

Local operation

Via display module

Equipment:
- Standard features 4-line, illuminated, graphic display; touch control
- Order code for "Display; operation", option BA "WLAN" offers standard equipment features in addition to access via Web browser

Information about WLAN interface → 98



A0032074

31 *Operation with touch control*

Display elements

- 4-line, illuminated, graphic display
- White background lighting; switches to red in event of device errors
- Format for displaying measured variables and status variables can be individually configured
- Permitted ambient temperature for the display: –20 to +60 °C (–4 to +140 °F)
  The readability of the display may be impaired at temperatures outside the temperature range.

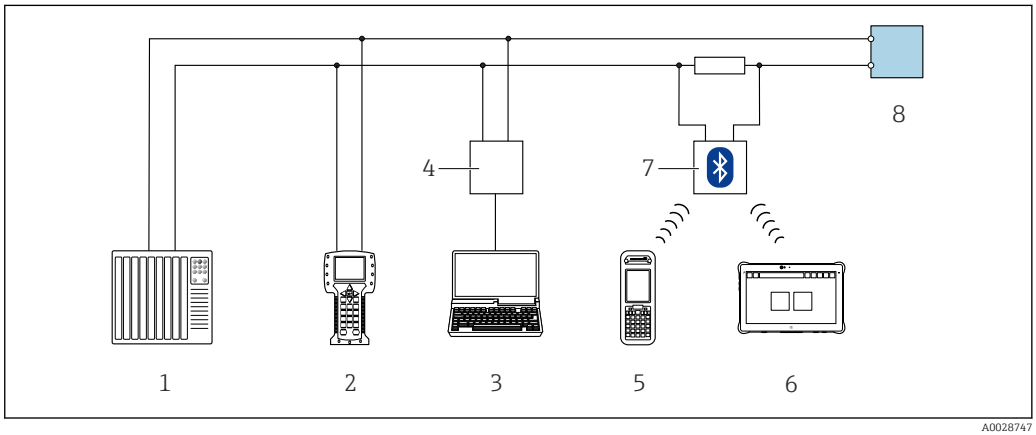
Operating elements

- External operation via touch control (3 optical keys) without opening the housing: ⊞, ⊟, Ⓔ
- Operating elements also accessible in the various zones of the hazardous area

Remote operation

Via HART protocol

This communication interface is available in device versions with a HART output.



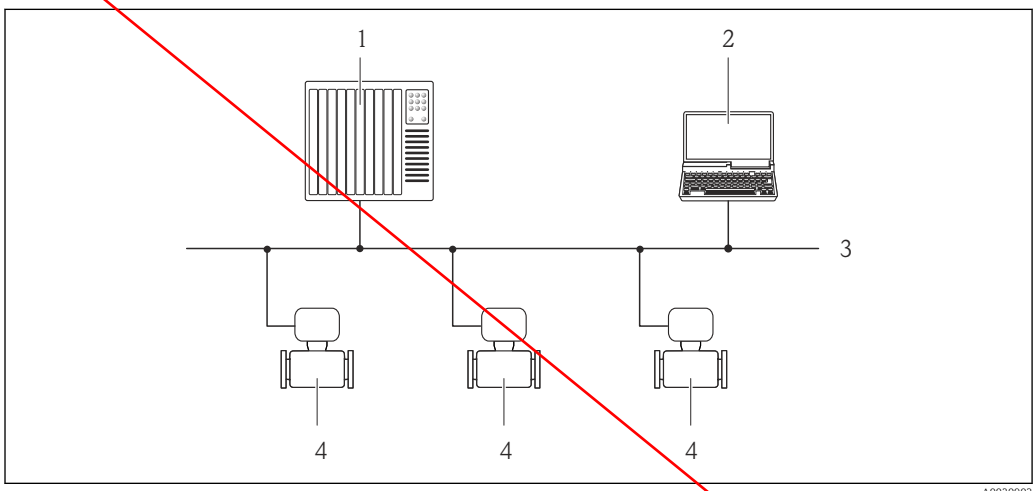
A0028747

32 *Options for remote operation via HART protocol*

1 *Control system (e.g. PLC)*
2 *Field Communicator 475*
3 *Computer with operating tool (e.g. FieldCare, AMS Device Manager, SIMATIC PDM)*
4 *Commubox FXA195 (USB)*
5 *Field Xpert SFX350 or SFX370*
6 *Field Xpert SMT70*
7 *VIATOR Bluetooth modem with connecting cable*
8 *Transmitter*

Via PROFIBUS DP network

This communication interface is available in device versions with PROFIBUS DP.

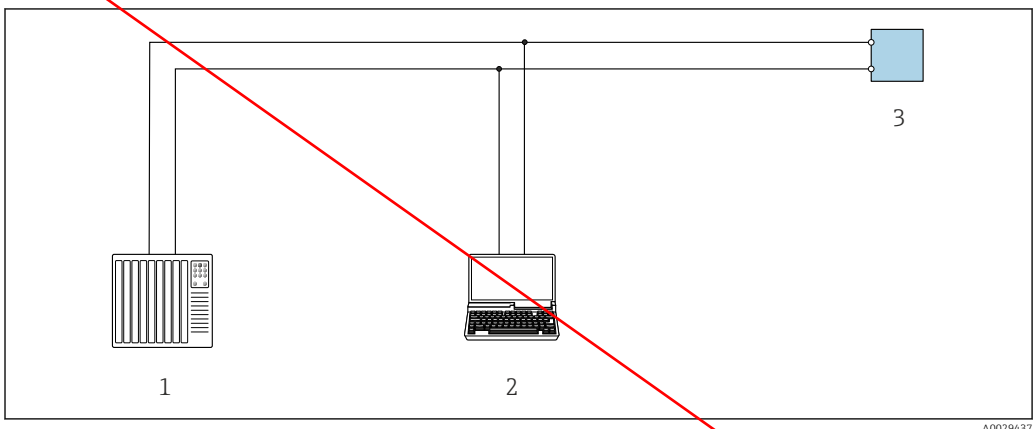


33 *Options for remote operation via PROFIBUS DP network*

1 *Automation system*
2 *Computer with PROFIBUS network card*
3 *PROFIBUS DP network*
4 *Measuring device*

Via Modbus RS485 protocol

This communication interface is available in device versions with a Modbus-RS485 output.



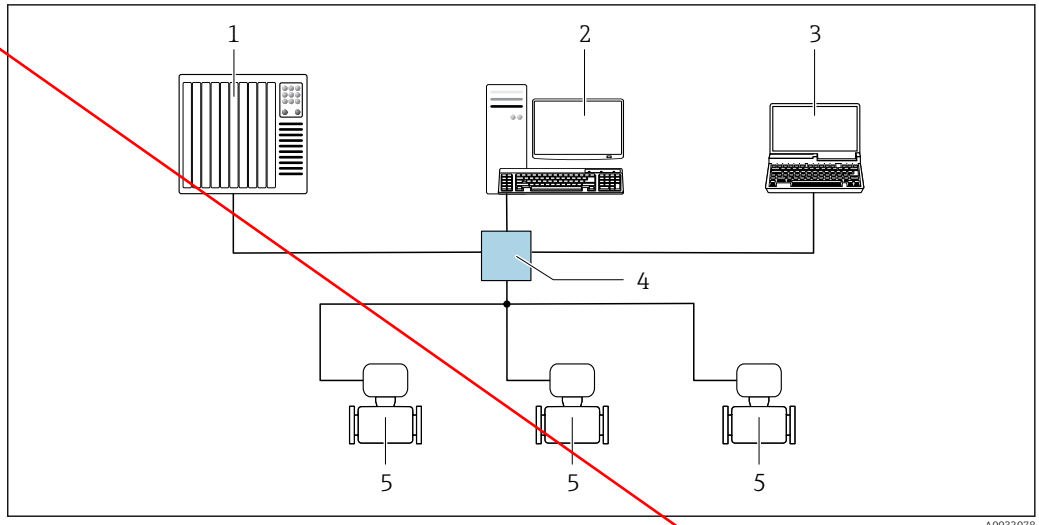
34 *Options for remote operation via Modbus-RS485 protocol (active)*

1 *Control system (e.g. PLC)*
2 *Computer with Web browser (e.g. Internet Explorer) for accessing the integrated device Web server or with operating tool (e.g. FieldCare, DeviceCare) with COM DTM "CDI Communication TCP/IP" or Modbus DTM*
3 *Transmitter*

Via EtherNet/IP network

This communication interface is available in device versions with EtherNet/IP.

Star topology



35 *Options for remote operation via EtherNet/IP network: star topology*

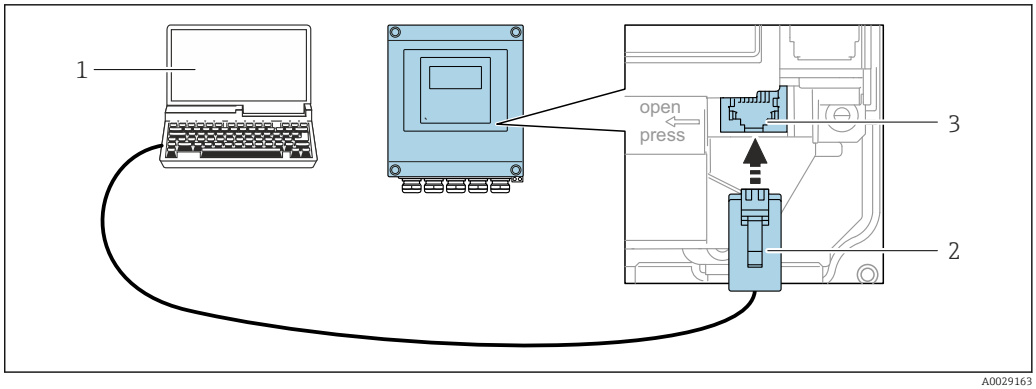
1 *Automation system, e.g. "RSLogix" (Rockwell Automation)*
2 *Workstation for measuring device operation: with Custom Add-On Profile for "RSLogix 5000" (Rockwell Automation) or with Electronic Data Sheet (EDS)*
3 *Computer with Web browser (e.g. Internet Explorer) for accessing the integrated device Web server or computer with operating tool (e.g. FieldCare, DeviceCare) with COM DTM "CDI Communication TCP/IP"*
4 *Ethernet switch*
5 *Measuring device*

Service interface

Via service interface (CDI-RJ45)

This communication interface is present in the following device version:

- Order code for "Output", option **H**: 4 to 20 mA HART, pulse/frequency output, switch output
- Order code for "Output", option **I**: 4 to 20 mA HART, 2 x pulse/frequency/switch output, status input
- Order code for "Output", option **J**: 4 to 20 mA HART, certified pulse output, switch output; status input
- Order code for "Output", option **L**: PROFIBUS DP
- Order code for "Output", option **M**: Modbus RS485
- Order code for "Output", option **O**: Modbus RS485, 4 to 20 mA, 2 x pulse/frequency/switch output
- Order code for "Output", option **P**: Modbus RS485, 4 to 20 mA, certified pulse output, pulse/frequency/switch output
- Order code for "Output", option **N**: EtherNet/IP

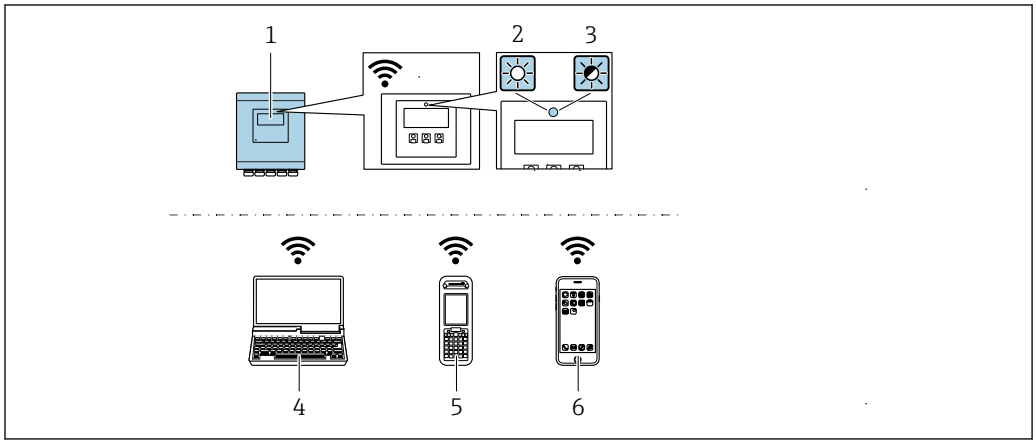


36 *Connection via service interface (CDI-RJ45)*

1 *Computer with Web browser (e.g. Microsoft Internet Explorer, Microsoft Edge) for accessing the integrated device Web server or with "FieldCare", "DeviceCare" operating tool with COM DTM "CDI Communication TCP/IP" or Modbus DTM*
2 *Standard Ethernet connecting cable with RJ45 plug*
3 *Service interface (CDI-RJ45) of the measuring device with access to the integrated Web server*

Via WLAN interface

The optional WLAN interface is available on the following device version:
Order code for "Display", option BA "WLAN":
4-line, illuminated, graphic display; touch control + WLAN



A0043149

1 *Transmitter with integrated WLAN antenna*
2 *LED lit constantly: WLAN reception is enabled on measuring device*
3 *LED flashing: WLAN connection established between operating unit and measuring device*
4 *Computer with WLAN interface and Web browser (e.g. Microsoft Internet Explorer, Microsoft Edge) for accessing the integrated device Web server or with operating tool (e.g. FieldCare, DeviceCare)*
5 *Mobile handheld terminal with WLAN interface and Web browser (e.g. Microsoft Internet Explorer, Microsoft Edge) for accessing the integrated device Web server or operating tool (e.g. FieldCare, DeviceCare)*
6 *Smart phone or tablet (e.g. Field Xpert SMT70)*

Function	WLAN: IEEE 802.11 b/g (2.4 GHz) ▪ Access point with DHCP server (default setting) ▪ Network
Encryption	WPA2-PSK AES-128 (in accordance with IEEE 802.11i)
Configurable WLAN channels	1 to 11
Degree of protection	IP67
Available antenna	Internal antenna
Range	Typically 10 m (32 ft)

Supported operating tools

Different operating tools can be used for local or remote access to the measuring device. Depending on the operating tool used, access is possible with different operating units and via a variety of interfaces.

Supported operating tools	Operating unit	Interface	Additional information
Web browser	Notebook, PC or tablet with Web browser	▪ CDI-RJ45 service interface ▪ WLAN interface ▪ Ethernet-based fieldbus (EtherNet/IP)	Special Documentation for the device
DeviceCare SFE100	Notebook, PC or tablet with Microsoft Windows system	▪ CDI-RJ45 service interface ▪ WLAN interface ▪ Fieldbus protocol	→ 105

Supported operating tools	Operating unit	Interface	Additional information
FieldCare SFE500	Notebook, PC or tablet with Microsoft Windows system	▪ CDI-RJ45 service interface ▪ WLAN interface ▪ Fieldbus protocol	→ 🖹 105
Device Xpert	Field Xpert SFX 100/350/370	Fieldbus protocol HART	Operating Instructions BA01202S Device description files: Use update function of handheld terminal

Other operating tools based on FDT technology with a device driver such as DTM/iDTM or DD/EDD can be used for device operation. These operating tools are available from the individual manufacturers. Integration into the following operating tools, among others, is supported:

- FactoryTalk AssetCentre (FTAC) from Rockwell Automation → www.rockwellautomation.com
- Process Device Manager (PDM) from Siemens → www.siemens.com
- Asset Management Solutions (AMS) from Emerson → www.emersonprocess.com
- FieldCommunicator 375/475 from Emerson → www.emersonprocess.com
- Field Device Manager (FDM) from Honeywell → www.honeywellprocess.com
- FieldMate from Yokogawa → www.yokogawa.com
- PACTWare → www.pactware.com

The related device description files are available: www.endress.com → Downloads

Web server

Thanks to the integrated Web server, the device can be operated and configured via a Web browser and via a service interface (CDI-RJ45) or via a WLAN interface. The structure of the operating menu is the same as for the local display. In addition to the measured values, device status information is also displayed, allowing users to monitor the status of the device. Furthermore the device data can be managed and the network parameters can be configured.

A device that has a WLAN interface (can be ordered optionally) is required for the WLAN connection: order code for "Display", option BA "WLAN". The device acts as an Access Point and enables communication by computer or a mobile handheld terminal.

Supported functions
Data exchange between the operating unit (such as a notebook for example) and the measuring device:
- Upload the configuration from the measuring device (XML format, configuration backup)
- Save the configuration to the measuring device (XML format, restore configuration)
- Export event list (.csv file)
- Export parameter settings (.csv file or PDF file, document the measuring point configuration)
- Export the Heartbeat verification log (PDF file, only available with the "Heartbeat Verification" application package)
- Flash firmware version for device firmware upgrade, for instance
- Download driver for system integration
- Visualize up to 1000 saved measured values (only available with the **Extended HistoROM** application package → 🖹 103)

Web server special documentation → 🖹 106

HistoROM data management

The measuring device features HistoROM data management. HistoROM data management comprises both the storage and import/export of key device and process data, making operation and servicing far more reliable, secure and efficient.

Additional information on the data storage concept

There are different types of data storage units in which device data are stored and used by the device:

	HistoROM backup	T-DAT	S-DAT

Available data	▪ Event logbook such as diagnostic events for example
	▪ Device firmware package
	▪ Driver for system integration for exporting via Web server, e.g:
	  ▪ GSD for PROFIBUS DP
	  ▪ EDS for EtherNet/IP
		▪ Measured value logging ("Extended HistoROM" order option)
		▪ Current parameter data record (used by firmware at run time)
		▪ Peakhold indicator (min/max values)
		▪ Totalizer values
			▪ Sensor data: nominal diameter etc.
			▪ Serial number
			▪ Calibration data
			▪ Device configuration (e.g. SW options, fixed I/O or multi I/O)

Storage location	Fixed on the user interface board in the connection compartment	Attachable to the user interface board in the connection compartment	In the sensor plug in the transmitter neck part

Data backup

Automatic
- The most important device data (sensor and transmitter) are automatically saved in the DAT modules
- If the transmitter or measuring device is replaced: once the T-DAT containing the previous device data has been exchanged, the new measuring device is ready for operation again immediately without any errors
- If the sensor is replaced: once the sensor has been replaced, new sensor data are transferred from the S-DAT in the measuring device and the measuring device is ready for operation again immediately without any errors

Data transmission

Manual
- Transfer of a device configuration to another device using the export function of the specific operating tool, e.g. with FieldCare, DeviceCare or Web server: to duplicate the configuration or to store in an archive (e.g. for backup purposes)
- Transmission of the drivers for system integration via Web server, e.g.:
  - GSD for PROFIBUS DP
  - EDS for EtherNet/IP

Event list

Automatic
- Chronological display of up to 20 event messages in the events list
- If the **Extended HistoROM** application package (order option) is enabled: up to 100 event messages are displayed in the events list along with a time stamp, plain text description and remedial measures
- The events list can be exported and displayed via a variety of interfaces and operating tools e.g. DeviceCare, FieldCare or Web server

Data logging

Manual
If the **Extended HistoROM** application package (order option) is enabled:
- Record up to 1 000 measured values via 1 to 4 channels
- User configurable recording interval
- Record up to 250 measured values via each of the 4 memory channels
- Export the measured value log via a variety of interfaces and operating tools e.g. FieldCare, DeviceCare or web server

Certificates and approvals

Current certificates and approvals for the product are available via the Product Configurator at www.endress.com.

1. Select the product using the filters and search field.
2. Open the product page.

The **Configuration** button opens the Product Configurator.

CE mark

The device meets the legal requirements of the applicable EU Directives. These are listed in the corresponding EU Declaration of Conformity along with the standards applied.

Endress+Hauser confirms successful testing of the device by affixing to it the CE mark.

UKCA marking

The device meets the legal requirements of the applicable UK regulations (Statutory Instruments). These are listed in the UKCA Declaration of Conformity along with the designated standards. By selecting the order option for UKCA marking, Endress+Hauser confirms a successful evaluation and testing of the device by affixing the UKCA mark.

Contact address Endress+Hauser UK:
Endress+Hauser Ltd.
Floats Road
Manchester M23 9NF
United Kingdom
www.uk.endress.com

RCM mark

The measuring system meets the EMC requirements of the "Australian Communications and Media Authority (ACMA)".

Ex approval

The devices are certified for use in hazardous areas and the relevant safety instructions are provided in the separate "Control Drawing" document. Reference is made to this document on the nameplate.

Drinking water approval

- ACS
- KTW/W270
- NSF 61
- WRAS BS 6920

HART certification

HART interface

The measuring device is certified and registered by the FieldComm Group. The measuring system meets all the requirements of the following specifications:
- Certified according to HART 7
- The device can also be operated with certified devices of other manufacturers (interoperability)

PROFIBUS conformity

PROFIBUS interface

The measuring device is registered with PI (PROFIBUS and PROFINET International). It meets all the requirements of PROFIBUS PA Profile 3.02 specifications and can also be operated with certified devices of other manufacturers (interoperability).

Modbus RS485 certification

The measuring device meets all the requirements of the MODBUS/TCP conformity test and has the "MODBUS/TCP Conformance Test Policy, Version 2.0". The measuring device has successfully passed all the test procedures carried out.

EtherNet/IP certification

The measuring device is certified and registered by the ODVA (Open Device Vendor Association). The measuring system meets all the requirements of the following specifications:
- Certified in accordance with the ODVA Conformance Test
- EtherNet/IP Performance Test
- EtherNet/IP PlugFest compliance
- The device can also be operated with certified devices of other manufacturers (interoperability)

Radio approval

The measuring device has radio approval.

For detailed information regarding radio approval, see the Special Documentation → 106

Measuring instrument approval

The measuring device is (optionally) approved as a cold water meter (MI-001) for volume measurement in service subject to legal metrological control in accordance with the European Measuring Instruments Directive 2014/32/EU (MID).

The measuring device is qualified to OIML R49: 2013.

Other standards and guidelines

- EN 60529
  Degrees of protection provided by enclosures (IP code)
- EN 61010-1
  Safety requirements for electrical equipment for measurement, control and laboratory use - general requirements
- IEC/EN 61326-3-2
  Emission in accordance with Class A requirements. Electromagnetic compatibility (EMC requirements).
- ANSI/ISA-61010-1 (82.02.01)
  Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use - Part 1 General Requirements
- CAN/CSA-C22.2 No. 61010-1-12
  Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use - Part 1 General Requirements
- NAMUR NE 21
  Electromagnetic compatibility (EMC) of industrial process and laboratory control equipment
- NAMUR NE 32
  Data retention in the event of a power failure in field and control instruments with microprocessors
- NAMUR NE 43
  Standardization of the signal level for the breakdown information of digital transmitters with analog output signal.
- NAMUR NE 53
  Software of field devices and signal-processing devices with digital electronics
- NAMUR NE 105
  Specifications for integrating fieldbus devices in engineering tools for field devices
- NAMUR NE 107
  Self-monitoring and diagnosis of field devices
- NAMUR NE 131
  Requirements for field devices for standard applications

Ordering information

Detailed ordering information is available for your nearest sales organization www.addresses.endress.com or in the Product Configurator under www.endress.com :

1. Click Corporate
2. Select the country
3. Click Products
4. Select the product using the filters and search field
5. Open the product page

The Configuration button to the right of the product image opens the Product Configurator.

Product Configurator - the tool for individual product configuration
- Up-to-the-minute configuration data
- Depending on the device: Direct input of measuring point-specific information such as measuring range or operating language
- Automatic verification of exclusion criteria
- Automatic creation of the order code and its breakdown in PDF or Excel output format
- Ability to order directly in the Endress+Hauser Online Shop

Application packages

Many different application packages are available to enhance the functionality of the device. Such packages might be needed to address safety aspects or specific application requirements.

The application packages can be ordered with the device or subsequently from Endress+Hauser. Detailed information on the order code in question is available from your local Endress+Hauser sales center or on the product page of the Endress+Hauser website: www.endress.com.

Cleaning

Package	Description
Electrode cleaning circuit (ECC)	The electrode cleaning circuit (ECC) function has been developed to have a solution for applications where magnetite (Fe_3O_4) deposits frequently occur (e.g. hot water). Since magnetite is highly conductive this build up leads to measuring errors and ultimately to the loss of signal. The application package is designed to avoid build-up of very conductive matter and thin layers (typical of magnetite).

Diagnostics functions

Package	Description
Extended HistoROM	Comprises extended functions concerning the event log and the activation of the measured value memory. Event log: Memory volume is extended from 20 message entries (standard version) to up to 100 entries. Data logging (line recorder): ▪ Memory capacity for up to 1000 measured values is activated. ▪ 250 measured values can be output via each of the 4 memory channels. The recording interval can be defined and configured by the user. ▪ Measured value logs can be accessed via the local display or operating tool e.g. FieldCare, DeviceCare or Web server.

Heartbeat Technology

Package	Description
Heartbeat Verification +Monitoring	**Heartbeat Verification** Meets the requirement for traceable verification to DIN ISO 9001:2008 Chapter 7.6 a) "Control of monitoring and measuring equipment". ▪ Functional testing in the installed state without interrupting the process. ▪ Traceable verification results on request, including a report. ▪ Simple testing process via local operation or other operating interfaces. ▪ Clear measuring point assessment (pass/fail) with high test coverage within the framework of manufacturer specifications. ▪ Extension of calibration intervals according to operator's risk assessment. **Heartbeat Monitoring** Continuously supplies data, which are characteristic of the measuring principle, to an external condition monitoring system for the purpose of preventive maintenance or process analysis. These data enable the operator to: ▪ Draw conclusions - using these data and other information - about the impact process influences (such as corrosion, abrasion, buildup etc.) have on the measuring performance over time. ▪ Schedule servicing in time. ▪ Monitor the process or product quality, e.g. gas pockets.

Accessories

Various accessories, which can be ordered with the device or subsequently from Endress+Hauser, are available for the device. Detailed information on the order code in question is available from your local Endress+Hauser sales center or on the product page of the Endress+Hauser website: www.endress.com.

Device-specific accessories

For the transmitter

Accessories	Description
Promag 400 transmitter	Transmitter for replacement or storage. Use the order code to define the following specifications: ▪ Approvals ▪ Output/input ▪ Display/operation ▪ Housing ▪ Software For details, see Installation Instructions EA00104D

Display guard	Is used to protect the display against impact or scoring, for example from sand in desert areas. Order number: 71228792 Installation Instructions EA01093D
Connecting cable for remote version	Coil current and electrode cables, various lengths, reinforced cables available on request.
Ground cable	Set, consisting of two ground cables for potential equalization.
Post mounting kit	Post mounting kit for transmitter.
Compact → Remote conversion kit	For converting a compact device version to a remote device version.
Conversion kit Promag 50/53 → Promag 400	For converting a Promag with transmitter 50/53 to a Promag 400.

For the sensor

Accessory	Description
Ground disks	Are used to ground the medium in lined measuring tubes to ensure proper measurement. For details, see Installation Instructions EA00070D

Communication-specific accessories

Accessories	Description
Commubox FXA195 HART	For intrinsically safe HART communication with FieldCare via the USB interface. Technical Information TI00404F
Commubox FXA291	Connects Endress+Hauser field devices with a CDI interface (= Endress+Hauser Common Data Interface) and the USB port of a computer or laptop. Technical Information TI405C/07
HART Loop Converter HMX50	Is used to evaluate and convert dynamic HART process variables to analog current signals or limit values. ▪ Technical Information TI00429F ▪ Operating Instructions BA00371F
Wireless HART adapter SWA70	Is used for the wireless connection of field devices. The WirelessHART adapter can be easily integrated into field devices and existing infrastructures, offers data protection and transmission safety and can be operated in parallel with other wireless networks with minimum cabling complexity. Operating Instructions BA00061S
Fieldgate FXA42	Is used to transmit the measured values of connected 4 to 20 mA analog measuring devices, as well as digital measuring devices ▪ Technical Information TI01297S ▪ Operating Instructions BA01778S ▪ Product page: www.endress.com/fxa42

Field Xpert SMT70	The Field Xpert SMT70 tablet PC for device configuration enables mobile plant asset management in hazardous and non-hazardous areas. It is suitable for commissioning and maintenance staff to manage field instruments with a digital communication interface and to record progress. This tablet PC is designed as an all-in-one solution with a preinstalled driver library and is an easy-to-use, touch-sensitive tool which can be used to manage field instruments throughout their entire life cycle. ▪ Technical Information TI01342S ▪ Operating Instructions BA01709S ▪ Product page: www.endress.com/smt70
Field Xpert SMT77	The Field Xpert SMT77 tablet PC for device configuration enables mobile plant asset management in areas categorized as Ex Zone 1. ▪ Technical Information TI01418S ▪ Operating Instructions BA01923S ▪ Product page: www.endress.com/smt77

Service-specific accessories

Accessory	Description
Applicator	Software for selecting and sizing Endress+Hauser measuring devices: ▪ Choice of measuring devices with industrial requirements ▪ Calculation of all the necessary data for identifying the optimum flowmeter: e.g. nominal diameter, pressure loss, flow velocity and accuracy. ▪ Graphic illustration of the calculation results ▪ Determination of the partial order code, administration, documentation and access to all project-related data and parameters over the entire life cycle of a project. Applicator is available: ▪ Via the Internet: https://portal.endress.com/webapp/applicator ▪ As a downloadable DVD for local PC installation.
W@M	W@M Life Cycle Management Improved productivity with information at your fingertips. Data relevant to a plant and its components is generated from the first stages of planning and during the asset's complete life cycle. W@M Life Cycle Management is an open and flexible information platform with online and on-site tools. Instant access for your staff to current, in-depth data shortens your plant's engineering time, speeds up procurement processes and increases plant uptime. Combined with the right services, W@M Life Cycle Management boosts productivity in every phase. For more information, see: www.endress.com/lifecyclemanagement
FieldCare	FDT-based plant asset management tool from Endress+Hauser. It can configure all smart field units in your system and helps you manage them. By using the status information, it is also a simple but effective way of checking their status and condition. Operating Instructions BA00027S and BA00059S
DeviceCare	Tool for connecting and configuring Endress+Hauser field devices. Innovation brochure IN01047S
Commubox FXA291	Connects Endress+Hauser field devices with a CDI interface (= Endress +Hauser Common Data Interface) and the USB port of a computer or laptop. Technical Information TI00405C

System components

Accessories	Description
Memograph M graphic data manager	The Memograph M graphic data manager provides information on all the relevant measured variables. Measured values are recorded correctly, limit values are monitored and measuring points analyzed. The data are stored in the 256 MB internal memory and also on a SD card or USB stick. ▪ Technical Information TI00133R ▪ Operating Instructions BA00247R

Supplementary documentation

For an overview of the scope of the associated Technical Documentation, refer to the following:
- *W@M Device Viewer* (www.endress.com/deviceviewer): Enter the serial number from the nameplate
- *Endress+Hauser Operations App*: Enter the serial number from the nameplate or scan the matrix code on the nameplate

Standard documentation

Brief Operating Instructions

Brief Operating Instructions for the sensor

Measuring device	Documentation code
Proline Promag W	KA01266D

Transmitter Brief Operating Instructions

Measuring device	Documentation code			
	HART	PROFIBUS DP	Modbus RS485	EtherNet/IP
Proline 400	KA01263D	KA01420D	KA01419D	KA01418D

Operating Instructions

Measuring device	Documentation code			
	HART	PROFIBUS DP	Modbus RS485	EtherNet/IP
Promag W 400	BA01063D	BA01234D	BA01231D	BA01214D

Description of device parameters

Measuring device	Documentation code			
	HART	PROFIBUS DP	Modbus RS485	EtherNet/IP
Promag 400	GP01043D	GP01044D	GP01045D	GP01046D

Supplementary device-dependent documentation

Special Documentation

Content	Documentation code
Display modules A309/A310	SD01793D
Information on Custody Transfer Measurement	SD02038D
Information on Custody Transfer Measurement	SD02561D

Content	Documentation code			
	HART	PROFIBUS DP	Modbus RS485	EtherNet/IP
Web server	SD01811D	SD01813D	SD01812D	SD01814D
Heartbeat Verification + Monitoring	SD01847D	SD02569D	SD02568D	SD02570D

Installation Instructions

Content	Comment
Installation instructions for spare part sets and accessories	Documentation code: specified for each individual accessory → 🖹 103.

Registered trademarks

HART®
Registered trademark of the FieldComm Group, Austin, USA

PROFIBUS®
Registered trademark of the PROFIBUS User Organization, Karlsruhe, Germany

Modbus®
Registered trademark of SCHNEIDER AUTOMATION, INC.

EtherNet/IP™
Trademark of ODVA, Inc.



www.addresses.endress.com

Endress+Hauser

People for Process Automation

INS-02

TMP SENSOR

For Earth, For Life
Kubota

Submittal Transmittal

TMP Sensor

Project Name	TAYLOR BAY BEACH CLUB WWTF UPGRADE
Project Site	8220 178TH AVENUE, LONGBRANCH, WA 98351
Engineer	Gray & Osborne, Inc 1130 RAINIER AVENUE SOUTH, SUITE 300
Submit to	Gray & Osborne, Inc
Prepared by	Shingo Kubo | Lead Project Manager KUBOTA Water and Environment U.S.A. Corporation 19910 N Creek Pkwy, Suite 100 Bothell, WA 98011
KMU Project #	KMU-OPID85
Issued Date	September 29, 2025
Package #	OPID85- INS-02-C-TMP Sensor
Item	Tag # 01 PTR 01 01 PTR 02

Clarifications;

1. Section1 contains Kubota scope list. The subjected item for this submittal is marked in red.

2. Section2 contains the manufacture submittal and datasheet for review.

Response to 60% review comment;

1) General – Make Corrections Noted

a. Note that BABA certifications from manufacturers should be included in the final

Kubota Response: Endress Hauser instruments do not comply with BABA requirement as shown in ATTACHMENT B.

ATTACHMENT B

SCOPE OF SUPPLY COMPONENTS THAT DO NOT COMPLY WITH BABA REQUIREMENTS

Part Identification (Name)	Equipment Description and Type	Manufacturer	Number of Units	Total Lump Sum Equipment Cost for Line Item
Kubota SMU Equipment	FS150 SMU Units + Associated Lifting Tool	Kubota	4 SMUs 1 Lifting Tool + Chains	$80,400.00
SMU Basin Associated Endress + Hauser Instrumentation	1. Air Pressure Transmitters 2. Blower Flow Meters 3. Permeate Flow Meter 4. Pump Pressure Transmitter 5. Level Transmitter	Endress + Hauser	Type 1 - QTY 3 Type 2 - QTY 2 Type 3 - QTY 1 Type 4 - QTY 2 Type 5 - QTY 2	$33,896.00
SMU Basin Hach Instrumentation	1. Air Pressure Transmitters 2. Blower Flow Meters 3. Permeate Flow Meters	Hach	Type 1 - QTY 1 Type 2 - QTY 1 Type 3 - QTY 1	$12,633.00
Kubota Standard CIP System	Kubota CIP system based around Mazzei injector, rotometer and flow control valve	Various	1 System of Supply	$18,500.00
PVC Isolation Valves + Check Valves	3 inch PVC Ball Valves 3 inch PVC Check Valves	Asahi	11 Ball Valves 3 Check Vavles	$11,072.00

b. Note that manufacturer services should be included in the final submittal.

Kubota Response: Manufacturer service is included per the specifications. For the items that Kubota is certified to provide service, Kubota will provide it.

14) INS-02-A-TMP Sensor – No Exceptions Taken / Make Corrections Noted / Amend & Resubmit

a. The model number listed is acceptable. Please edit the PDF to indicated only those items, models, or series of equipment that are being supplied and cross out all extraneous material per 01300.

Kubota Response: See section 2 for the equipment datasheet with cross out.

b. Note that all hardware needs to be 316 stainless steel in accordance with 13418 2.4.

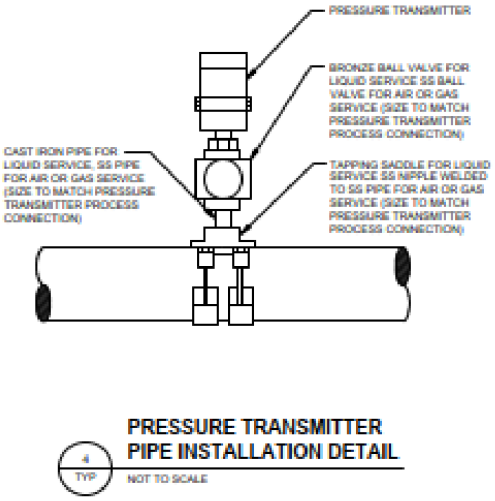
Kubota Response: Kubota believes that SECTION 13419 applies to TMP sensor (pressure transmitter). 316L is used for process connection and the connection housing. The electrical housing with display is coated aluminum Nema4X. Remote display mount type has been selected in order to place the electrical housing with display away from permeate piping and closed to operator's accessible location to operate it. Ceramic is recommended for the material of sensor element as ceramic is considered more robust than metallic plate for vacuum applications. Please confirm if this approach is acceptable.

Response to 100% review comment;

14) INS-02-A-TMP Sensor – No Exceptions Taken / Make Corrections Noted / Amend &

Resubmit

a. The submitted sensor model is acceptable; however the single compartment, integral, pipe mounted unit is preferred to the remote display. Please revise this section as noted. See detail from current plan set below:



4 TYP **PRESSURE TRANSMITTER PIPE INSTALLATION DETAIL**
NOT TO SCALE

Kubota Response: The submittal has been updated accordingly.

For Earth, For Life
Kubota

SECTION 1

KUBOTA Water and Environment U.S.A. Corporation
19910 N Creek Pkwy, Suite 100 Bothell, WA 98011| Phone: 425 898 2858 | Fax: 425-898-2853

No	Equipment Location	Tag	Category	Function	Name	Type	Chosen Size/Capacity	Unit	Material	Manufacturer	Model/ Specification	Motor HP	Voltage	FLA	QTY
	MBR Equipment	**x**													
1	MBR	02 MBR 01 02 MBR 02 02 MBR 03 02 MBR 04	SMU	Membrane Filtration	MBR SMU	Flat Plate			304SS	KUBOTA	FS150				4
2	MBR	n/a	SMU	SMU Maintenance	MBR SMU Lifting Tool	Lifting Tool			CS, SS	KUBOTA	TG150				1
3	MBR	n/a	SMU	SMU Maintenance	MBR SMU Lifting Chain	Lifting Tool			304SS	KUBOTA	CS30M				4
4	MBR	02 MOV 03 02 MOV 04	Auto Valve	Diffuser Cleaning	MBR Diffuser Cleaning Valve	ON/OFF Plug	3	inch	CI/CI	Auma/Pratt	SQ12.2-AC01.2/S601 w/extention stem	1/12	120 VAC	2.9	2
5	MBR	n/a	Other Valve	Isolation Valve	SMU Air Isolation Valve(inlet)	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S30				4
6	MBR	n/a	Other Valve	Isolation Valve	SMU Air Isolation Valve(outlet)	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S30				4
7	MBR	BV281 BV282 BV283 BV284	Other Valve	Isolation Valve	SMU PRMT Isolation Valve	Manual Butterfly	2	inch	DI, EPDM, Nylon Coat	Bray	S30				4
8	MBR	n/a	Other Valve	Manual Valves	Isolation Valves for CIP injection	Manual Ball	1	inch	PVC	ASAHI	Type21 True Union				4
9	MBR	02 LS 03 02 LS 04 02 LS 05 02 LS 06	Gauge, Switch	Level Measurement	MBR Level Switch	Float			PP, PU	Conery	2902-B8S1 w/ counter weight and brackets		Loop power		4
10	MBR	n/a	Fabrication	Fabrication	MBR SMU Guide & Stabilizer + Seismic Bracing				304SS	TBD					4
11	MBR	n/a	Fabrication	Fabrication	MBR SMU Fasteners				304SS	TBD					40
12	MBR	n/a	Fabrication	Fabrication	MBR In-Basin Pipe&Supports (Permeate Drop Pipe)				PVC	TBD					4
13	MBR	n/a	Fabrication	Fabrication	MBR In-Basin Pipe&Supports (Air Drop Pipe)				304SS	TBD					8
	Permeate (PRMT) Control Equipment	**x**													
14	PRMT	01 PMP 01 01 PMP 02 01 PMP 03	Permeate Pump	Permeate Extraction	PRMT Pump	Rotary Lobe	45	gpm		Boerger	AN 70 w/ piggyback mount	5	460 VAC	6.6	3
15	PRMT	PI169 PI170 PI171	Gauge, Switch	Pressure Gauge	PRMT Pump Pressuge Gauge(Inlet)		-15 - +15	psig	SS	Ashcroft or equivalent	1279 w/ grycelin filled				3
16	PRMT	PI172 PI173 PI174	Gauge, Switch	Pressure Gauge	PRMT Pump Pressuge Gauge (Inlet)		-15 - +15	psig	SS	Ashcroft or equivalent	1279 w/ grycelin filled				3
17	PRMT	01 PTR 01 01 PTR 02	Pressure Sensor	TMP Measurement	PRMT Pump Pressure Transmitter	Diaphragm	-15 - +15	psi	SS	Endress & Hauser	Cerabar PMCB51		Loop power		2
18	PRMT	01 MFM 01 01 MFM 02	Flow Sensor	Flow Measurement	PRMT Flow Meter	Electromagnetic	3	inch	PU	Endress & Hauser	Promag W 400		24VDC		2
19	MBR	n/a	Other Valve	Isolation Valve	MBR PRMT Pump isolation valve	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S30				8
20	MBR	CV261 CV261 CV261	Other Valve	Check valve	MBR PRMT Pump discharge check valve	Manual ball	3	inch	PVC, EPDM	ASAHI	True Union Ball Check				3
21	PRMT	01 TM 01	Other Instrument	Turbidity Measurement	PRMT Turbidity Meter	Laser	0-5	NTU		HACH	TU5300sc				1
22	PRMT	01 TM 01	Other Instrument	Turbidity Measurement	PRMT Turbidity Transmitter					HACH	SC4500		24VDC		1
23	PRMT	n/a	Other Instrument	Turbidity Measurement	Turbidity Meter Maintenance Kit					HACH					1
	Return Activated Sludge (RAS) Control	**x**													
24	MBR	Relocated from MBR 02 SLS02 02 SLS03	Other Instrument	Level Measurement	MBR Level Sensor	Hydrostatic	15	ft	SS	Endress & Hauser	Waterpilot FMX21 w/ brackets		Loop power		2
	MBR Blower	**x**													
25	MBR BLW	01 MSB 01 01 MSB 02 01 MSB 03	Blower	Blower	MBR Blower	Positive Displacement	114	scfm	CI	Aerzen	GM 4S DN 80	5	460 VAC	6.6	3

No	Equipment Location	Tag	Category	Function	Name	Type	Chosen Size/Capacity	Unit	Material	Manufacturer	Model/ Specification	Motor HP	Voltage	FLA	QTY
26	MBR BLW	n/a	Option	Noise Suppression	MBR Blower Sound Enclosure	With Blower									3
27	MBR BLW	n/a	Option	Blower Temperature	MBR Blower Temperature Gauge	With Blower									3
28	MBR BLW	n/a	Option	Blower Pressure	MBR Blower Pressure Gauge	With Blower									3
29	MBR BLW	n/a	Option	Blower Temperature	MBR Blower Temperature Switch	With Blower									3
30	MBR BLW	01 AFM 01 01 AFM 02	Flow Sensor	Air Flow Measurement	MBR Blower Flow Meter	Thermal Mass	3	inch	PU	Endress & Hauser	t-mass I 300, w/ flow conditioner plate		24VDC		2
31	MBR BLW	n/a	Other Valve	Manual Valves	Air Scour Blower Isolation Valves	Manual Butterfly	3	inch	DI, FKM, SS Disk	Bray	S30				4
	Clean-In-Place Equipment	**x**													
32	SMU CIP	n/a	Chemical Injection	Chemical Injection	SMU CIP System PVC pipes		1	inch	PVC	KUBOTA	Loose ship parts shown on xxx				1
33	SMU CIP	n/a	Flow Sensor	Flow Measurement	CIP solution Flow Meter	Electromagnetic	1	inch	PU				24 VDC		1
34	SMU CIP	n/a	Flow Sensor	Flow Measurement	CIP shelf chenical Flow Meter	Electromagnetic	3/8	inch	PU	Keyence	FD-Q10C		24VDC		1
35	SMU CIP	n/a	Auto Valve	Flow Control	CIP Flow Control Valve	ON/OFF Ball	1	inch	DI	ASAHI	S19-120VAC--1"-C20/S20		120VAC	0.18	1
36	SMU CIP	n/a	Other Valve	Manual Valves	Isolation Valves on CIP Station	Manual Ball	1, 0.5	inch	PVC	ASAHI	Type21 True Union				1
37	SMU CIP	n/a	Other Valve	Manual Valves	Pressure reducing valve	Pressure Reducing	1.5	inch	CI	Zurn	ZW209				1
	System Control Equipment	**x**													
38	CONTROL	n/a	Control Panel	Control Panel	Control Panel	OIT, PLC					NEMA 4/12, 72" x 72" x 18" floor mount enclosure (estimated size) , Allen Bradley 1756-L81E PLC (BABA-Version), FactoryTalk View SE		120VAC	TBD	1
39	D. SERVICE	n/a	D. Service	Direct Service	Direct Service						Design support, start-up, field service, remote service				1

SECTION 2

TI01506P/00/EN/08.24-00
71647841
2024-03-26

Technical Information
Cerabar PMC51B

Process pressure and level measurement in liquids or gases



Digital pressure transmitter with ceramic process membrane

Applications

- Pressure measuring ranges: up to 40 bar (600 psi)
- Completely vacuum resistant: up to +100 °C (212 °F) process temperature
- Accuracy: up to ±0.055%

Advantages

The new Cerabar generation introduces a robust pressure transmitter that combines numerous benefits: Easiest local or remote operation, allows condition-based maintenance and offers smart safety in processes. The firmware is designed to ensure extremely easy handling. Intuitive and clear wizard navigation guides the user through the commissioning and verification of the device. The Bluetooth connectivity provides safe and remote operation. The large display guarantees excellent readability. The device features a ceramic membrane for abrasive, corrosive or vacuum applications with integrated membrane breakage diagnostic.

Endress+Hauser
People for Process Automation

Configuration summary

Mat. no.	Description Order code	Quantity	Unit
71409424	Cerabar PMC51B PMC51B-CABADJH63HFA1VNJD+FAF1JAKB~~MB~~	1	ST

010	Approval:	CA	CSA C/US General Purpose
020	Output:	BA	2-wire 4-20mA HART
030	Display; Operation:	D	Segment display w/o buttons + Bluetooth
040	Housing; Material:	J	Dual compartment; Alu, coated
050	Electrical Connection:	H	Thread NPT1/2, IP66/68 NEMA Type 4X/6P
055	Pressure Type:	6	Gauge
075	Sensor Range:	3H	1bar/100kPa/15psi
090	Calibration; Unit:	F	Sensor range; psi
105	Process Connection, Sealing Surface:	A1	Thread ASME B1.20.1, NPT
110	Process Connection:	VNJ	FNPT1/2, 316L
200	Seal:	D	FKM
545	>Reference Accuracy:	FA	Platinum
550	>Calibration:	F1	Factory calibration certificate, 5-point
580	>>Test, Certificate, Declaration:	JA	Inspection certificate 3.1, EN10204 (material certificate wetted metallic parts)
		KB	Pressure test, internal procedure, test report
~~600~~	~~>Sensor Design:~~	~~MB~~	~~Sensor remote, cable PE, 5m/200in + mounting bracket, wall/pipe, 316L~~

Remote version is removed.
Compact mount is applied.

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About this document

Symbols

Safety symbols

DANGER

This symbol alerts you to a dangerous situation. Failure to avoid this situation will result in serious or fatal injury.

WARNING

This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in serious or fatal injury.

CAUTION

This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minor or medium injury.

NOTICE

This symbol contains information on procedures and other facts which do not result in personal injury.

Electrical symbols

Ground connection: ⏚

Terminal for connection to the grounding system.

Symbols for certain types of information

Permitted: ✓

Procedures, processes or actions that are permitted.

Forbidden: ✗

Procedures, processes or actions that are forbidden.

Additional information: ℹ

Reference to documentation: 📖

Reference to page: 📄

Series of steps: 1., 2., 3.

Result of an individual step: ↳

Symbols in graphics

Item numbers: 1, 2, 3 ...

Series of steps: 1., 2., 3.

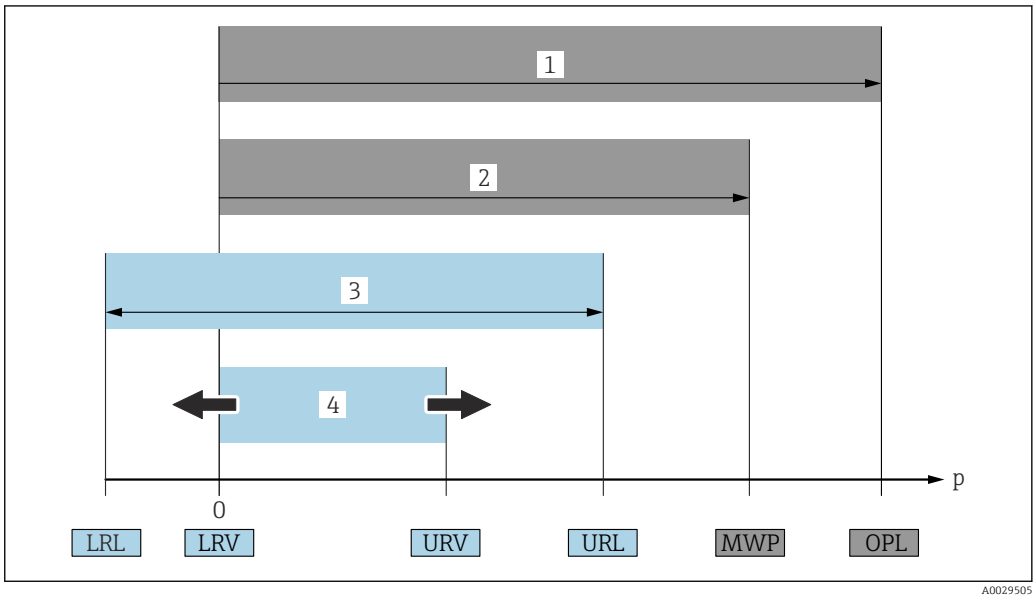
Views: A, B, C, ...

Symbols on the device

Safety instructions: ⚠ → 📖

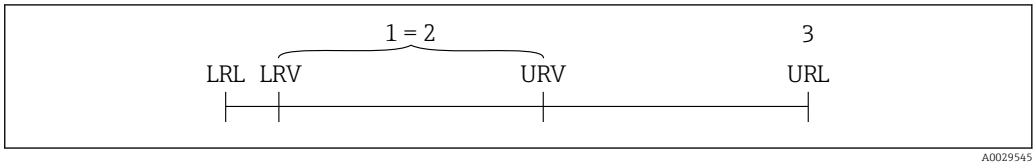
Observe the safety instructions contained in the associated Operating Instructions.

List of abbreviations



1 *OPL: The OPL (overpressure limit = measuring cell overload limit) for the device depends on the lowest-rated element, with regard to pressure, of the selected components, i.e. the process connection has to be taken into consideration in addition to the measuring cell. Pay attention to the pressure/temperature dependency.*
2 *The MWP (maximum working pressure) for the measuring cells depends on the lowest-rated element, with regard to pressure, of the selected components, i.e. the process connection has to be taken into consideration in addition to the measuring cell. Pay attention to the pressure/temperature dependency. The MWP may be applied at the device for an unlimited period of time. The MWP can be found on the nameplate.*
3 *The maximum measuring range corresponds to the span between the LRL and URL. This measuring range is equivalent to the maximum calibratable/adjustable span.*
4 *The calibrated/adjusted span corresponds to the span between the LRV and URV. Factory setting: 0 to URL. Other calibrated spans can be ordered as customized spans.*
p Pressure
LRL Lower range limit
URL Upper range limit
LRV Lower range value
URV Upper range value
TD Turn down. Example - see the following section.

Turn down calculation



1 *Calibrated/adjusted span*
2 *Zero point-based span*
3 *Upper range limit*

Example:
- Measuring cell: 10 bar (150 psi)
- Upper range limit (URL) = 10 bar (150 psi)
- Calibrated/adjusted span: 0 to 5 bar (0 to 75 psi)
- Lower range value (LRV) = 0 bar (0 psi)
- Upper range value (URV) = 5 bar (75 psi)

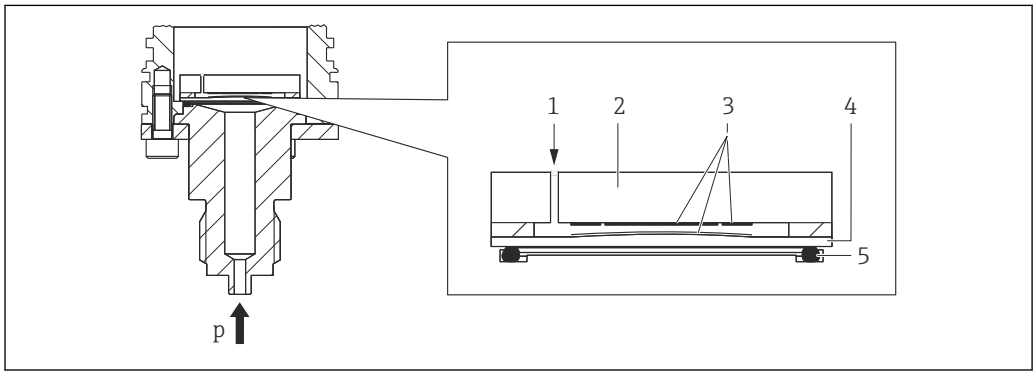
$$TD = \frac{URL}{|URV - LRV|}$$

In this example, the TD is therefore 2:1. This measuring span is based on the zero point.

Function and system design

Measuring principle

Ceramic membrane (Ceraphire®)



A0043088

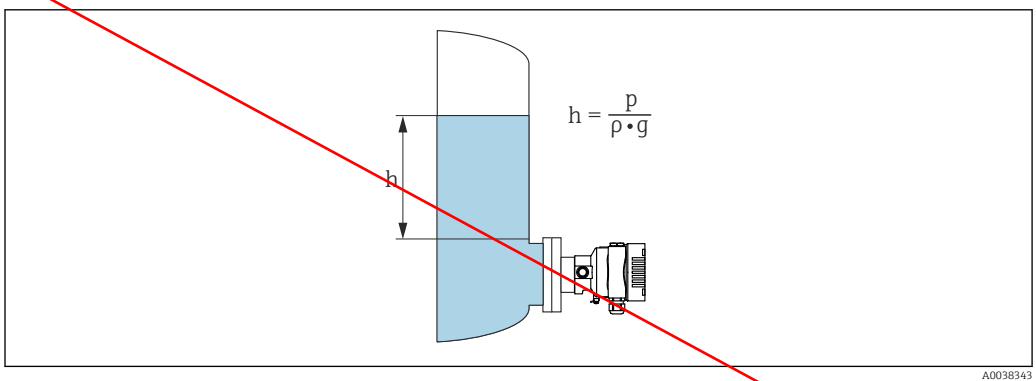
1 Atmospheric pressure (gauge pressure measuring cells)
2 Ceramic meter body
3 Electrodes
4 Ceramic membrane
5 Seal
p Pressure

The ceramic measuring cell is an oil-free measuring cell. The pressure acts directly on the robust ceramic membrane, causing it to deflect. A pressure-dependent change in capacitance is measured at the electrodes of the ceramic meter body and the membrane. The measuring range is determined by the thickness of the ceramic membrane.

Advantages:
- High overload resistance
- Thanks to ultrapure 99.9 % ceramic
  - Extremely high chemical durability
  - Resistant to abrasion and corrosion
  - High mechanical durability
- Suitable for vacuum applications

Measuring system

Level measurement (level, volume and mass):



A0038343

h Height (level)
p Pressure
ρ Density of the medium
g Gravitational acceleration

Advantages:

- Volume and mass measurements in any vessel shape with a freely programmable characteristic curve
- Has a wide range of uses, e.g.
  - For foam formation
  - In vessels with agitators or screen fittings
  - For liquid gases

Communication and data processing

- 4 to 20 mA with HART communication protocol (optional)
- Bluetooth (optional)
- PROFINET with Ethernet-APL: 10BASE-T1L communication protocol

Dependability for devices with HART, Bluetooth, PROFINET with Ethernet-APL

IT security

Endress+Hauser can only provide a warranty if the device is installed and used as described in the Operating Instructions. The device is equipped with security mechanisms to protect it against any inadvertent changes to the device settings. IT security measures in line with operators' security standards and designed to provide additional protection for the device and device data transfer must be implemented by the operators themselves.

Device-specific IT security

The device offers specific functions to support protective measures by the operator. These functions can be configured by the user and guarantee greater in-operation safety if used correctly. An overview of the most important functions is provided in the following section:

- Write protection via hardware write protection switch
- Access code to change user role (applies to operation via Bluetooth, FieldCare, DeviceCare and asset management tools (e.g. AMS, PDM and Web server)

Function/interface	Factory setting	Recommendation
Access code (also applies to Web server login or FieldCare connection)	Not enabled (0000)	Assign a customized access code during commissioning.
Web server	Enabled	On an individual basis following risk assessment.
Service interface (CDI)	Enabled	On an individual basis following risk assessment.
Write protection via hardware write protection switch	Not enabled	On an individual basis following risk assessment.

Protecting access via a password

Different passwords are available to protect write access to the parameters of the device.

Protect write access to the parameters of the device via the local display, Web browser or operating tool (e.g. FieldCare, DeviceCare). Access authorization is clearly regulated through the use of a user-specific access code.

User-specific access code

Write access to the parameters of the device via the local display, Web browser or operating tool (e.g. FieldCare, DeviceCare) can be protected using the editable, user-specific access code.

General notes on the use of passwords

- During commissioning, change the access code used when the device was delivered
- When defining and managing the access code, comply with the general rules for the generation of a secure password
- The user is responsible for managing the access code and for using the code with due care

Access via Web server

Thanks to the integrated Web server, the device can be operated and configured using a Web browser and via PROFINET with Ethernet-APL. In addition to the measured values, status information on the device is displayed and can be used to monitor device health. Furthermore the device data can be managed and the network parameters can be configured.

Access to the network is required for the PROFINET with Ethernet-APL connection.

Supported functions
Data exchange between the operating unit (such as a notebook, for example,) and measuring device:
- Export parameter settings (PDF file, create documentation of the measuring point configuration)
- Download driver (GSDML) for system integration

The Web server is enabled when the device is delivered. The Web server can be disabled via the **Web server functionality** parameter if necessary (e.g. after commissioning).

The device and status information can be hidden on the login page. This prevents unauthorized access to the information.

Detailed information on the device parameters:
"Description of Device Parameters" document

Input

Measured variable

Measured process variables

- Absolute pressure
- Gauge pressure

Measuring range

Depending on the device configuration, the maximum working pressure (MWP) and the overpressure limit (OPL) can deviate from the values in the tables.

Absolute pressure

Measuring cell	Maximum measuring range		Smallest calibratable span (preset at factory) [1]	
	lower (LRL)	upper (URL)		
	[bar_{abs} (psi_{abs})]	[bar_{abs} (psi_{abs})]	[bar (psi)]	Platinum
100 mbar (1.5 psi) 0		+0.1 (+1.5)	0.005 (0.075) [2]	20 mbar (0.3 psi)
250 mbar (3.75 psi)	0	+0.25 (+3.75)	0.005 (0.075) [3]	50 mbar (1 psi)
400 mbar (6 psi)	0	+0.4 (+6)	0.005 (0.075) [4]	80 mbar (1.2 psi)
1 bar (15 psi)	0	+1 (+15)	0.01 (0.15) [5]	200 mbar (3 psi)
2 bar (30 psi)	0	+2 (+30)	0.02 (0.3) [5]	400 mbar (6 psi)
4 bar (60 psi)	0	+4 (+60)	0.04 (0.6) [5]	800 mbar (12 psi)
10 bar (150 psi)	0	+10 (+150)	0.1 (1.5) [5]	2 bar (30 psi)
40 bar (600 psi)	0	+40 (+600)	0.4 (6) [5]	8 bar (120 psi)

1) The maximum TD is 5:1 in the case of platinum.
2) Largest factory-configurable turn down: 20:1
3) Largest factory-configurable turn down: 50:1
4) Largest factory-configurable turn down: 80:1
5) Largest factory-configurable turn down: 100:1

Absolute pressure

Measuring cell	MWP	OPL	Vacuum resistance	Burst pressure [1]
	[bar_{abs} (psi_{abs})]	[bar_{abs} (psi_{abs})]	[bar_{abs} (psi_{abs})]	[bar (psi)]
100 mbar (1.5 psi)	2.7 (40.5)	4 (60)	0	4 (60)
250 mbar (3.75 psi)	3.3 (49.5)	5 (75)	0	5 (75)
400 mbar (6 psi)	5.3 (79.5)	8 (120)	0	8 (120)
1 bar (15 psi)	6.7 (100.5)	10 (150)	0	10 (150)
2 bar (30 psi)	12 (180)	18 (270)	0	18 (270)
4 bar (60 psi)	16.7 (250.5)	25 (375)	0	25 (375)
10 bar (150 psi)	26.7 (400.5)	40 (600)	0	40 (600)
40 bar (600 psi)	40 (600)	60 (900)	0	60 (900)

1) The information applies to the standard device (without a diaphragm seal).

Gauge pressure

Measuring cell	Maximum measuring range		Smallest calibratable span (preset at factory) [1]	
	lower (LRL)	upper (URL)		
	[bar (psi)]	[bar (psi)]	[bar (psi)]	Platinum
100 mbar (1.5 psi)	−0.1 (−1.5)	+0.1 (+1.5)	0.005 (0.075) [2]	20 mbar (0.3 psi)
250 mbar (3.75 psi)	−0.25 (−3.75)	+0.25 (+3.75)	0.005 (0.075) [3]	50 mbar (1 psi)

Measuring cell	Maximum measuring range		Smallest calibratable span (preset at factory) [1]	
	lower (LRL)	upper (URL)		
	[bar (psi)]	[bar (psi)]	[bar (psi)]	Platinum
400 mbar (6 psi)	−0.4 (−6)	+0.4 (+6)	0.005 (0.075) [4]	80 mbar (1.2 psi)
1 bar (15 psi)	−1 (−15)	+1 (+15)	0.01 (0.15) [5]	200 mbar (3 psi)
2 bar (30 psi)	−1 (−15)	+2 (+30)	0.02 (0.3) [5]	400 mbar (6 psi)
4 bar (60 psi)	−1 (−15)	+4 (+60)	0.04 (0.6) [5]	800 mbar (12 psi)
10 bar (150 psi)	−1 (−15)	+10 (+150)	0.1 (1.5) [5]	2 bar (30 psi)
40 bar (600 psi)	−1 (−15)	+40 (+600)	0.4 (6) [5]	8 bar (120 psi)

1) The maximum TD is 5:1 in the case of platinum.
2) Largest factory-configurable turn down: 20:1
3) Largest factory-configurable turn down: 50:1
4) Largest factory-configurable turn down: 80:1
5) Largest factory-configurable turn down: 100:1

Gauge pressure

Measuring cell	MWP	OPL	Vacuum resistance	Burst pressure [1]
	[bar (psi)]	[bar (psi)]	[bar_{abs} (psi_{abs})]	[bar (psi)]
100 mbar (1.5 psi)	2.7 (40.5)	4 (60)	0.7 (10.5)	4 (60)
250 mbar (3.75 psi)	3.3 (49.5)	5 (75)	0.5 (7.5)	5 (75)
400 mbar (6 psi)	5.3 (79.5)	8 (120)	0	8 (120)
1 bar (15 psi)	6.7 (100.5)	10 (150)	0	10 (150)
2 bar (30 psi)	12 (180)	18 (270)	0	18 (270)
4 bar (60 psi)	16.7 (250.5)	25 (375)	0	25 (375)
10 bar (150 psi)	26.7 (400.5)	40 (600)	0	40 (600)
40 bar (600 psi)	40 (600)	60 (900)	0	60 (900)

1) The information applies to the standard device (without a diaphragm seal).

Output

Output signal

Current output

4 to 20 mA analog, 2-wire

4 to 20 mA with superimposed digital communication protocol HART, 2-wire

The current output offers a choice of three different operating modes:
- 4.0 to 20.5 mA
- NAMUR NE 43: 3.8 to 20.5 mA (factory setting)
- US mode: 3.9 to 20.8 mA

~~**PROFINET with Ethernet-APL**~~

10BASE-T1L, 2-wire 10 Mbit

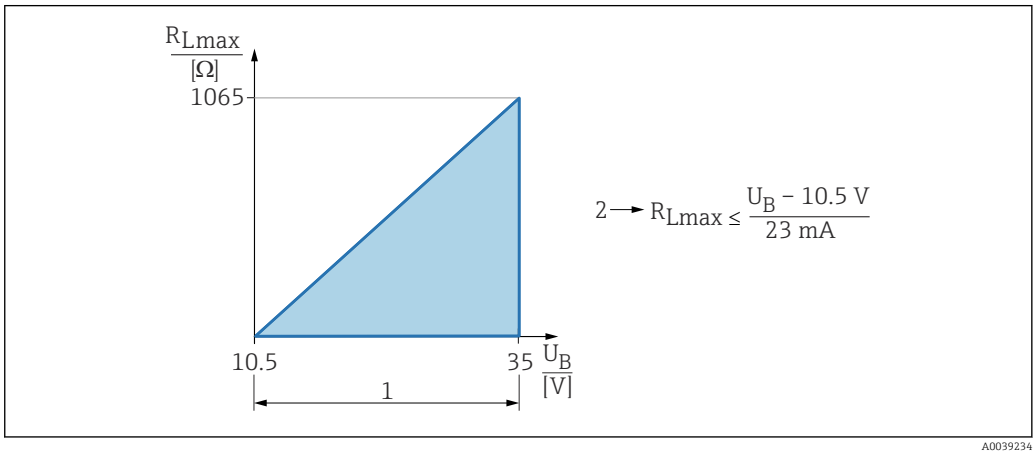
Signal on alarm

Signal on alarm in accordance with NAMUR recommendation NE 43.

- 4 to 20 mA analog:
  - Signal over-range: > 20.5 mA
  - Signal under-range: < 3.8 mA
  - Min alarm (< 3.6 mA, factory setting)
- 4 to 20 mA HART:
  Options:
  - Max alarm: can be set from 21.5 to 23 mA
  - Min. alarm: < 3.6 mA (factory setting)
- PROFINET with Ethernet-APL:
  - According to "Application layer protocol for decentralized periphery", Version 2.4
  - Diagnostics according to PROFINET PA Profile 4.02

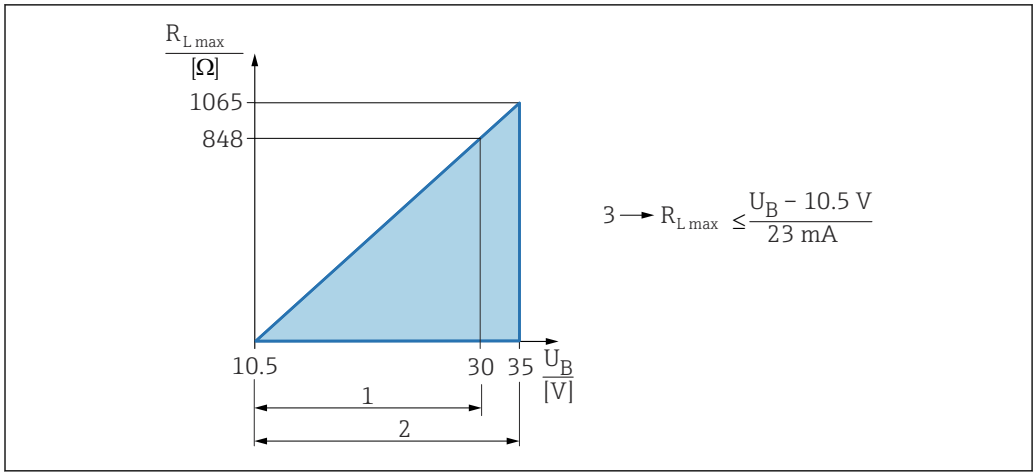
Load

4 to 20 mA analog



1 10.5 to 35 V power supply
2 R_{Lmax} maximum load resistance
U_B Supply voltage

4 to 20 mA HART



1 Power supply 10.5 to 30 VDC Ex i
2 Power supply 10.5 to 35 VDC, for other types of protection and non-certified device versions
3 R_{Lmax} maximum load resistance
U_B Supply voltage

Operation via handheld terminal or PC with operating program: take minimum communication resistance of 250 Ω into consideration.

Damping

A damping affects all outputs (output signal, display). Damping can be enabled as follows:
- Via the DIP switch on the electronic insert (analog electronics only)
- Factory setting: 1 s

Ex connection data

See the separate technical documentation (Safety Instructions (XA)) on www.endress.com/download.

Linearization

The device's linearization function allows the user to convert the measured value to any units of height or volume. User-defined linearization tables of up to 32 value pairs can be entered if necessary.

Protocol-specific data

HART

- Manufacturer ID: 17 (0x11{hex})
- Device type ID: 0x112A
- Device revision: 1
- HART specification: 7
- DD revision: 1
- Device description files (DTM, DD) information and files at:
  - www.endress.com
  - www.fieldcommgroup.org
- HART load: min. 250 Ohm

HART device variables (preset at the factory)

The following measured values are assigned to the device variables at the factory:

Device variable	Measured value
Primary variable (PV) [1]	Pressure [2]
Secondary variable (SV)	Sensor temperature

Device variable	Measured value
Tertiary variable (TV)	Electronics temperature
Quaternary variable (QV)	Sensor pressure [3]

1) The PV is always applied to the current output.
2) The pressure is the calculated signal after damping and position adjustment.
3) The Sensor pressure is the raw signal of the measuring cell before damping and position adjustment.

Choice of HART device variables

- **Pressure** option (after position adjustment and damping)
- Scaled variable
- Sensor temperature
- Sensor pressure
  Sensor Pressure is the raw signal from sensor before damping and position adjustment.
- Electronics temperature
- Percent of range
- Loop current
  The loop current is the output current set by the applied pressure.

Supported functions

- Burst mode
- Additional transmitter status
- Device locking

PROFINET with Ethernet-APL

Protocol	Application layer protocol for decentral device periphery and distributed automation, Version 2.4
Communication type	Ethernet Advanced Physical Layer 10BASE-T1L
Conformance Class	Conformance Class B
Netload Class	Netload Class II
Baud rates	Automatic 10 Mbit/s with full-duplex detection
Cycle times	From 32 ms
Polarity	Auto-polarity for automatic correction of crossed TxD and RxD pairs
Media Redundancy Protocol (MRP)	Yes
System redundancy support	System redundancy S2 (2 AR with 1 NAP)
Device profile	Application interface identifier 0xB310 Generic device
Manufacturer ID	0x11
Device type ID	A22A
Device description files (GSD, FDI, DTM, DD)	Information and files available at: ▪ www.endress.com On the product page for the device: Documents/Software → Device drivers ▪ www.profibus.org
Supported connections	▪ 2 x AR (IO Controller AR) ▪ 1 x AR (IO-Supervisor Device AR connection allowed) ▪ 1 x Input CR (Communication Relation) ▪ 1 x Output CR (Communication Relation) ▪ 1 x Alarm CR (Communication Relation)
Configuration options for device	▪ Manufacturer-specific software (FieldCare, DeviceCare) ▪ Web browser ▪ Device master file (GSD), can be read out via the integrated Web server of the device ▪ DIP switch for setting the service IP address

Configuration of the device name	▪ DCP protocol ▪ Process Device Manager (PDM) ▪ Integrated Web server
Supported functions	▪ Identification & maintenance Simple device identification via: ▪ Control system ▪ Nameplate ▪ Measured value status The process variables are communicated with a measured value status ▪ Blinking feature via the local display for simple device identification and assignment ▪ Device operation via operating tools (e.g., FieldCare, DeviceCare, SIMATIC PDM)
System integration	For information on system integration, see Operating Instructions ▪ Cyclic data transmission ▪ Overview and description of the modules ▪ Status coding ▪ Startup configuration ▪ Factory setting

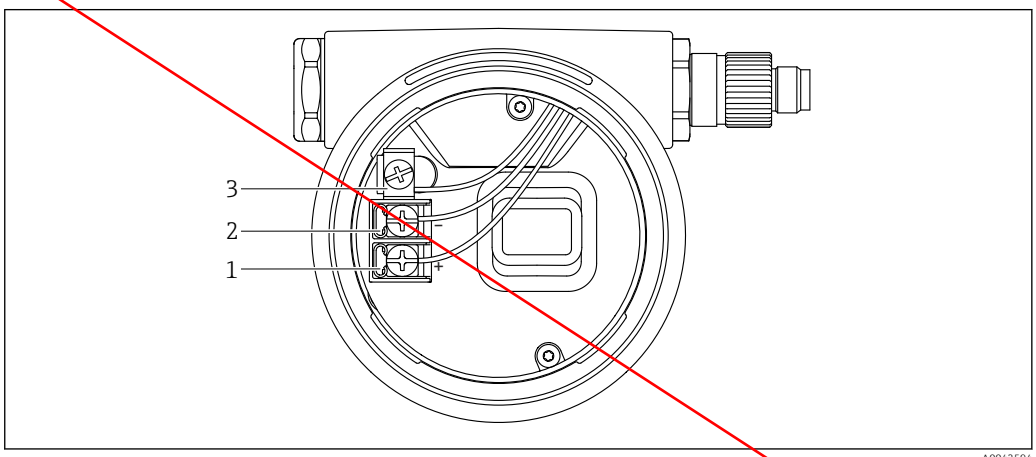
Wireless HART data

- Minimum starting voltage: 10.5 V
- Start-up current: 3.6 mA
- Start-up time: <5 s
- Minimum operating voltage: 10.5 V
- Multidrop current: 4 mA

Power supply

Terminal assignment

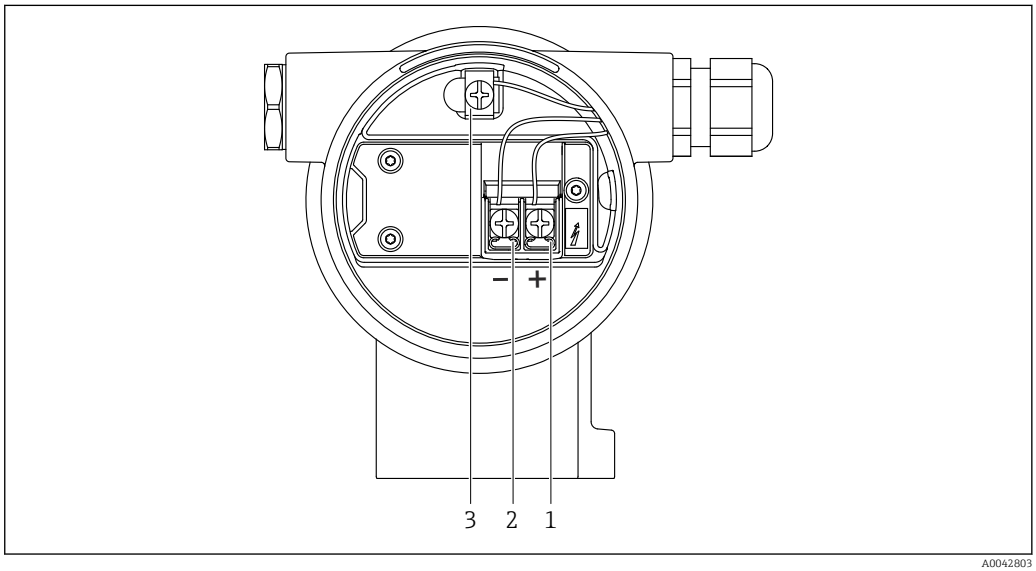
Single compartment housing



1 *Connection terminals and ground terminal in the connection compartment*

1 *Positive terminal*
2 *Negative terminal*
3 *Internal ground terminal*

Dual compartment housing



2 *Connection terminals and ground terminal in the connection compartment*

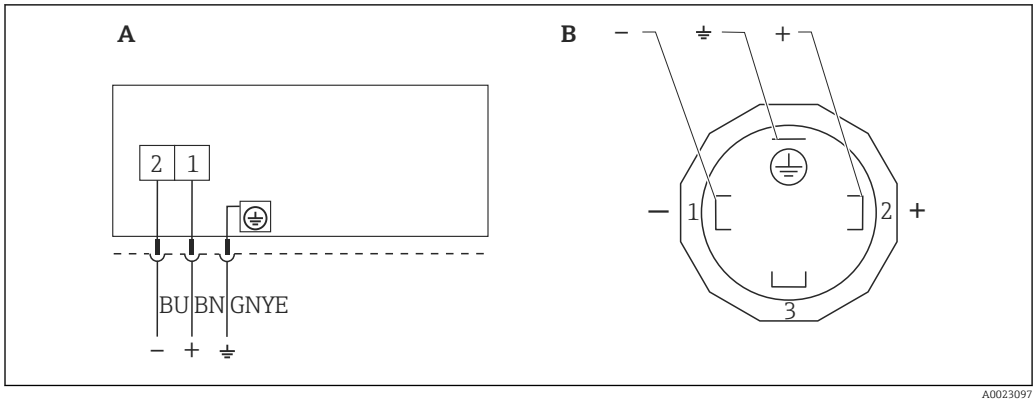
1 *Positive terminal*
2 *Negative terminal*
3 *Internal ground terminal*

Available device plugs

In the case of devices with a plug, it is not necessary to open the housing for connection purposes.

Use the enclosed seals to prevent the penetration of moisture into the device.

Devices with valve plug

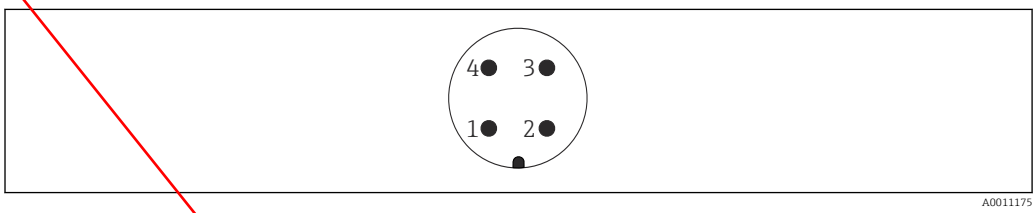


3 *BN = brown, BU = blue, GNYE = green/yellow*

A Electrical connection for devices with valve connector
B View of the plug-in connection on the device

Material: PA 6.6

Devices with M12 plug



4 *View of the plug-in connection on the device*

Pin	Analog/HART
1	Signal +
2	Not assigned
3	Signal –
4	Ground

Pin	PROFINET with Ethernet-APL
1	APL signal –
2	APL signal +
3	Shielding
4	Not assigned

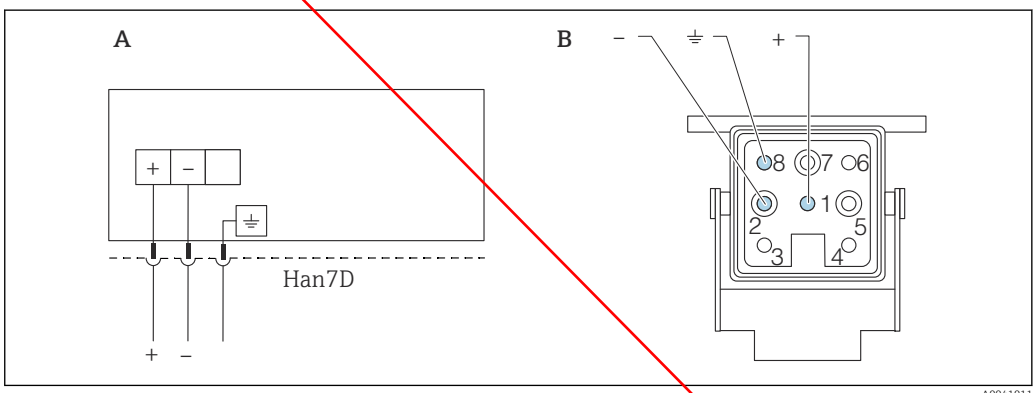
Endress+Hauser offers the following accessories for devices with an M12 plug:

Plug-in jack M 12x1, straight
- Material:
  Body: PBT; union nut: nickel-plated die-cast zinc; seal: NBR
- Degree of protection (fully locked): IP67
- Order number: 52006263

Plug-in jack M 12x1, elbowed (not for PROFINET with Ethernet-APL)
- Material:
  Body: PBT; union nut: nickel-plated die-cast zinc; seal: NBR
- Degree of protection (fully locked): IP67
- Order number: 71114212

Cable 4x0.34 mm² (20 AWG) with M12 plug-in jack, elbowed, screw plug, length 5 m (16 ft)
- Material: body: TPU; union nut: nickel-plated die-cast zinc; cable: PVC
- Degree of protection (fully locked): IP67/68
- Order number: 52010285
- Cable colors
  - 1 = BN = brown
  - 2 = WT = white
  - 3 = BU = blue
  - 4 = BK = black

Devices with a Harting plug Han7D



A Electrical connection for devices with Harting plug Han7D
B View of the plug-in connection on the device
- Brown
⏚ Green/yellow
+ Blue

Material: CuZn, gold-plated contacts of the plug-in jack and plug

Supply voltage

- Analog/HART: Ex d, Ex e, non-Ex: supply voltage: 10.5 to 35 V_{DC}
- Analog/HART: Ex i: supply voltage: 10.5 to 30 V_{DC}
- HART: Nominal current: 4 to 20 mA HART
- ~~PROFINET over Ethernet-APL: APL performance class A (9.6 to 15 V_{DC} 540 mW)~~

Analog/HART: The power unit must be safety-approved (e.g. PELV, SELV, Class 2) and must comply with the relevant protocol specifications. For 4 to 20 mA, the same requirements apply as for HART.

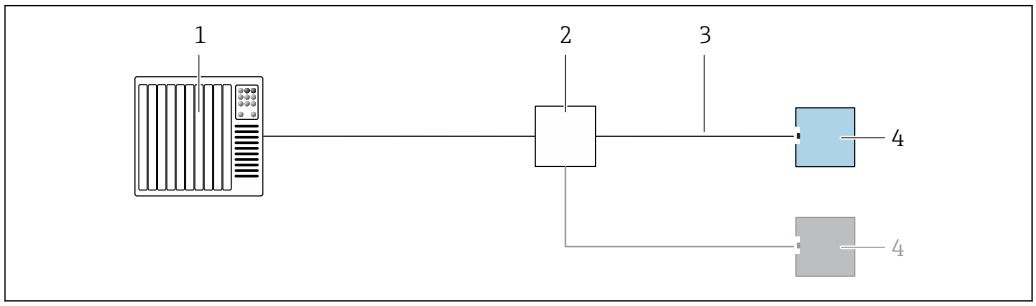
PROFINET with Ethernet-APL: The APL field switch must be safety-approved (e.g. PELV, SELV, Class 2) and must comply with the relevant protocol specifications.

A suitable circuit breaker should be provided for the device in accordance with IEC/EN 61010.

Electrical connection

Connection examples

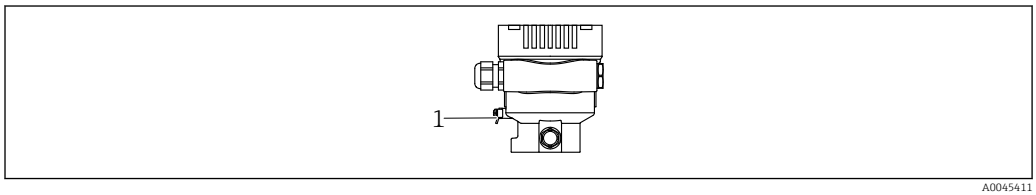
PROFINET with Ethernet-APL



5 Connection example for PROFINET with Ethernet-APL

1 *Automation system*
2 *APL field switch*
3 *Observe cable specifications*
4 *Transmitter*

Potential equalization



1 *Ground terminal for connecting the potential matching line*

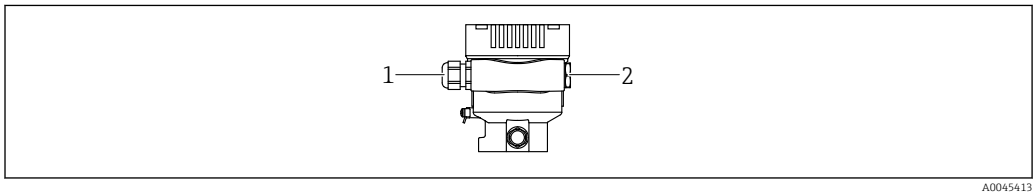
If necessary, the potential matching line can be connected to the outer ground terminal of the device before the device is connected.

For optimum electromagnetic compatibility:
- Keep the potential matching line as short as possible
- Maintain a cross-section of at least 2.5 mm² (14 AWG)

Terminals

- Supply voltage and internal ground terminal: 0.5 to 2.5 mm² (20 to 14 AWG)
- External ground terminal: 0.5 to 4 mm² (20 to 12 AWG)

Cable entries



1 *Cable entry*
2 *Dummy plug*

The type of cable entry depends on the device version ordered.

Always route connecting cables downwards so that moisture cannot penetrate the connection compartment.

If necessary, create a drip loop or use a weather protection cover.

Cable specification

- The cable outer diameter depends on the cable entry used
- Cable outer diameter
  - Plastic: Ø5 to 10 mm (0.2 to 0.38 in)
  - Nickel-plated brass: Ø7 to 10.5 mm (0.28 to 0.41 in)
  - Stainless steel: Ø7 to 12 mm (0.28 to 0.47 in)

PROFINET with Ethernet-APL

The reference cable type for APL segments is fieldbus cable type A, MAU type 1 and 3 (specified in IEC 61158-2). This cable meets the requirements for intrinsically safe applications according to IEC TS 60079-47 and can also be used in non-intrinsically safe applications.

Cable type	A
Cable capacitance	45 to 200 nF/km
Loop resistance	15 to 150 Ω/km
Cable inductance	0.4 to 1 mH/km

Further details are provided in the Ethernet-APL Engineering Guideline (https://www.ethernet-apl.org).

Overvoltage protection

Devices without optional overvoltage protection

Equipment from Endress+Hauser fulfills the requirements of the product standard IEC / DIN EN 61326-1 (Table 2 Industrial Environment).

Depending on the type of port (DC power supply, input/output port) different testing levels according to IEC / DIN EN 61326-1 against transient overvoltages (Surge) are applied (IEC / DIN EN 61000-4-5 Surge):
Test level on DC power ports and input / output ports is 1000 V line to earth

Overvoltage category

Overvoltage category II

Performance characteristics

Response time

- HART: acyclic: min. 330 ms, typically 590 ms (depends on commands and number of preambles)
- HART: cyclic (burst): min. 160 ms, typically 350 ms (depends on commands and number of preambles)
- ~~PROFINET with Ethernet-APL: cyclic: min. 32 ms~~

Reference operating conditions

- As per IEC 62828-2
- Ambient temperature T_A = constant, in the range of +22 to +28 °C (+72 to +82 °F)
- Humidity φ = constant, in the range of: 5 to 80 % rF ± 5 %
- Ambient pressure p_A = constant, in the range of: 860 to 1060 mbar (12.47 to 15.37 psi)
- Position of the measuring cell: horizontal ±1°
- Input of LOW SENSOR TRIM and HIGH SENSOR TRIM for lower range value and upper range value
- Supply voltage: 24 V DC ±3 V DC
- Load with HART: 250 Ω
- Turn down (TD) = URL/ | URV - LRV |
- Zero based span

Total performance

The performance characteristics refer to the accuracy of the device. The factors that influence the accuracy can be divided into two groups

- Total performance of device
- Installation factors

All of the performance characteristics meet the requirement of ≥ ± 3 sigma.

The total performance of the device comprises the reference accuracy and the ambient temperature effect and is calculated using the following formula:

Total performance = $\pm \sqrt{((E1)^2 + (E2)^2)}$

E1 = Reference accuracy

E2 = Temperature effect

Calculation of E2:

Temperature effect per ±28 °C (50 °F)

(Corresponds to a range of −3 to +53 °C (+27 to +127 °F))

$E2 = E2_M + E2_E$

$E2_M$ = Main temperature error

$E2_E$ = Electronics error

The values refer to the calibrated span.

Calculation of the total performance with the Endress+Hauser Applicator

Detailed inaccuracies, e.g. for other temperature ranges, can be calculated with the Applicator "Sizing Pressure Performance".

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Reference accuracy [E1]

The reference accuracy comprises the non-linearity according to the limit point method, pressure hysteresis and non-repeatability in accordance with [IEC62828-1 / IEC 61298-2]. Reference accuracy for standard up to TD 100:1, for platinum up to TD 10:1.

Gauge pressure measuring cells

Measuring cell	Standard	Platinum
100 mbar (1.5 psi)	TD 1:1 to 10:1 = ±0.15 % TD > 10:1 = ±0.015 % · TD	TD 1:1 to 10:1 = ±0.075 %
250 mbar (3.75 psi)	TD 1:1 to 10:1 = ±0.1 % TD > 10:1 = ±0.01 % · TD	TD 1:1 to 10:1 = ±0.075 %
400 mbar (6 psi) 1 bar (15 psi) 2 bar (30 psi) 4 bar (60 psi) 10 bar (150 psi) 40 bar (600 psi)	TD 1:1 to 10:1 = ±0.075 % TD > 10:1 = ±0.0075 % · TD	TD 1:1 to 10:1 = ±0.055 %

Absolute pressure measuring cells

Measuring cell	Standard	Platinum
100 mbar (1.5 psi)	TD 1:1 to 10:1 = ±0.15 % TD > 10:1 = ±0.015 % · TD	TD 1:1 to 10:1 = ±0.075 %
250 mbar (3.75 psi)	TD 1:1 to 10:1 = ±0.1 % TD > 10:1 = ±0.01 % · TD	TD 1:1 to 10:1 = ±0.075 %
400 mbar (6 psi) 1 bar (15 psi) 2 bar (30 psi) 4 bar (60 psi) 10 bar (150 psi) 40 bar (600 psi)	TD 1:1 to 10:1 = ±0.075 % TD > 10:1 = ±0.0075 % · TD	TD 1:1 to 10:1 = ±0.055 %

Measuring uncertainty for small absolute pressure measuring ranges

The smallest extended uncertainty of measurement that can delivered by our standards in the 0.001 to 35 mbar (0.0000145 to 0.5075 psi) range is 0.1 % of the reading + 0.004 mbar (0.000058 psi).

Temperature effect [E2]

$E2_M$ - Main temperature error

The output changes due to the effect of the ambient temperature [IEC 62828-1 / IEC 61298-3] with respect to the reference temperature [IEC 62828-1]. The values specify the maximum error due to min./max. ambient or process temperature conditions.

100 mbar (1.5 psi), 250 mbar (3.75 psi) and 400 mbar (6 psi) measuring cell
- Standard: ±(0.277 % · TD + 0.275 %)
- Platinum: ±(0.277 % · TD + 0.275 %)

1 bar (15 psi), 2 bar (30 psi), 4 bar (60 psi), 10 bar (150 psi) and 40 bar (600 psi) measuring cell
- Standard: ±(0.157 % · TD + 0.235 %)
- Platinum: ±(0.157 % · TD + 0.235 %)

$E2_E$ - Electronics error

- Analog output 4 to 20 mA: 0.2 %
- Digital output HART: 0 %
- Digital output PROFINET: 0 %

Resolution Current output: <1 µA

Total error

The total error of the device comprises the total performance and the long-term stability effect and is calculated using the following formula:

Total error = total performance + long-term stability

Calculation of the total error with the Endress+Hauser Applicator

Detailed inaccuracies, e.g. for other temperature ranges, can be calculated with the Applicator "Sizing Pressure Performance".

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Long-term stability

The specifications refer to the upper range limit (URL).

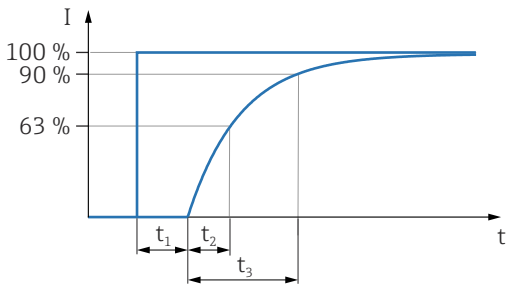
100 mbar (1.5 psi), 250 mbar (3.75 psi), 400 mbar (6 psi) and 1 bar (15 psi) measuring cell
- 1 year: ±0.20 %
- 5 years: ±0.40 %
- 10 years: ±0.50 %

2 bar (30 psi), 4 bar (60 psi), 10 bar (150 psi) and 40 bar (600 psi) measuring cell
- 1 year: ±0.10 %
- 5 years: ±0.25 %
- 10 years: ±0.40 %

Response time T63 and T90

Dead time, time constant

Representation of dead time and time constant as per IEC62828-1:



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Step response time = dead time (t_1) + time constant T90 (t_3) according to IEC62828-1

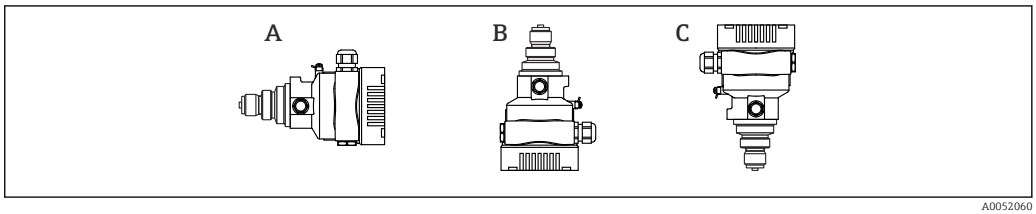
Dynamic behavior, current output (analog electronics)

- Dead time (t_1): maximum 50 ms
- Time constant T63 (t_2): maximum 40 ms
- Time constant T90 (t_3): maximum 90 ms

Dynamic behavior, current output (HART electronics)

- Dead time (t_1): maximum 50 ms
- Time constant T63 (t_2): maximum 85 ms
- Time constant T90 (t_3): maximum 200 ms

Installation factors



- A: Membrane axis is horizontal: calibration position, no measurement error
- B: Membrane pointing upwards: measurement error ≤ +0.2 mbar (+0.003 psi)
- C: Membrane pointing downwards: measurement error ≤ −0.2 mbar (−0.003 psi)

A position-dependent zero point shift can be corrected on the device.

Warm-up time (according to IEC62828-4)

≤5 s

Mounting

Orientation

- A position-dependent zero point shift (when the vessel is empty the measured value does not display zero) can be corrected
- The use of shutoff devices and/or water pocket pipes is recommended for mounting
- The orientation depends on the measuring application

Installation instructions

- The devices are mounted according to the same guidelines as pressure gauges (DIN EN837-2)
- To ensure optimal readability of the local display, adjust the housing and local display
- Endress+Hauser offers a mounting bracket to mount the device on pipes or walls
- Use flushing rings for flanges if there is a risk of medium buildup or clogging at the process connection
  - The flushing ring is clamped between the process connection and process
  - Material buildup in front of the membrane is flushed away, and the pressure chamber is vented, via the two lateral flushing holes
- When measuring in media containing solids (e.g. dirty liquids), installing separators and drain valves is useful for capturing and removing sediment
- Using a valve manifold allows for easy commissioning, installation and maintenance without interrupting the process
- When mounting the device, establishing the electrical connection and during operation: prevent the penetration of moisture into the housing
- Point the cable and plug downwards as much as possible to prevent moisture from entering (e.g. rainwater or condensation)

Sensor selection and arrangement

Mounting the device

Pressure measurement in gases

Mount the device with the shutoff device above the tapping point so that any condensate can flow into the process.

Pressure measurement in steam

Observe the maximum permitted ambient temperature of the transmitter!

Mounting:
- Ideally, mount the device with the O-shaped siphon below the tapping point
  The device may also be mounted above the tapping point
- Fill the siphon with liquid before commissioning

Advantages of using siphons:
- Protects the measuring device from hot, pressurized media due to the formation and collection of condensate
- Attenuation of water hammer
- The defined water column only causes minimal (negligible) measured errors and minimal (negligible) thermal effects on the device

For technical data (e.g. materials, dimensions or order numbers), see the accessory document SD01553P.

Pressure measurement in liquids

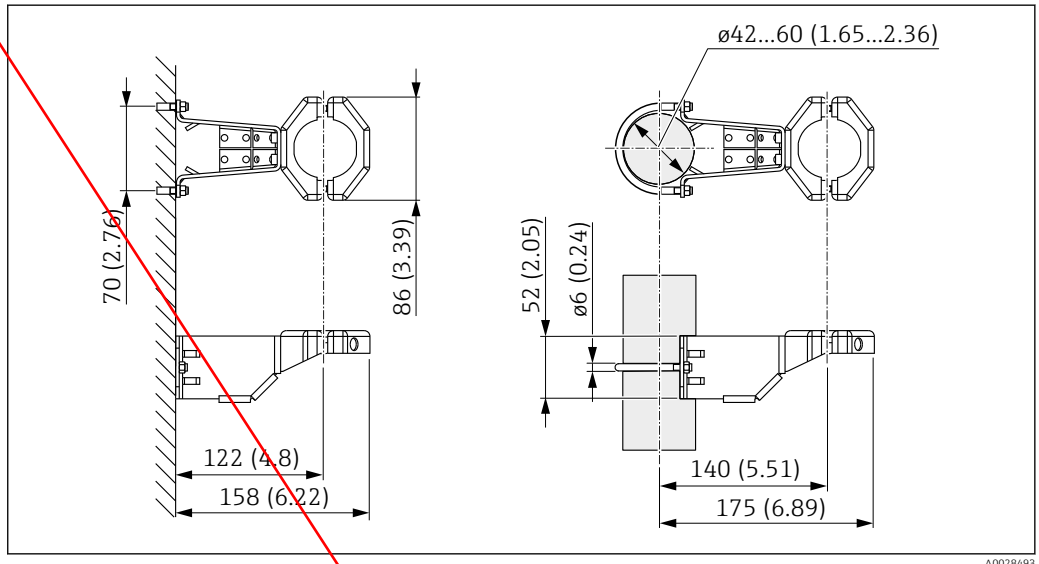
Mount the device with the shutoff device below or at the same level as the tapping point.

Level measurement

- Always mount the device below the lowest measuring point
- Do not install the device at the following positions:
  - In the filling curtain
  - In the tank outlet
  - In the suction area of a pump
  - At a point in the tank which could be affected by pressure pulses from the agitator
- Mount the device downstream from a shutoff device: the calibration and function check can be carried out more easily

Mounting bracket for device or separate housing

The device or the separate housing can be mounted on walls or pipes (for pipes with a diameter of 1 ¼" to 2") using the mounting bracket.



Unit of measurement mm (in)

Ordering information:
- Can be ordered via the Product Configurator
- Can be ordered as a separate accessory, part number 71102216

The mounting bracket is included in the delivery if you order the device with a separate housing.

Special mounting instructions

Wall and pipe mounting with a manifold (optional)

If the device is mounted on a shutoff device (e.g. manifold or shutoff valve), then use the bracket provided for this purpose. This makes it easier to disassemble the device.

For technical data, see the SD01553P accessory document.

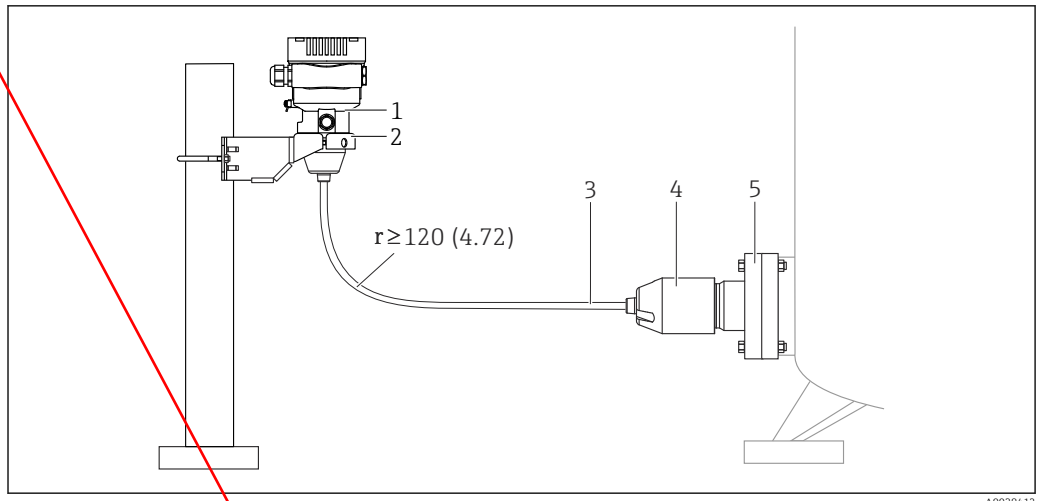
Sensor, remote (separate housing)

The housing of the device (including electronic insert) is mounted away from the measuring point.

This version thus facilitates trouble-free measurement
- Under particularly difficult measuring conditions (at installation locations that are cramped or difficult to access)
- If the measuring point is exposed to vibrations

Cable versions:
- PE: 2 m (6.6 ft), 5 m (16 ft) and 10 m (33 ft)
- FEP: 5 m (16 ft).

The sensor is supplied with the process connection and cable fitted. The housing (including electronic insert) and a mounting bracket are enclosed as separate units. The cable is provided with a socket at both ends. These sockets are simply connected to the housing (including electronic insert) and the sensor.



1 *Sensor, remote (including electronic insert)*
2 *Mounting bracket provided, suitable for wall mounting or pipe mounting*
3 *Cable, both ends are fitted with a socket*
4 *Process connection adapter*
5 *Process connection with sensor*

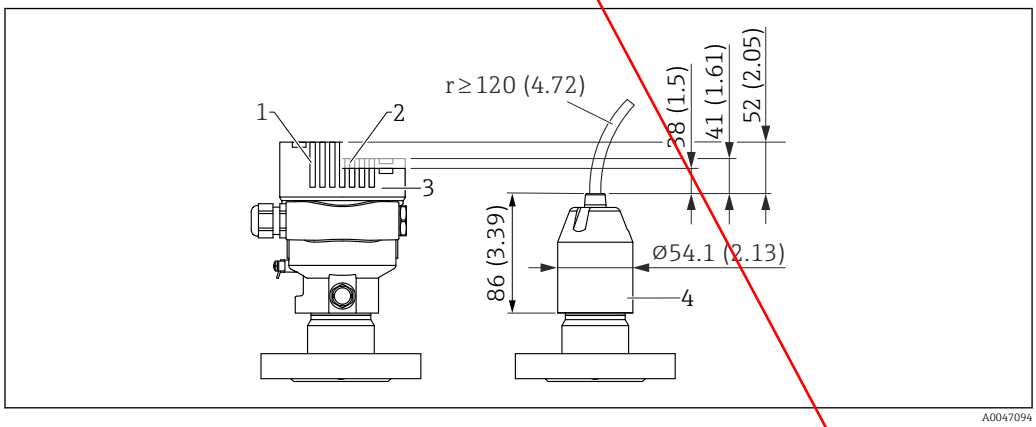
Ordering information:
- Sensor, remote (including electronic insert), and mounting bracket can be ordered via the Product Configurator
- Mounting bracket can also be ordered as a separate accessory, part number 71102216

Technical data for cable:
- Minimum bending radius: 120 mm (4.72 in)
- Cable extraction force: max. 450 N (101.16 lbf)
- Resistance to UV light

Use in hazardous area:
- Intrinsically safe installations (Ex ia/IS)
- FM/CSA IS: for Div.1 installation only

Reduction of the installation height

If this version is used, the mounting height of the process connection is reduced compared to the dimensions of the standard version.



1 *Device with display, cover with sight glass made of glass (devices for Ex d, dust Ex)*
2 *Device with display, cover with plastic sight glass*
3 *Device without display, cover without sight glass*
4 *Process connection adapter*

Environment

Ambient temperature range

The following values apply up to a process temperature of +85 °C (+185 °F). At higher process temperatures, the permitted ambient temperature is reduced.

- Without segment display or graphic display:
  Standard: −40 to +85 °C (−40 to +185 °F)
- With segment display or graphic display: −40 to +85 °C (−40 to +185 °F) with limitations in optical properties such as display speed and contrast. Can be used without limitations up to −20 to +60 °C (−4 to +140 °F)
  Segment display: up to −50 to +85 °C (−58 to +185 °F) with restricted operating life and performance
- Separate housing: −20 to +60 °C (−4 to +140 °F)

Hazardous area

- For devices for use in hazardous areas, see the Safety Instructions, Installation Drawing or Control Drawing
- Devices that have the most common explosion protection certificates (e.g. ATEX/ IEC Ex, etc.) can be used in explosive atmospheres up to the ambient temperature.

Storage temperature

- Without LCD display:
  Standard: −40 to +90 °C (−40 to +194 °F)
- With LCD display: −40 to +85 °C (−40 to +185 °F)
- Separate housing: −40 to +60 °C (−40 to +140 °F)

With M12 plug, elbowed: −25 to +85 °C (−13 to +185 °F)

Operating altitude

Up to 5 000 m (16 404 ft) above sea level.

Climate class

Class 4K4H (air temperature: −20 to +55 °C (−4 to +131 °F), relative humidity: 4 to 100 %) satisfied as per DIN EN 60721-3-4.

Condensation is possible.

Degree of protection

Test as per IEC 60529 and NEMA 250-2014

Housing and process connection

IP66/68, TYPE 4X/6P

(IP68: (1.83 mH_2O for 24 h))

Cable entries

- Gland M20, plastic, IP66/68 TYPE 4X/6P
- Gland M20, brass nickel plated, IP66/68 TYPE 4X/6P
- Gland M20, 316L, IP66/68 TYPE 4X/6P
- Thread M20, IP66/68 TYPE 4X/6P
- Thread G1/2, IP66/68 TYPE 4X/6P
  If the G1/2 thread is selected, the device is delivered with an M20 thread as standard and a G1/2 adapter is included with the delivery, along with the corresponding documentation
- Thread NPT1/2, IP66/68 TYPE 4X/6P
- Dummy plug transport protection: IP22, TYPE 2
- Plug HAN7D, 90 deg. IP65 NEMA Type 4X
- Plug M12
  When housing is closed and connecting cable is plugged in: IP66/67 NEMA Type 4X
  When housing is open or connecting cable is not plugged in: IP20, NEMA Type 1

NOTICE

Plug M12 and plug HAN7D: incorrect mounting can invalidate the IP protection class!

- ▶ The degree of protection only applies if the connecting cable used is plugged in and screwed tight.
- ▶ The degree of protection only applies if the connecting cable used is specified according to IP67 NEMA Type 4X.
- ▶ The IP protection classes are only maintained if the dummy cap is used or the cable is connected.

Process connection and process adapter when using the separate housing

FEP cable

- IP69 (on sensor side)
- IP66 TYPE 4/6P
- IP68 (1.83 mH_2O for 24 h) TYPE 4/6P

PE cable

- IP69 (on sensor side)
- IP66 TYPE 4/6P
- IP68 (1.83 mH_2O for 24 h) TYPE 4/6P

Vibration resistance

Single compartment housing

Mechanical construction	Sinusoidal oscillation IEC62828-1/IEC61298-3	Shock
Device	10 Hz to 60 Hz: ±0.35 mm (0.0138 in) 60 Hz to 1000 Hz: 5 g	30 g
Device with Ex d and XP version [1]	10 Hz to 60 Hz: ±0.15 mm (0.0059 in) 60 Hz to 1000 Hz: 2 g	30 g

1) Not for the high-temperature version with Ex d and XP.

Aluminum dual compartment housing

Mechanical construction	Sinusoidal oscillation IEC62828-1/IEC61298-3	Shock
Device	10 Hz to 60 Hz: ±0.15 mm (0.0059 in) 60 Hz to 1000 Hz: 2 g	30 g
Device with Ex d version [1]	10 Hz to 60 Hz: ±0.15 mm (0.0059 in) 60 Hz to 1000 Hz: 2 g	30 g

1) Not for the high-temperature version with Ex d and XP.

Electromagnetic compatibility (EMC)

- Electromagnetic compatibility as per EN 61326 series and NAMUR recommendation EMC (NE21)
- With regard to the safety function (SIL), the requirements of EN 61326-3-x are satisfied
- Maximum deviation with interference influence: < 0.5% of span with full measuring range (TD 1:1)

For more details refer to the EU Declaration of Conformity.

Process

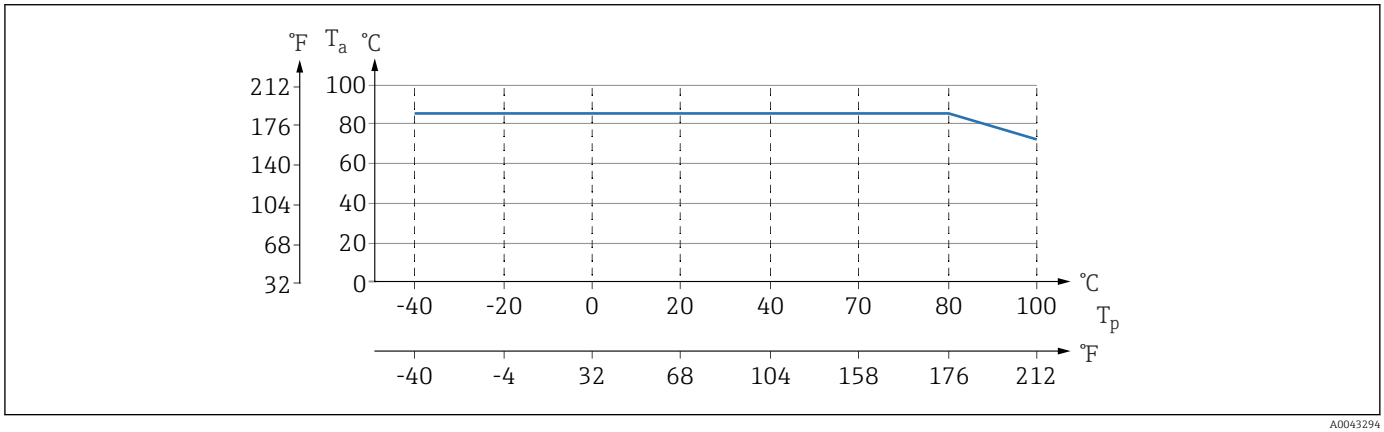
Process temperature range

NOTICE

The permitted process temperature depends on the process connection, process seal, ambient temperature and the type of approval.

- ▶ All the temperature data in this document must be taken into consideration when selecting the device.

−40 to +100 °C (−40 to +212 °F)



6 *Values apply for vertical mounting without insulation.*

T_p *Process temperature*
T_a *Ambient temperature*

The process temperature ranges indicated refer to the permanent operation of the device (maximum 5 °C (41 °F) deviation is permitted)

Seals

Pay attention to the process temperature range of the seal. The temperatures indicated depend on the resistance of the seal to the medium.

Seal	Temperature
FKM	−25 to +100 °C (−13 to +212 °F)
FKM Cleaned for oxygen service	−10 to +60 °C (+14 to +140 °F)
~~FFKM Perlast G75LT~~	~~−20 to +100 °C (−4 to +212 °F)~~
~~FFKM Kalrez 6375~~	~~+5 to +100 °C (+41 to +212 °F)~~
~~FFKM Chemraz 505~~	~~−10 to +100 °C (+14 to +212 °F)~~
EPDM	−40 to +100 °C (−40 to +212 °F)
~~HNBR~~	~~−25 to +100 °C (−13 to +212 °F)~~

Oxygen applications (gaseous)

Oxygen and other gases can react explosively to oils, grease and plastics. The following precautions must be taken:

- All components of the system, such as devices, must be cleaned in accordance with national requirements.
- Depending on the materials used, a certain maximum temperature and a maximum pressure must not be exceeded for oxygen applications.

The cleaning of the device (not accessories) is provided as an optional service.

Devices with measuring cells, nominal value < 10 bar (150 psi)
- p_{max}: Over pressure limit (OPL) of the measuring cell and depending on the process connection used
- Devices with PVDF thread:
  - Only mount with the enclosed mounting bracket!
  - p_{max}: 15 bar (225 psi)
- T_{max}: 60 °C (140 °F)

Devices with measuring cells, nominal value ≥ 10 bar (150 psi)
- p_{max}: 40 bar (600 psi)
- T_{max}: 60 °C (140 °F)

Thermal shock

Applications with jumps in temperature

Extreme jumps in temperature can result in temporary measuring errors. Temperature compensation takes place after a few minutes. Internal temperature compensation is faster the smaller the jump in temperature and the longer the time interval involved.

For more information: contact the Endress+Hauser sales office.

Process pressure range

Pressure specifications

WARNING

The maximum pressure for the device depends on the lowest-rated component with regard to pressure (components are: process connection, optional mounted parts or accessories).

- ▶ Only operate the device within the specified limits for the components!
- ▶ MWP (maximum working pressure): The MWP is specified on the nameplate. This value refers to a reference temperature of +20 °C (+68 °F) and may be applied to the device for an unlimited time. Note temperature dependence of MWP. For flanges, refer to the following standards for the permitted pressure values at higher temperatures: EN 1092-1 (with regard to their stability/ temperature property, the materials 1.4435 and 1.4404 are grouped together under EN 1092-1; the chemical composition of the two materials can be identical.), ASME B 16.5a, JIS B 2220 (the latest version of the standard applies in each case). MWP data that deviate from this are provided in the relevant sections of the Technical Information.
- ▶ The overpressure limit is the maximum pressure a device may be subjected to during a test. It is greater than the maximum working pressure by a certain factor. This value refers to a reference temperature of +20 °C (+68 °F).
- ▶ The Pressure Equipment Directive (2014/68/EU) uses the abbreviation "PS". The abbreviation "PS" corresponds to the MWP (maximum working pressure) of the device.
- ▶ In the case of measuring cell range and process connection combinations where the overpressure limit (OPL) of the process connection is smaller than the nominal value of the measuring cell, the device is set at the factory, at the very maximum, to the OPL value of the process connection. If the entire measuring cell range must be used, select a process connection with a higher OPL value (1.5 x PN; MWP = PN).
- ▶ Oxygen applications: do not exceed values for P_{max} and T_{max}.

Burst pressure

As of the specified burst pressure, the complete destruction of the pressure-bearing parts and/or a device leak must be expected. It is therefore imperative to avoid such operating conditions by carefully planning and sizing your facility.

Ultrapure gas applications

Endress+Hauser also offers devices for special applications, such as for ultrapure gas, that are cleaned of oil and grease. No special restrictions regarding the process conditions apply to these devices.

Steam applications and saturated steam applications

For steam and saturated steam applications: Use a device with a metallic membrane or provide a water pocket pipe for temperature decoupling when installing.

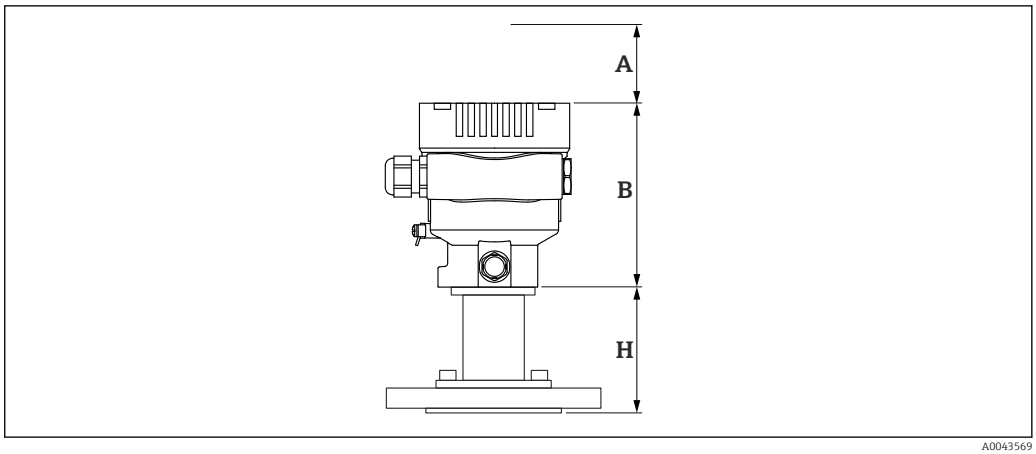
Mechanical construction

Design, dimensions

Device height

The device height is calculated from
- the height of the housing
- the height of the individual process connection

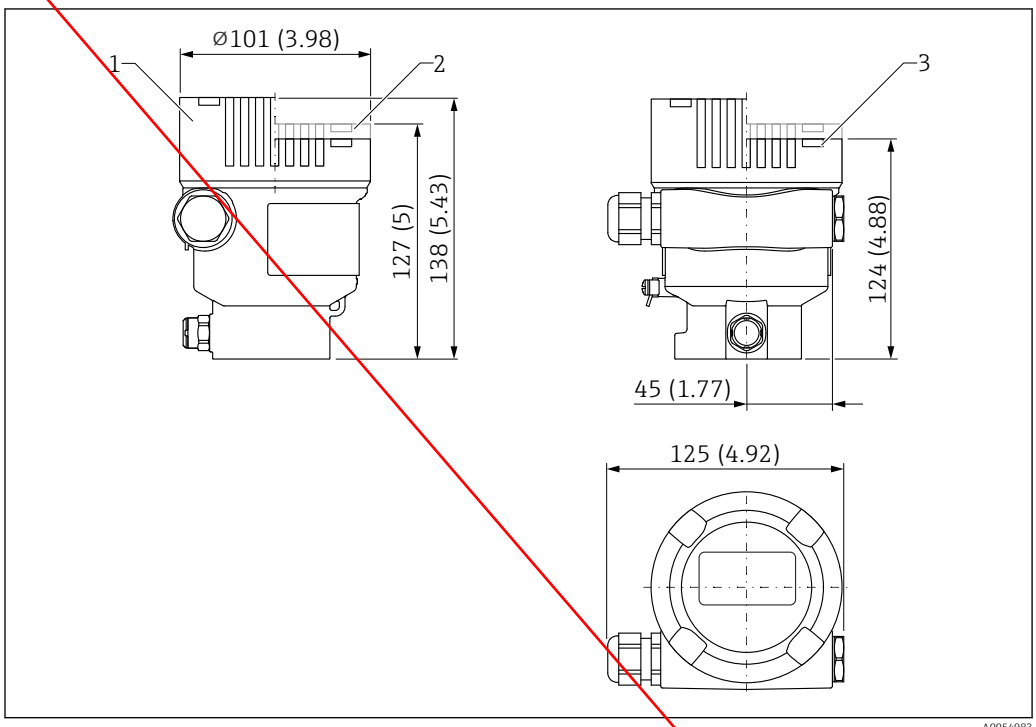
The individual heights of the components can be found in the following sections. To calculate the device height, add the individual heights of the components. Take the installation clearance into consideration (space that is used to install the device).



A Installation clearance
B Height of the housing
H Height of the process connection

Dimensions

Single compartment housing

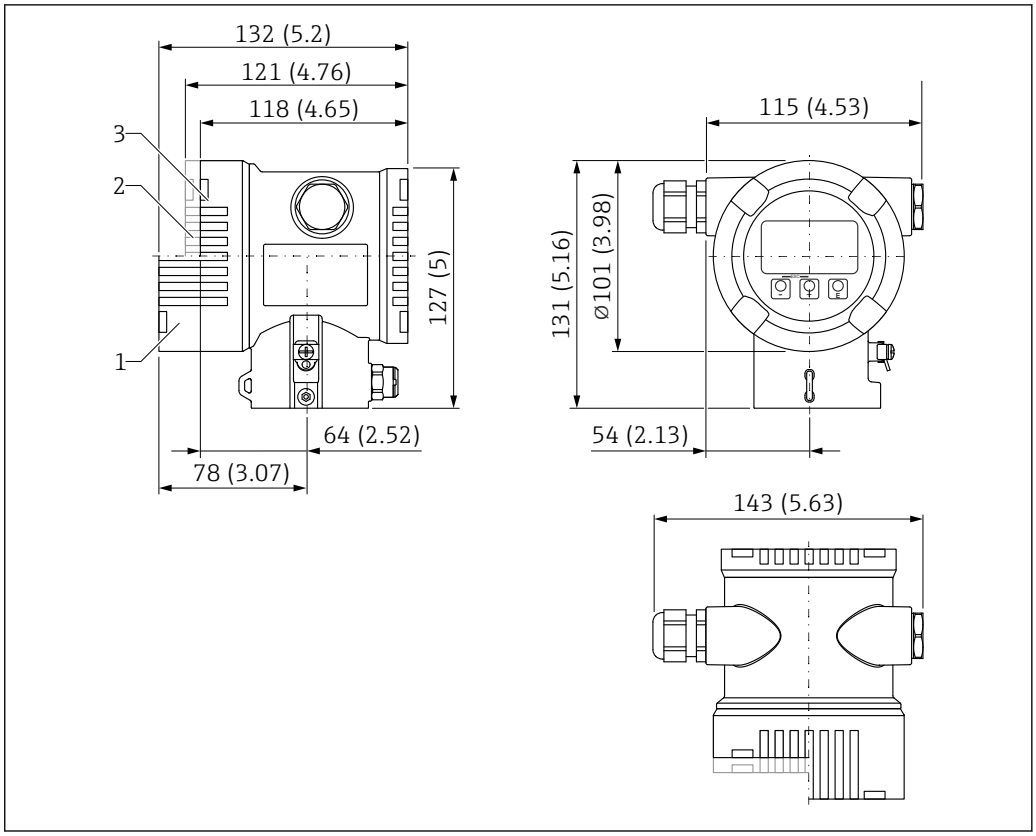


Unit of measurement mm (in)

1 *Device with display, cover with sight glass made of glass (devices for Ex d/XP, dust Ex): 138 mm (5.43 in)*
2 *Device with display, cover with plastic sight glass: 127 mm (5 in)*
3 *Device without display, cover without sight glass: 124 mm (4.88 in)*

Cover optionally with ANSI Safety Red (color RAL3002) coating.

Dual compartment housing

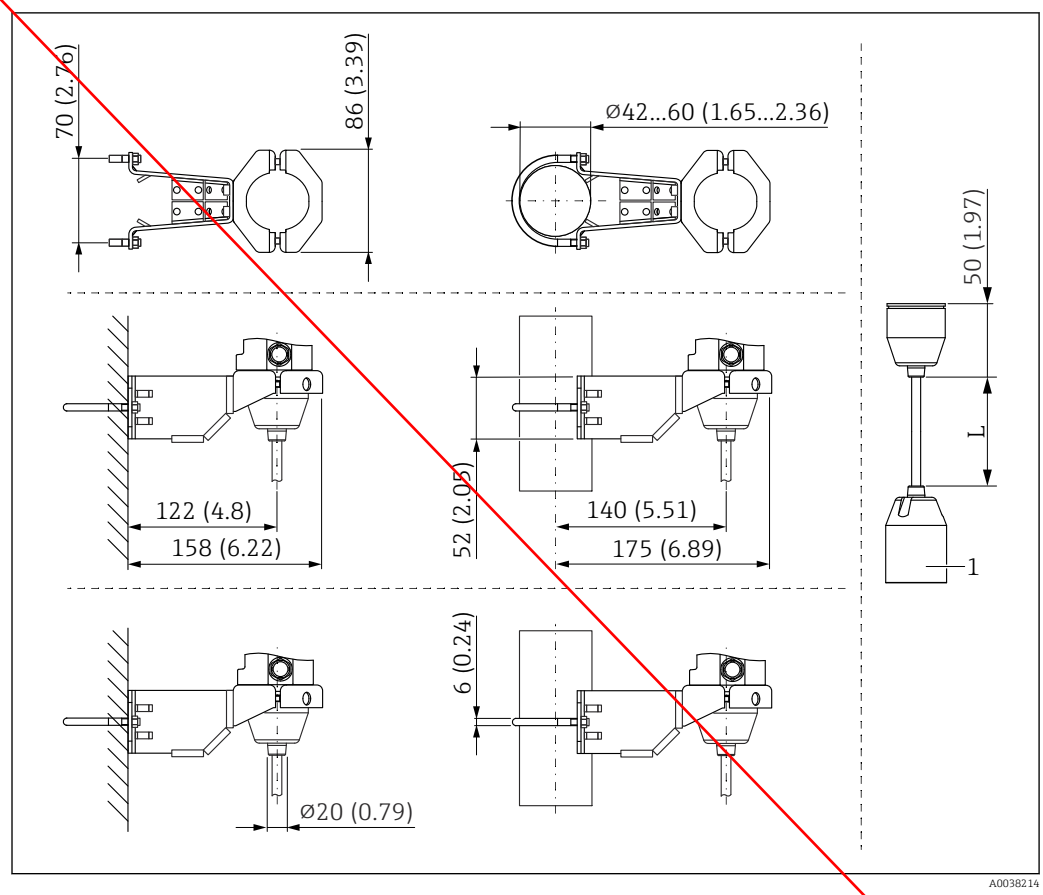


Unit of measurement mm (in)

1 Device with display, cover with sight glass made of glass (devices for Ex d/XP, dust Ex): 132 mm (5.2 in)
2 Device with display, cover with plastic sight glass: 121 mm (4.76 in)
3 Device without display, cover without sight glass: 118 mm (4.65 in)

Cover optionally with ANSI Safety Red (color RAL3002) coating.

Sensor, remote (separate housing)



Unit of measurement mm (in)

1 86 mm (3.39 in)
L Length of cable versions

OPL and MWP

The maximum overpressure limit (OPL) and the maximum working pressure (MWP) of the sensor can deviate from the maximum OPL and MWP of the process connection.

For the maximum OPL and MWP, see the technical documentation of the process connection.

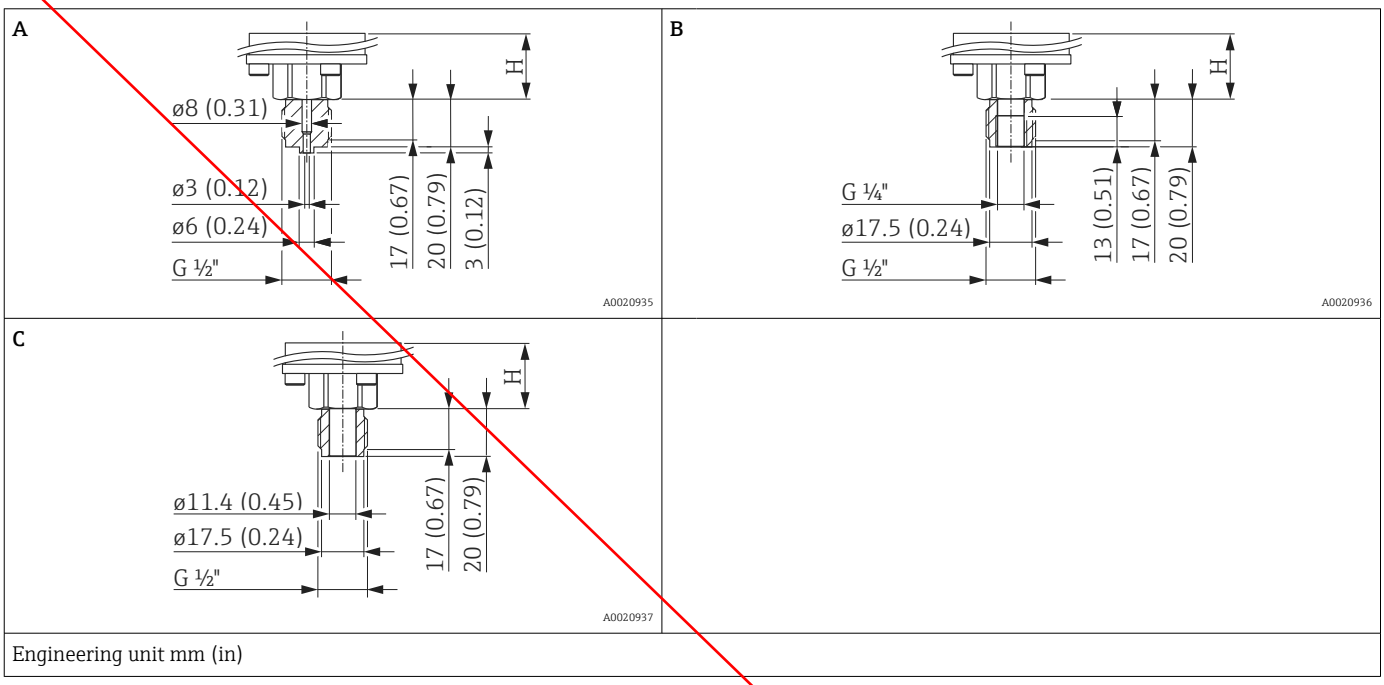
Explanation of terms

- DN or NPS or A = alphanumeric identifier of the flange size
- PN or Class or K = alphanumeric pressure rating of a component

Height H

Process connection	Height H	
	Standard	Ex d version
FNPT1/2 MNPT1/2 MNPT1/2 FNPT1/4 G1/2 M20x1.5 B0202 B0203	28 mm (1.1 in)	94 mm (3.7 in)
MNPT1-1/2 MNPT2 G1-1/2 G2 M44x1.25	59 mm (2.32 in)	125 mm (4.92 in)
Flanges	83 mm (3.27 in)	150 mm (5.91 in)

Thread ISO228 G, internal membrane

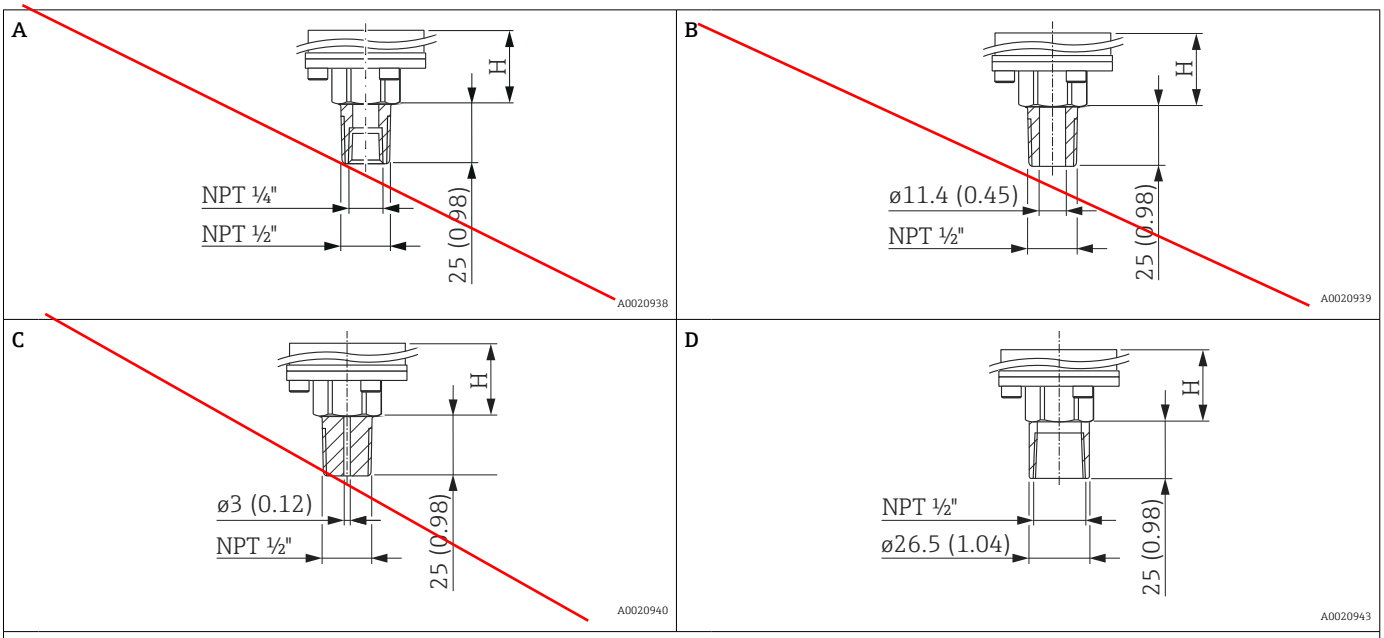


Engineering unit mm (in)

Item	Designation	Material	Weight [1] kg (lb)
A	Thread ISO228 G ½" A EN837	AISI 316L	0.60 (1.32)
		Alloy C276 (2.4819)	
		PVDF ▪ Only mount with a mounting bracket (included) ▪ MWP 10 bar (150 psi), OPL max. 15 bar (225 psi) ▪ Process temperature range: −10 to +60 °C (+14 to +140 °F)	
B	Thread ISO228 G ½" A, G ¼" (female)	AISI 316L	
		Alloy C276 (2.4819)	
C	Thread ISO228 G ½" A, Bore 11.4 mm (0.45 in)	AISI 316L	
		Alloy C276 (2.4819)	

1) Total weight consisting of sensor assembly and process connection.

Thread ASME B1.20.1, NPT, internal membrane



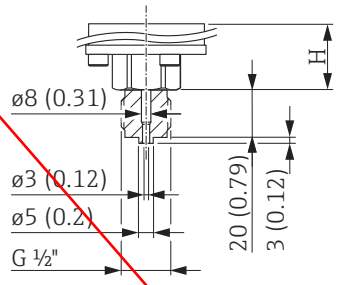
Engineering unit mm (in)

Item	Designation	Material	Weight [1]
			kg (lb)
A [2]	Thread ASME MNPT ½", FNPT ¼"	AISI 316L	0.60 (1.32)
		Alloy C276 (2.4819)	
B	Thread ASME MNPT ½", Bore 11.4 mm (0.45 in)	AISI 316L	
		Alloy C276 (2.4819)	
C	Thread ASME MNPT ½", Bore 3 mm (0.12 in)	**PVDF** ▪ Only mount with a mounting bracket (included) ▪ MWP 10 bar (150 psi), OPL max. 15 bar (225 psi) ▪ Process temperature range: −10 to +60 °C (+14 to +140 °F)	
D	Thread ASME FNPT ½"	AISI 316L	
		Alloy C276 (2.4819)	

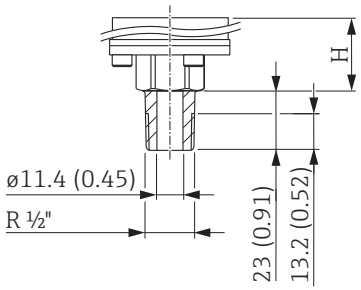
1) Total weight consisting of sensor assembly and process connection.
2) URL max. 100 bar (1 500 psi)

Thread JIS, internal membrane

A



B



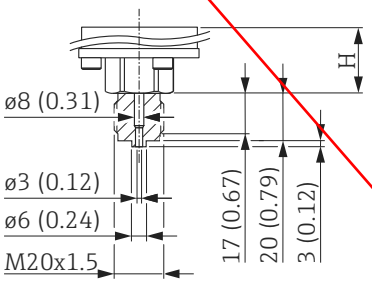
Engineering unit mm (in)

Item	Designation	Material	Weight [1]
			kg (lb)
A	JIS B0202 G ½" (male)	AISI 316L	0.60 (1.32)
B	JIS B0203 R ½" (male)		

1) Total weight consisting of sensor assembly and process connection.

Thread, metric (DIN 13), internal membrane

A

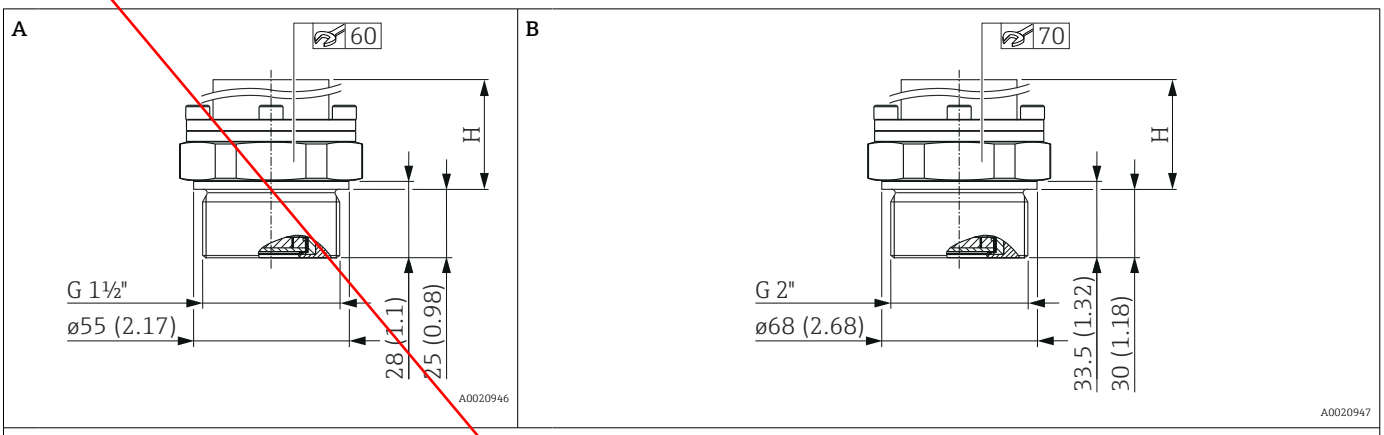


Engineering unit mm (in)

Item	Designation	Material	Weight [1]
			kg (lb)
A	DIN 13 M20 x 1.5, EN837 3 mm (0.12 in)	AISI 316L	0.60 (1.32)
		Alloy C276 (2.4819)	

1) Total weight consisting of sensor assembly and process connection.

Thread ISO228 G, flush membrane

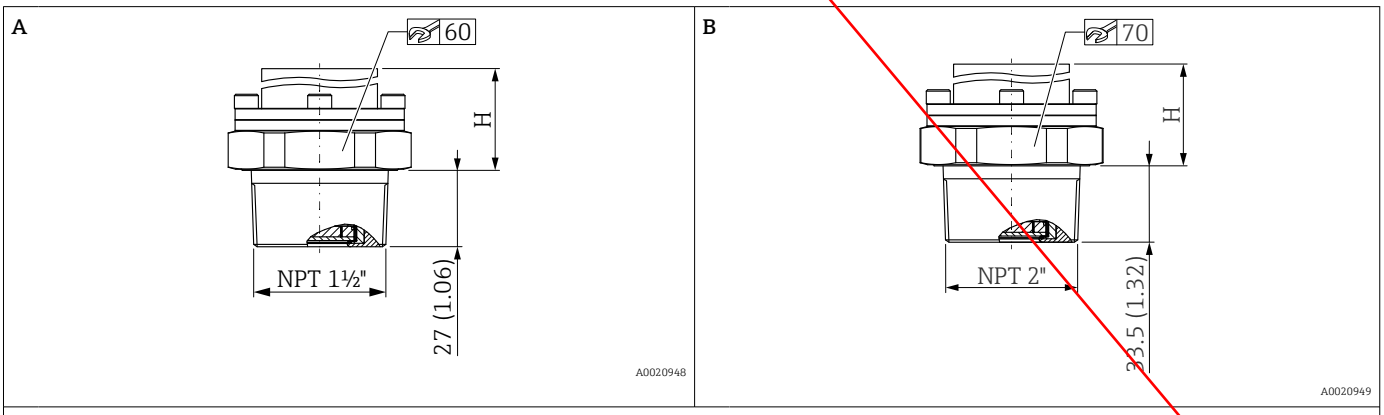


Unit mm (in).

Position	Designation	Material	Weight [1]		
			kg (lb)		
A	Thread ISO228 G 1 ½" A	AISI 316L	0.8 (1.76)		
		B	Thread ISO228 G 2" A	AISI 316L	1.2 (2.65)

1) Total weight consisting of sensor assembly and process connection.

Thread ASME, NPT, flush membrane

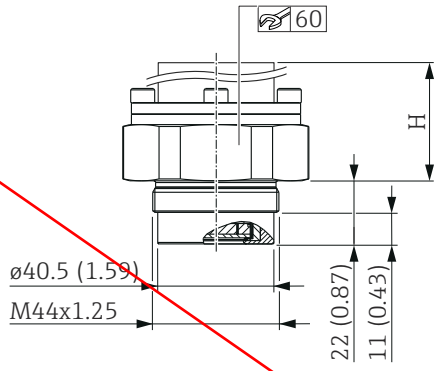


Unit mm (in)

Position	Designation	Material	Weight [1]
			kg (lb)
A	Thread ASME 1 ½" MNPT	AISI 316L	0.80 (1.76)
B	Thread ASME 2" MNPT	AISI 316L	1.20 (2.65)

1) Total weight consisting of sensor assembly and process connection.

Thread DIN 13, flush membrane



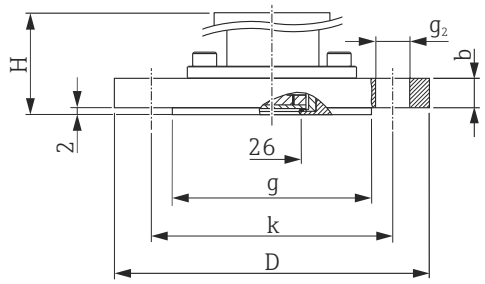
Unit mm (in)

Designation	Material	Weight [1]
		kg (lb)
DIN 13 M44 x 1.25	AISI 316L	0.90 (1.98)
	Alloy C276 (2.4819)	

1) Total weight consisting of the sensor assembly and the process connection.

Flange EN1092-1, flush membrane

Connection dimensions according to EN1092-1.



D *Diameter of flange*
b *Thickness*
g *Raised face*
k *Pitch diameter*
g_2 *Diameter of hole*

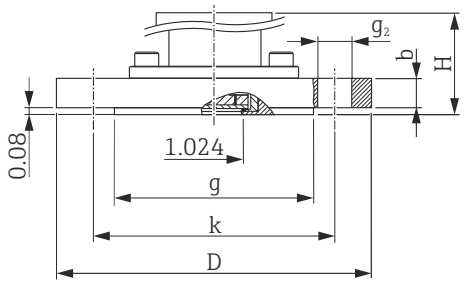
Engineering unit mm

Flange							Boltholes			Weight [1]
Material	DN	PN	Form	D	b	g	Quantity	g_2	k	
				mm	mm	mm		mm	mm	kg (lb)
AISI 316L	DN 25	PN 10-40	B1	115	18	68	4	14	85	1.9 (4.19)
AISI 316L	DN 32	PN 10-40	B1	140	18	78	4	18	100	2.5 (5.51)
AISI 316L	DN 40	PN 10-40	B1	150	18	88	4	18	110	3.0 (6.62)
PVDF [2] [3]	DN 40	PN 10-16	B2	150	21.4	88	4	18	110	1.3 (2.87)
ETFE [3]	DN 40	PN 10-40	B2	150	21	88	4	18	110	3.0 (6.62)
AISI 316L	DN 50	PN 10-40	B1	165	20	102	4	18	125	3.5 (7.72)
PVDF [2] [3]	DN 50	PN 10-16	B2	165	21.4	102	4	18	125	1.4 (3.09)
ETFE [3]	DN 50	PN 25-40	B2	165	21	102	4	18	125	3.7 (8.16)
AISI 316L	DN 80	PN 10-40	B1	200	24	138	8	18	160	5.8 (12.79)
ETFE [3]	DN 80	PN 25-40	B2	200	25	138	8	18	160	5.2 (11.47)

1) Total weight consisting of sensor assembly and process connection.
2) MWP 10 bar (150 psi), OPL max. 15 bar (225 psi); process temperature range: −10 to +60 °C (+14 to +140 °F)
3) ETFE coating on AISI 316L (1.4404). When using in hazardous areas: avoid electrostatic charge on the plastic surfaces.

Flange ASME B16.5, RF, flush membrane

Connection dimensions in accordance with ASME B16.5, raised face RF



A0034685

D *Diameter of flange*
b *Thickness*
g *Raised face*
k *Pitch diameter*
g_2 *Diameter of hole*

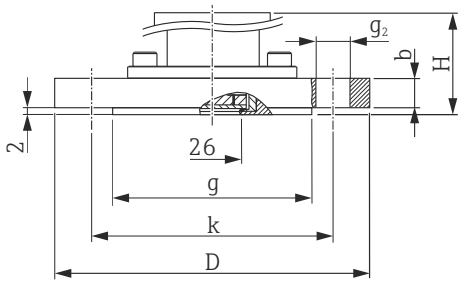
Engineering unit in

Flange						Boltholes			Weight [1]
Material	NPS	Class	D	b	g	Quantity	g_2	k	
	in		in	in	in		in	in	kg (lb)
AISI 316/316L [2] [3]	1	150	4.25	1.18	2	4	0.62	3.12	2.3 (5.07)
AISI 316/316L [2] [3]	1	300	4.88	1.18	2	4	0.75	3.5	8.5 (18.74)
AISI 316/316L [2]	1 ½	150	5	0.69	2.88	4	0.62	3.88	2.1 (4.63)
AISI 316/316L [2]	1 ½	300	6.12	0.81	2.88	4	0.88	4.5	3.3 (7.28)
AISI 316/316L [2]	2	150	6	0.75	3.62	4	0.75	4.75	3.1 (6.84)
ETFE [4]	2	150	6	0.75	3.62	4	0.75	4.75	3.1 (6.84)
AISI 316/316L [2]	2	300	6.5	0.88	3.62	8	0.75	5	4.0 (8.82)
AISI 316/316L [2]	3	150	7.5	0.94	5	4	0.75	6	5.7 (12.57)
ETFE [4]	3	150	7.5	0.94	5	4	0.75	6	5.7 (12.57)
PVDF [5]	3	150	7.5	0.94	5	4	0.75	6	1.6 (3.53)
AISI 316/316L [2]	3	300	8.25	1.12	5	8	0.88	6.62	7.5 (16.54)
AISI 316/316L [2]	4	150	9	0.94	6.19	8	0.75	7.5	7.6 (16.76)
ETFE [4]	4	150	9	0.94	6.19	8	0.75	7.5	7.8 (17.20)
AISI 316/316L [2]	4	300	10	1.25	6.19	8	0.88	7.88	12.4 (27.34)

1) Total weight consisting of sensor assembly and process connection.
2) Combination of AISI 316 for required pressure resistance and AISI 316L for required chemical resistance (dual rated)
3) Screws must be 15 mm (0.59 in) longer than the standard flange screws
4) ETFE coating on AISI 316/316L. When using in hazardous areas: avoid electrostatic charge on the plastic surfaces.
5) MWP 10 bar (150 psi), OPL max. 15 bar (225 psi); process temperature range: −10 to +60 °C (+14 to +140 °F)

Flange JIS B2220, RF, flush membrane

Connection dimensions in accordance with JIS B 2220 BL, raised face RF



A0034684

D *Diameter of flange*
b *Thickness*
g *Raised face*
k *Pitch diameter*
g_2 *Diameter of hole*

Engineering unit mm

Flange						Boltholes			Weight [1]
Material	A [2]	K [3]	D	b	g	Quantity	g_2	k	
			mm	mm	mm		mm	mm	kg (lb)
50 A	10 K	155	16	96	4	19	120	2.9 (6.39)	
80 A	10 K	185	18	127	8	19	150	3.9 (8.60)	
100 A	10 K	210	18	151	8	19	175	5.3 (11.69)	

1) Total weight consisting of sensor assembly and process connection.
2) Alphanumeric designation of the flange size.
3) Alphanumeric pressure rating of a component.

Weight

Housing

Weight including electronics and display.

- Single compartment housing: 1.1 kg (2.43 lb)
- Dual compartment housing
  Aluminum: 1.4 kg (3.09 lb)

Sensor, remote (separate housing)

- Housing: see the Housing section
- Housing adapter: 0.55 kg (1.21 lb)
- Process connection adapter: 0.36 kg (0.79 lb))
- Cable:
  - PE cable, 2 meters: 0.18 kg (0.40 lb)
  - PE cable, 5 meters: 0.35 kg (0.77 lb)
  - PE cable, 10 meters: 0.64 kg (1.41 lb)
  - FEP cable, 5 meters: 0.62 kg (1.37 lb)
- Mounting bracket: 0.46 kg (1.01 lb)

Process connections

Weight, see the specific process connection.

Ex d version: 0.63 kg (1.39 lb)

Accessories

Mounting bracket: 0.5 kg (1.10 lb)

Materials in contact with process

Membrane material

Al_2O_3 Aluminum-oxide ceramic, ultrapure 99.9 %, Ceraphire® (see also www.endress.com)

Seal

- FKM
- EPDM (FDA 21 CFR 177.2600)
- HNBR (FDA 21 CFR 177.2600)
- FFKM Perlast G75LT
- FFKM Chemraz 505
- FFKM Kalrez 6375

Process connections

See the specific process connection.

Accessories

For technical data (e.g. materials, dimensions or order numbers), see the accessory document SD01553P.

Materials not in contact with process

Single compartment housing, aluminum, coated

- Housing: aluminum EN AC 43400
- Housing coating, cover: polyester
- EN AC-43400 aluminum cover with Lexan 943A PC sight glass
  EN AC-443400 aluminum cover with borosilicate sight glass; dust-Ex for Ex d/XP
- Dummy cover: aluminum EN AC 43400
- Cover sealing materials: HNBR
- Cover sealing materials: FVMQ (in low temperature version only)
- Potential equalization: 316L
- Seal under potential equalization: EPDM
- Plug: PBT-GF30-FR or aluminum
- Plug sealing material: EPDM
- Nameplate: plastic foil
- TAG plate: plastic foil, stainless steel or provided by the customer

The cable entry (material: Stainless steel, nickel-plated brass, plastic) can be ordered via the "Electrical connection" product structure.

Dual compartment housing, aluminum, coated

- Housing: aluminum EN AC 43400
- Housing coating, cover: polyester
- EN AC-43400 aluminum cover with Lexan 943A PC sight glass
  EN AC-443400 aluminum cover with borosilicate sight glass; dust-Ex for Ex d/XP
- Dummy cover: aluminum EN AC 43400
- Cover sealing materials: HNBR
- Cover sealing materials: FVMQ (in low temperature version only)
- Potential equalization: 316L
- Seal under potential equalization: EPDM
- Plug: PBT-GF30-FR or aluminum
- Plug sealing material: EPDM
- Nameplate: plastic foil
- TAG plate: plastic foil, stainless steel or provided by the customer

The cable entry (material: Stainless steel, nickel-plated brass, plastic) can be ordered via the "Electrical connection" product structure.

Electrical connection

Coupling M20, plastic

- Material: PA
- Seal on cable gland: EPDM
- Dummy plug: plastic

Coupling M20, nickel-plated brass
- Material: nickel-plated brass
- Seal on cable gland: EPDM
- Dummy plug: plastic

Coupling M20, 316L
- Material: 316L
- Seal on cable gland: EPDM
- Dummy plug: plastic

M20 coupling, 316 L, hygiene
- Material: 316L
- Seal on cable gland: EPDM

M20 thread
The device is supplied with M20 thread as standard.
Transport plug: LD-PE

Thread G ½
The device is supplied with an M20 thread as standard and an adapter to G½ including documentation is included.
- Adapter made of PA66-GF or aluminum or 316L (depends on housing version ordered)
- Transport plug: LD-PE

NPT ½ thread
The device is supplied with an NPT½ thread as standard (aluminum housing, 316L housing) or with an M20 thread and an adapter to NPT½ including documentation (plastic housing, hygienic housing).
- Adapter made of PA66-GF or 316L (depends on housing version ordered)
- Transport plug: LD-PE

Thread NPT ¾
The device is supplied with thread NPT ¾ as standard
Transport plug: LD-PE

M20 coupling, blue plastic
- Material: PA, blue
- Seal on cable gland: EPDM
- Dummy plug: plastic

M12 plug
- Material: nickel-plated CuZn or 316L (depends on housing version ordered)
- Transport cap: LD-PE

HAN7D plug
Material: aluminum, die-cast zinc, steel

Valve plug ISO44000 M16
- Material: PA6
- Transport plug: LD-PE

Separate housing

- Mounting bracket
  - Bracket: AISI 316L (1.4404)
  - Screw and nuts: A4-70
  - Half-shells: AISI 316L (1.4404)
- Seal for cable from separate housing: EPDM
- Gland for cable of separate housing: AISI 316L (1.4404)
- PE cable for separate housing: abrasion-proof cable with strain-relief Dynema members; shielded using aluminum-coated foil; insulated with polyethylene (PE-LD), black; copper wires, twisted, UV-resistant
- FEP cable for separate housing: abrasion-proof cable; shielded using galvanized steel wire netting; insulated with fluorinated ethylene propylene (FEP), black; copper cores, twisted, UV-resistant
- Process connection adapter for separate housing: AISI 316L (1.4404)

Connecting parts

- Connection between housing and process connection: AISI 316L (1.4404)
- Measuring cell body: AISI 316L (1.4404)

Accessories

For technical data (e.g. materials, dimensions or order numbers), see the accessory document SD01553P.

Display and user interface

Operating concept (not for devices with 4 to 20 mA analog)

Operator-oriented menu structure for user-specific tasks
- User navigation
- Diagnostics
- Application
- System

Fast and safe commissioning
- Interactive wizard with graphical user interface for guided commissioning in FieldCare, DeviceCare or DTM, AMS and PDM-based third-party tools or SmartBlue
- Menu guidance with short explanations of the individual parameter functions
- Standardized operation at the device and in the operating tools
- ~~PROFINET with Ethernet-APL: access to the device via Web server~~

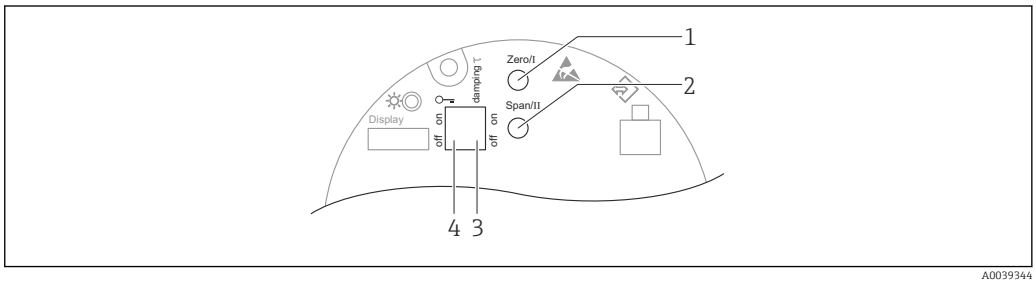
Efficient diagnostic behavior increases measurement availability
- Remedial measures are integrated in plain text
- Diverse simulation options

Bluetooth module (optionally integrated in local display)
- Quick and easy setup with SmartBlue app or PC with DeviceCare, version 1.07.00 and higher, or FieldXpert SMT70
- No additional tools or adapters required
- Encrypted single point-to-point data transmission (tested by Fraunhofer Institute) and password-protected communication via *Bluetooth*® wireless technology

Local operation

Operating keys and DIP switches on the electronic insert

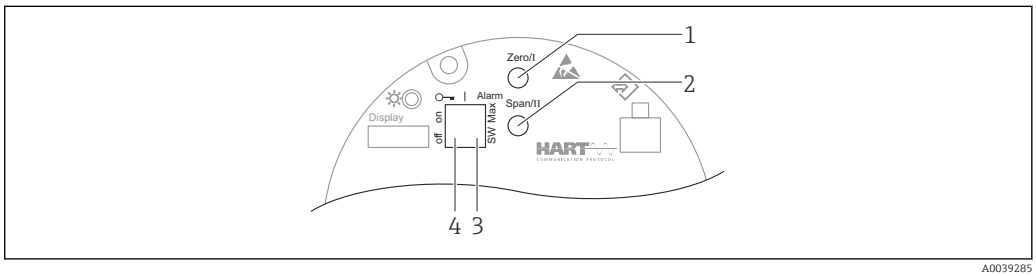
Analog 4 to 20 mA



A0039344

1 Operating key for lower range value (Zero)
2 Operating key for upper range value (Span)
3 DIP switch for damping
4 DIP switch for locking and unlocking the device

HART

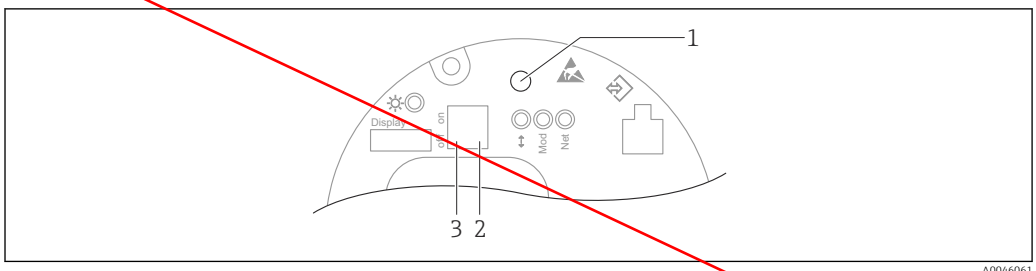


A0039285

1 Operating key for lower range value (Zero)
2 Operating key for upper range value (Span)
3 DIP switch for alarm current
4 DIP switch for locking and unlocking the device

The setting of the DIP switches has priority over the settings made via other operation methods (e.g. FieldCare/DeviceCare).

PROFINET with Ethernet-APL



A0046061

1 Operating key for position adjustment (zero point correction) and device reset
2 DIP switch for setting the service IP address
3 DIP switch for locking and unlocking the device

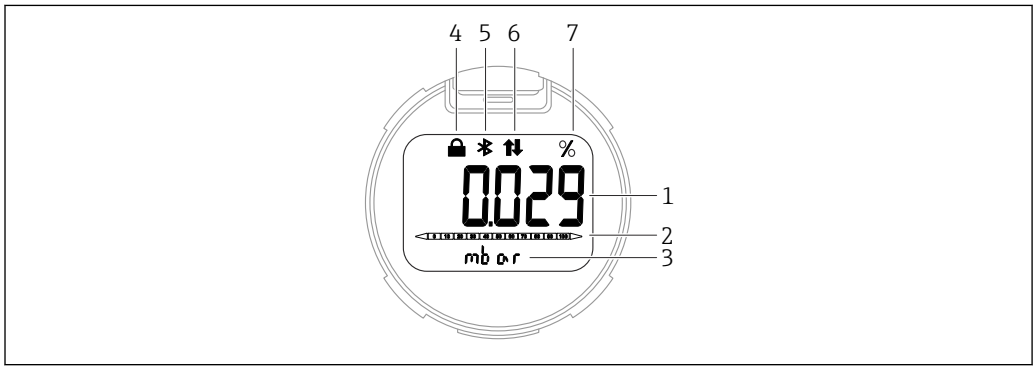
The setting of the DIP switches has priority over the settings made via other operation methods (e.g. FieldCare/DeviceCare).

Local display

Device display (optional)

Functions:
Display of measured values and fault and notice messages

The device displays are available with the additional option of Bluetooth® wireless technology.



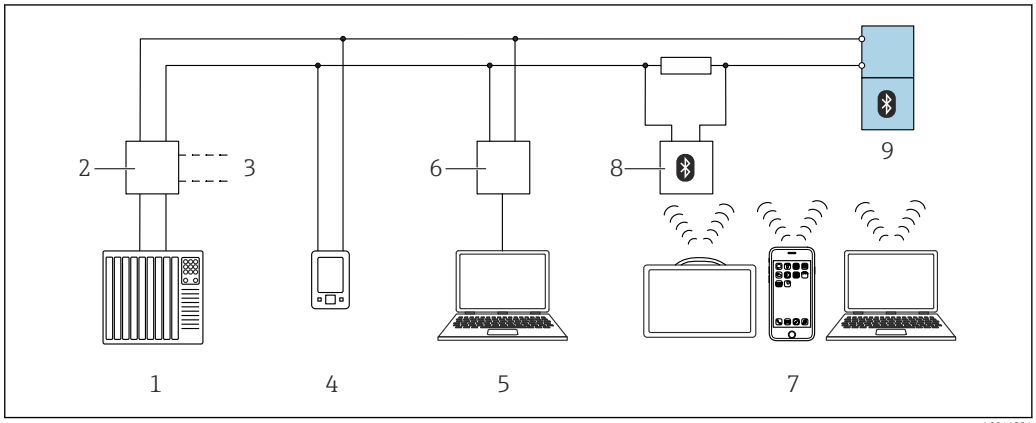
A0043599

7 Segment display

1 Measured value (up to 5 digits)
2 Bar graph proportional to the current output (not for PROFINET with Ethernet-APL)
3 Unit of measured value
4 Locked (symbol appears when the device is locked)
5 Bluetooth (symbol flashes if Bluetooth connection is active) (only HART and PROFINET with Ethernet-APL)
6 HART communication (symbol is displayed if HART communication is active) , or communication via PROFINET is active (only HART and PROFINET with Ethernet-APL)
7 Measured value output in %

Remote operation

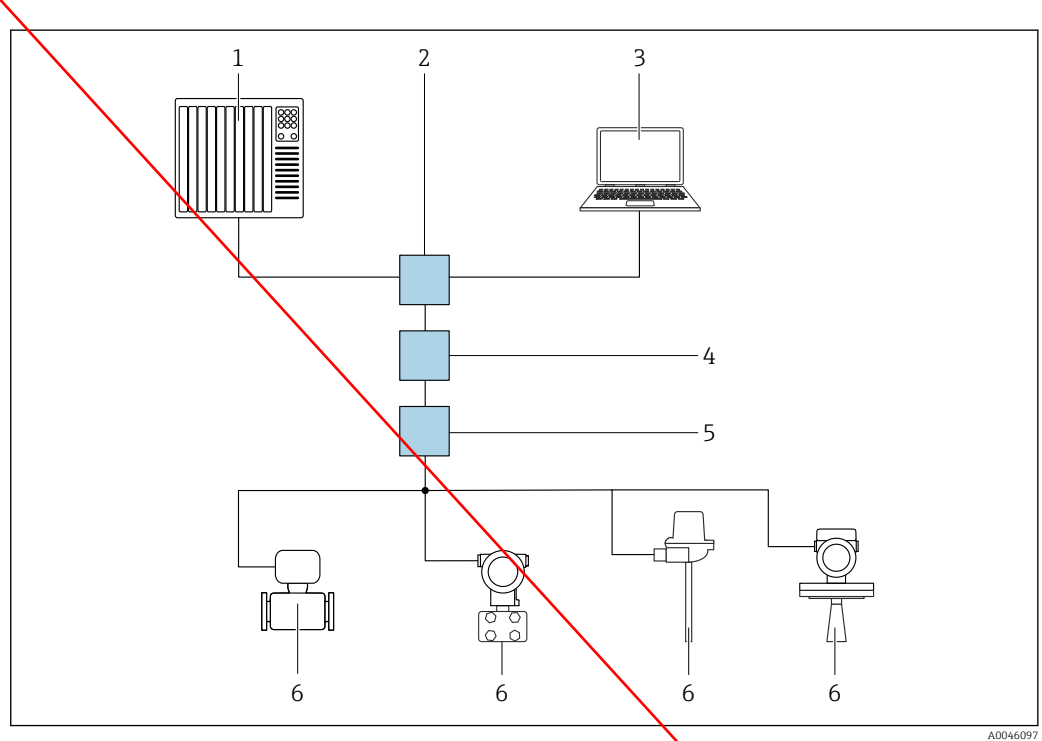
Via HART protocol or Bluetooth



8 *Options for remote operation via HART protocol*

1 *PLC (programmable logic controller)*
2 *Transmitter power supply unit, e.g. RN221N (with communication resistor)*
3 *Connection for Commubox FXA195 and AMS Trex™ device communicator*
4 *AMS Trex™ device communicator*
5 *Computer with operating tool (e.g. DeviceCare/FieldCare , AMS Device View, SIMATIC PDM)*
6 *Commubox FXA195 (USB)*
7 *Field Xpert SMT70/SMT77, smartphone or computer with operating tool (e.g. DeviceCare/FieldCare, AMS Device View, SIMATIC PDM)*
8 *Bluetooth modem with connecting cable (e.g. VIATOR)*
9 *Transmitter*

Via PROFINET with Ethernet-APL network



9 *Options for remote operation via PROFINET with Ethernet-APL network: star topology*

1 *Automation system, e.g. Simatic S7 (Siemens)*
2 *Ethernet switch*
3 *Computer with Web browser (e.g., Microsoft Edge) for accessing the integrated device Web server or computer with operating tool (e.g., FieldCare, DeviceCare, SIMATIC PDM) with iDTM Profinet Communication*
4 *APL power switch (optional)*
5 *APL field switch*
6 *APL field device*

Call up the website via the computer in the network. The IP address of the device must be known.

The IP address can be assigned to the device in a variety of ways:
- Dynamic Configuration Protocol (DCP), factory setting
  The automation system (e.g. Siemens S7) automatically assigns the IP address to the device
- Software addressing
  The IP address is entered via the IP address parameter
- DIP switch for service
  The device then has the fixed IP address 192.168.1.212
  The IP address is only adopted following a restart.
  The IP address can now be used to establish the connection to the network

The default setting is that the device uses the Dynamic Configuration Protocol (DCP). The automation system (e.g. Siemens S7) automatically assigns the IP of the device.

Via Web browser (for devices with PROFINET)

Function scope

Thanks to the integrated Web server the device can be operated and configured via a Web browser. The structure of the operating menu is the same as for the local display. In addition to the measured values, device status information is also displayed and allows users to monitor the status of the device. Furthermore the device data can be managed and the network parameters can be configured.

Via service interface (CDI)

With the Commubox FXA291, a CDI connection is established with the device interface and a Windows PC/notebook with a USB port.

Operation via Bluetooth® wireless technology (optional)

Requirement
- Device with Bluetooth display
- Smartphone or tablet with Endress+Hauser SmartBlue app or PC with DeviceCare from version 1.07.00 or FieldXpert SMT70

The connection has a range of up to 25 m (82 ft). The range can vary depending on environmental conditions such as attachments, walls or ceilings.

System integration

HART

Version 7

PROFINET with Ethernet-APL

PROFINET Profile 4.02

Supported operating tools

Smartphone or tablet with Endress+Hauser SmartBlue (app), DeviceCare, version 1.07.00 and higher, FieldCare, DTM, AMS and PDM.

PC with Web server via fieldbus protocol.

Certificates and approvals

Current certificates and approvals for the product are available at www.endress.com on the relevant product page:

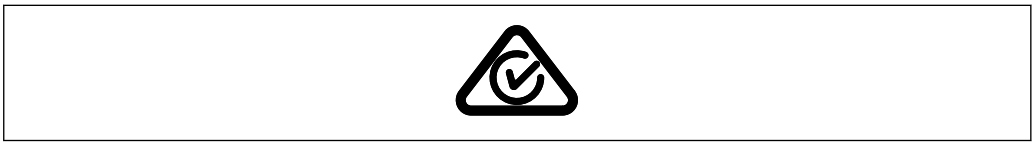
1. Select the product using the filters and search field.
2. Open the product page.
3. Select **Downloads**.

CE mark

The device meets the legal requirements of the relevant EC directives. Endress+Hauser confirms that the device has been successfully tested by applying the CE mark.

RCM-Tick marking

The supplied product or measuring system meets the ACMA (Australian Communications and Media Authority) requirements for network integrity, interoperability, performance characteristics as well as health and safety regulations. Here, especially the regulatory arrangements for electromagnetic compatibility are met. The products bear the RCM-Tick marking on the nameplate.



A0029561

Ex approvals

- ATEX
- CSA
- NEPSI
- UKCA
- INMETRO
- KC
- EAC
- JPN
- Combinations of different approvals also

All the data related to explosion protection is provided in separate Ex documentation which is also available upon request. The Ex documentation is supplied as standard with all devices approved for use in explosion hazardous areas.

Additional approvals in preparation.

Explosion-protected smartphones and tablets

If used in hazardous areas, mobile end devices with an Ex approval must be used.

Sanitary compatibility

The following applies for the ceramic membrane:

The US Food & Drug Administration (FDA) has no objections to the use of ceramics made from aluminum oxide as a surface material in contact with foodstuffs. This declaration is based on the FDA certificates of our ceramic suppliers.

EAC conformity

The device meets the legal requirements of the applicable EAC Directives. These are listed in the corresponding EAC Declaration of Conformity along with the standards applied.

Endress+Hauser confirms successful testing of the device by affixing to it the EAC mark.

Drinking water approval

- NSF/ANSI 61 drinking water approval
- KTW drinking water approval W 270

Overfill protection (in preparation)

The device is tested in accordance with the approval guidelines for overfill protection units (ZG-ÜS:2012-07) as overfill protection as per Section 63 of the German Water Resources Act (WHG).

Functional safety SIL/ IEC 61508 Declaration of Conformity (optional)

The devices with a 4-20 mA output signal have been developed according to the IEC 61508 standard. These devices can be used to monitor the process level and pressure up to SIL 3. For a detailed description of the safety functions, settings and functional safety data, see the "Functional Safety Manual".

Marine approval

- ABS (American Bureau of Shipping)
- LR (Lloyd's Register)
- BV (Bureau Veritas)
- DNV GL (Det Norske Veritas / German Lloyd)

Radio approval

Displays with Bluetooth LE have radio licenses according to CE and FCC. The relevant certification information and labels are provided on display.

CRN approval

A CRN approval (Canadian Registration Number) is available for some device versions. These devices are fitted with a separate plate bearing the registration number CRN 0F23358.5C. In order to obtain a CRN-approved device, a CRN-approved process connection must be ordered along with the option "CRN" in the order code for "Additional approvals".

Test reports

Test, certificate, declarations

- Inspection certificate 3.1, EN10204 (material certificate, wetted metallic parts)
  The selection of this feature for coated process membranes/process connections refers to the metallic base material
- NACE MR0175 / ISO 15156 (wetted metallic parts), declaration
- NACE MR0103 / ISO 17945 (wetted metallic parts), declaration
- AD 2000 (wetted, metallic parts), declaration, excluding membrane
- Pressure test, internal procedure, test report
- Helium leak test, internal procedure, test report
- PMI test, internal procedure (wetted metallic parts), test report

Test reports, declarations and inspection certificates are available in electronic format in the Device Viewer: enter the serial number from the nameplate (www.endress.com/deviceviewer).

Applicable for the order codes "Calibration" and "Test, certificate" .

Product documentation on paper

Test reports, declarations and inspection certificates in hard copy can optionally be ordered with the order option "Product documentation on paper". These documents are supplied with the ordered product.

Calibration

5-point calibration certificate

10-point calibration certificate, traceable to ISO/IEC 17025

Manufacturer declarations

Various manufacturer declarations can be downloaded from the Endress+Hauser website. Other manufacturer declarations can be ordered via the Endress+Hauser sales office.

Downloading the Declaration of Conformity

www.endress.com → Download

Pressure Equipment Directive 2014/68/EU (PED)

Pressure equipment with allowable pressure ≤ 200 bar (2 900 psi)

Pressure equipment (maximum working pressure PS ≤ 200 bar (2 900 psi)) can be classified as pressure accessories according to the Pressure Equipment Directive 2014/68/EU. If the maximum working pressure is ≤ 200 bar (2 900 psi) and the pressurized volume of the pressure equipment is ≤ 0.1 l, the pressure equipment is subject to the Pressure Equipment Directive (see Pressure Equipment Directive 2014/68/EU, Article 4, point 3). The Pressure Equipment Directive only requires that the pressure equipment shall be designed and manufactured in accordance with the "sound engineering practice of a Member State".

Reasons:

- Pressure Equipment Directive (PED) 2014/68/EU Article 4, point 3
- Pressure equipment directive 2014/68/EU, Commission's Working Group "Pressure", Guideline A-05 + A-06

Note:

A partial examination shall be performed for pressure instruments that are part of a safety instrumented system for the protection of a pipe or vessel from exceeding allowable limits (safety accessory in accordance with Pressure Equipment Directive 2014/68/EU, Article 2, point 4).

Pressure equipment with allowable pressure > 200 bar (2 900 psi)

Pressure equipment designated for application in every process fluid having a pressurized volume of <0.1 l and a max. allowable pressure PS > 200 bar (2 900 psi) must satisfy the essential safety requirements set out in Annex I of the Pressure Equipment Directive 2014/68/EU. According to Article 13 pressure equipment shall be classified by category in accordance with Annex II. Taking into account the low volume specified above, the pressure instruments can be categorized as category I pressure equipment. These devices must then bear the CE marking.

Reasons:

- Pressure Equipment Directive 2014/68/EU, Article 13, Annex II
- Pressure equipment directive 2014/68/EU, Commission's Working Group "Pressure", Guideline A-05

Note:

A partial examination shall be performed for pressure instruments that are part of a safety instrumented system for the protection of a pipe or vessel from exceeding allowable limits (safety accessory in accordance with Pressure Equipment Directive 2014/68/EU, Article 2, point 4).

Oxygen application

Verified cleaned, suitable for O2 service (wetted parts)

China RoHS symbol

The device is visibly identified according to SJ/T 11363-2006 (China-RoHS).

RoHS

The measuring system complies with the substance restrictions of the Restriction on Hazardous Substances Directive 2011/65/EU (RoHS 2).

Certification PROFINET with Ethernet-APL

PROFINET with Ethernet-APL interface

The device is certified and registered by the PNO (PROFIBUS Nutzerorganisation e.V. / PROFIBUS User Organization). The measuring system meets all the requirements of the following specifications:

- Certified according to:
  - Test specification for PROFINET devices
  - PROFINET Security Level – Netload Class
- The device can also be operated with certified devices of other manufacturers (interoperability)

Additional certification

Classification of process seal between electrical systems and (flammable or combustible) process liquids in accordance with UL 122701 (formerly ANSI/ISA 12.27.01)

Endress+Hauser devices are designed according to UL 122701 (formerly ANSI/ISA 12.27.01) which means that users do not need and can save on external secondary process seals in the pipe as required in the process seal sections of ANSI/NFPA 70 (NEC) and CSA 22.1 (CEC). These devices comply with North American installation practice and allow very safe and cost-effective installation for pressurized applications with hazardous fluids. The devices are assigned "single seal" as follows:

CSA C/US IS, XP, NI:

40 bar (600 psi)

Further information can be found in the control drawings of the relevant devices.

Metrological approval

If you select the "China" order option, the device is delivered with a Chinese nameplate according to the Chinese Quality Act.

Ordering information

Ordering information

Detailed ordering information is available from the nearest sales organization www.addresses.endress.com or in the Product Configurator under www.endress.com:

1. Select the product using the filters and search field.
2. Open the product page.

The **Configuration** button opens the Product Configurator.

Product Configurator - the tool for individual product configuration
- Up-to-the-minute configuration data
- Depending on the device: direct input of information specific to the measuring point, such as the measuring range or operating language
- Automatic verification of exclusion criteria
- Automatic creation of the order code and its breakdown in PDF or Excel output format
- Ability to order directly in the Endress+Hauser Online Shop

Scope of delivery

The scope of delivery comprises:
- Device
- Optional accessories

Accompanying documentation:
- Brief Operating Instructions
- Final inspection report
- Additional Safety Instructions for devices with approvals (e.g. ATEX, IECEx, NEPSI, etc.)
- Optional: factory calibration form, test certificates

The Operating Instructions are available on the Internet at:

www.endress.com → Download

Service

The following services, among others, can be selected using the Product Configurator.

- Cleaned of oil+grease (wetted)
- Verified cleaned, suitable for O2 applic. (wetted)
- PWIS-free (paint-wetting impairment substances)
  (The plastic protective cover is excluded from the PWIS cleaning)
- ANSI Safety Red coating, coated housing cover
- Set HART burst mode PV
- Set max. alarm current
- Bluetooth communication is disabled on delivery
- Product documentation on paper
  As an option, test reports, declarations and material test certificates can be ordered as a paper printout using the feature **Service**, format**Product documentation on paper**. The required documents can be selected under the feature **Test, certificate, declaration** and are then included with the device on delivery.

Measuring point (tag)

- Order code: marking
- Option: Z1, tagging (TAG), see additional specification
- Location of tag identifier: to be selected in the additional specifications
  - Tag plate, stainless steel
  - Self-adhesive paper label
  - Supplied plate
  - RFID TAG
  - RFID TAG + tag plate stainless steel
  - RFID TAG + self-adhesive paper label
  - RFID TAG + supplied label/plate
- Definition of tag name: to be defined in the additional specifications
  3 lines, each containing up to maximum 18 characters
  The specified tag name appears on the selected label and/or the RFID TAG
- Identification on electronic nameplate (ENP): 32 digits

Test reports, declarations and inspection certificates

All test reports, declarations and inspection certificates are provided electronically in the *Device Viewer*:
Enter the serial number from the nameplate (www.endress.com/deviceviewer)

Product documentation on paper
Test reports, declarations and inspection certificates in hard copy can optionally be ordered with feature 570 "Service", Version I7 "Product documentation on paper". The documents are then provided with the device upon delivery.

Accessories

Device-specific accessories

Mechanical accessories

- Mounting bracket for housing
- Mounting bracket for block & bleed valves
- Block&Bleed valves:
  - Block&Bleed valves can be ordered as **enclosed** accessories (seal for mounting is enclosed)
  - Block&Bleed valves can be ordered as **mounted** accessories (mounted manifolds are supplied with a documented leak test)
  - Certificates (e.g. 3.1 material certificate and NACE) and tests (e.g. PMI and pressure test) that are ordered with the device apply for the transmitter and the manifold
  - During the operating life of the valves, it may be necessary to re-tighten the pack
- Water pocket pipes (PZW)
- Flushing rings
- Weather protection covers

For technical data (e.g. materials, dimensions or order numbers), see the accessory document SD01553P.

Plug connectors

- Plug connector M12 90 deg, IP67 5m cable, union nut, Cu Sn/Ni
- Plug connector M12, IP67 union nut, Cu Sn/Ni
- Plug connector M12, 90 deg IP67 union nut, Cu Sn/Ni

The IP protection classes are only maintained if the dummy cap is used or the cable is connected.

Weld-in accessory

For details, refer to TI00426F/00/EN "Weld-in adapters, process adapters and flanges".

Device Viewer

All the spare parts for the device, along with the order code, are listed in the *Device Viewer* (www.endress.com/deviceviewer).

Documentation

For an overview of the scope of the associated Technical Documentation, refer to the following:
- *Device Viewer* (www.endress.com/deviceviewer): Enter the serial number from the nameplate
- *Endress+Hauser Operations app*: Enter serial number from nameplate or scan matrix code on nameplate.

Standard documentation

- Technical Information: planning guide
  The document contains all the technical data on the device and provides an overview of the accessories and other products that can be ordered for the device
- Brief Operating Instructions: takes you quickly to the 1st measured value
  The Brief Operating Instructions contain all the essential information from incoming acceptance to initial commissioning
- Operating Instructions: reference manual
  The Operating Instructions contain all the information that is required in the various phases of the life cycle of the device: from product identification, incoming acceptance and storage, to mounting, connection, operation and commissioning through to troubleshooting, maintenance and disposal

Supplementary device-dependent documentation

Additional documents are supplied depending on the device version ordered: Always comply strictly with the instructions in the supplementary documentation. The supplementary documentation is an integral part of the device documentation.

Field of Activities

Document FA00004P

Pressure measurement, powerful devices for process pressure, differential pressure, level and flow

Special Documentation

Document SD01553P

Mechanical accessories for pressure equipment

The documentation provides an overview of available manifolds, oval flange adapters, pressure gauge valves, shutoff valves, water pocket pipes, condensate pots, cable shortening kits, test adapters, flushing rings, Block&Bleed valves and protective roofs.

Registered trademarks

HART®
Registered trademark of the FieldComm Group, Austin, Texas, USA

PROFINET®
Registered trademark of the PROFIBUS User Organization, Karlsruhe, Germany

Bluetooth®
The Bluetooth® wordmark and logos are registered trademarks of Bluetooth SIG, Inc. and any use of these trademarks by Endress+Hauser is licensed. Other trademarks and trade names are those of their respective owners.

KALREZ®
Registered trademark of DuPont Performance Elastomers L.L.C., Wilmington, USA



www.addresses.endress.com

Endress+Hauser

People for Process Automation

INS-03

PERMEATE PUMP PRESSURE GAUGES

For Earth, For Life
Kubota

Submittal Transmittal

Permeate pump pressure gauges

Project Name	TAYLOR BAY BEACH CLUB WWTF UPGRADE
Project Site	8220 178TH AVENUE, LONGBRANCH, WA 98351
Engineer	Gray & Osborne, Inc 1130 RAINIER AVENUE SOUTH, SUITE 300
Submit to	Gray & Osborne, Inc
Prepared by	Shingo Kubo | Lead Project Manager KUBOTA Water and Environment U.S.A. Corporation 19910 N Creek Pkwy, Suite 100 Bothell, WA 98011
KMU Project #	KMU-OPID85
Issued Date	August 24, 2025
Package #	OPID85- INS-03-B-Permeate pump pressure gauges
Item	Tag # PI169 PI170 PI171 PI172 PI173 PI174

Clarifications;

1. Section1 contains Kubota scope list. The subjected item for this submittal is marked in red.

2. Section2 contains the manufacture submittal and datasheet for review.

1) General – Make Corrections Noted

a. Note that BABA certifications from manufacturers should be included in the final

Kubota Response: BABA certificate is included at the last page of section 2. Please note that the certificate is subjected to be updated after the manufacturer receives the order.

b. Note that manufacturer services should be included in the final submittal.

Kubota Response: Manufacturer field service is not applicable to this product.

15) INS-03-A-Permeate Pump Pressure Gauges –Make Corrections Noted

a. On submittal pg. 8, System code R is chosen, which has a steel process connection. The connection should be stainless steel.

Kubota Response: Corrected.

b. On submittal pg. 8, system code SH is selected for case design. SH is for dry, not liquid filled.

Kubota Response: Corrected.

For Earth, For Life
Kubota

SECTION 1

KUBOTA Water and Environment U.S.A. Corporation
19910 N Creek Pkwy, Suite 100 Bothell, WA 98011| Phone: 425 898 2858 | Fax: 425-898-2853

No	Equipment Location	Tag	Category	Function	Name	Type	Chosen Size/Capacity	Unit	Material	Manufacturer	Model/ Specification	Motor HP	Voltage	FLA	QTY
	MBR Equipment	**x**													
1	MBR	02 MBR 01 02 MBR 02 02 MBR 03 02 MBR 04	SMU	Membrane Filtration	MBR SMU	Flat Plate			304SS	KUBOTA	FS150				4
2	MBR	n/a	SMU	SMU Maintenance	MBR SMU Lifting Tool	Lifting Tool			CS, SS	KUBOTA	TG150				1
3	MBR	n/a	SMU	SMU Maintenance	MBR SMU Lifting Chain	Lifting Tool			304SS	KUBOTA	CS30M				4
4	MBR	02 MOV 03 02 MOV 04	Auto Valve	Diffuser Cleaning	MBR Diffuser Cleaning Valve	ON/OFF Plug	3	inch	CI/CI	Auma/Pratt	SQ12.2-AC01.2/S601 w/extention stem	1/12	120 VAC	2.9	2
5	MBR	n/a	Other Valve	Isolation Valve	SMU Air Isolation Valve(inlet)	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S30				4
6	MBR	n/a	Other Valve	Isolation Valve	SMU Air Isolation Valve(outlet)	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S30				4
7	MBR	BV281 BV282 BV283 BV284	Other Valve	Isolation Valve	SMU PRMT Isolation Valve	Manual Butterfly	2	inch	DI, EPDM, Nylon Coat	Bray	S30				4
8	MBR	n/a	Other Valve	Manual Valves	Isolation Valves for CIP injection	Manual Ball	1	inch	PVC	ASAHI	Type21 True Union				4
9	MBR	02 LS 03 02 LS 04 02 LS 05 02 LS 06	Gauge, Switch	Level Measurement	MBR Level Switch	Float			PP, PU	Conery	2902-B8S1 w/ counter weight and brackets		Loop power		4
10	MBR	n/a	Fabrication	Fabrication	MBR SMU Guide & Stabilizer + Seismic Bracing				304SS	TBD					4
11	MBR	n/a	Fabrication	Fabrication	MBR SMU Fasteners				304SS	TBD					40
12	MBR	n/a	Fabrication	Fabrication	MBR In-Basin Pipe&Supports (Permeate Drop Pipe)				PVC	TBD					4
13	MBR	n/a	Fabrication	Fabrication	MBR In-Basin Pipe&Supports (Air Drop Pipe)				304SS	TBD					8
	Permeate (PRMT) Control Equipment	**x**													
14	PRMT	01 PMP 01 01 PMP 02 01 PMP 03	Permeate Pump	Permeate Extraction	PRMT Pump	Rotary Lobe	45	gpm		Boerger	AN 70 w/ piggyback mount	5	460 VAC	6.6	3
15	PRMT	PI169 PI170 PI171	Gauge, Switch	Pressure Gauge	PRMT Pump Pressuge Gauge(Inlet)		-15 - +15	psig	SS	Ashcroft or equivalent	1279 w/ grycelin filled				3
16	PRMT	PI172 PI173 PI174	Gauge, Switch	Pressure Gauge	PRMT Pump Pressuge Gauge (Inlet)		-15 - +15	psig	SS	Ashcroft or equivalent	1279 w/ grycelin filled				3
17	PRMT	01 PTR 01 01 PTR 02	Pressure Sensor	TMP Measurement	PRMT Pump Pressure Transmitter	Diaphragm	-15 - +15	psi	SS	Endress & Hauser	Cerabar PMCB51		Loop power		2
18	PRMT	01 MFM 01 01 MFM 02	Flow Sensor	Flow Measurement	PRMT Flow Meter	Electromagnetic	3	inch	PU	Endress & Hauser	Promag W 400		24VDC		2
19	MBR	n/a	Other Valve	Isolation Valve	MBR PRMT Pump isolation valve	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S30				8
20	MBR	CV261 CV261 CV261	Other Valve	Check valve	MBR PRMT Pump discharge check valve	Manual ball	3	inch	PVC, EPDM	ASAHI	True Union Ball Check				3
21	PRMT	01 TM 01	Other Instrument	Turbidity Measurement	PRMT Turbidity Meter	Laser	0-5	NTU		HACH	TU5300sc				1
22	PRMT	01 TM 01	Other Instrument	Turbidity Measurement	PRMT Turbidity Transmitter					HACH	SC4500		24VDC		1
23	PRMT	n/a	Other Instrument	Turbidity Measurement	Turbidity Meter Maintenance Kit					HACH					1
	Return Activated Sludge (RAS) Control	**x**													
24	MBR	Relocated from MBR 02 SLS02 02 SLS03	Other Instrument	Level Measurement	MBR Level Sensor	Hydrostatic	15	ft	SS	Endress & Hauser	Waterpilot FMX21 w/ brackets		Loop power		2
	MBR Blower	**x**													
25	MBR BLW	01 MSB 01 01 MSB 02 01 MSB 03	Blower	Blower	MBR Blower	Positive Displacement	114	scfm	CI	Aerzen	GM 4S DN 80	5	460 VAC	6.6	3

No	Equipment Location	Tag	Category	Function	Name	Type	Chosen Size/Capacity	Unit	Material	Manufacturer	Model/ Specification	Motor HP	Voltage	FLA	QTY
26	MBR BLW	n/a	Option	Noise Suppression	MBR Blower Sound Enclosure	With Blower									3
27	MBR BLW	n/a	Option	Blower Temperature	MBR Blower Temperature Gauge	With Blower									3
28	MBR BLW	n/a	Option	Blower Pressure	MBR Blower Pressure Gauge	With Blower									3
29	MBR BLW	n/a	Option	Blower Temperature	MBR Blower Temperature Switch	With Blower									3
30	MBR BLW	01 AFM 01 01 AFM 02	Flow Sensor	Air Flow Measurement	MBR Blower Flow Meter	Thermal Mass	3	inch	PU	Endress & Hauser	t-mass I 300, w/ flow conditioner plate		24VDC		2
31	MBR BLW	n/a	Other Valve	Manual Valves	Air Scour Blower Isolation Valves	Manual Butterfly	3	inch	DI, FKM, SS Disk	Bray	S30				4
	Clean-In-Place Equipment	**x**													
32	SMU CIP	n/a	Chemical Injection	Chemical Injection	SMU CIP System PVC pipes		1	inch	PVC	KUBOTA	Loose ship parts shown on xxx				1
33	SMU CIP	n/a	Flow Sensor	Flow Measurement	CIP solution Flow Meter	Electromagnetic	1	inch	PU				24 VDC		1
34	SMU CIP	n/a	Flow Sensor	Flow Measurement	CIP shelf chenical Flow Meter	Electromagnetic	3/8	inch	PU	Keyence	FD-Q10C		24VDC		1
35	SMU CIP	n/a	Auto Valve	Flow Control	CIP Flow Control Valve	ON/OFF Ball	1	inch	DI	ASAHI	S19-120VAC--1"-C20/S20		120VAC	0.18	1
36	SMU CIP	n/a	Other Valve	Manual Valves	Isolation Valves on CIP Station	Manual Ball	1, 0.5	inch	PVC	ASAHI	Type21 True Union				1
37	SMU CIP	n/a	Other Valve	Manual Valves	Pressure reducing valve	Pressure Reducing	1.5	inch	CI	Zurn	ZW209				1
	System Control Equipment	**x**													
38	CONTROL	n/a	Control Panel	Control Panel	Control Panel	OIT, PLC					NEMA 4/12, 72" x 72" x 18" floor mount enclosure (estimated size) , Allen Bradley 1756-L81E PLC (BABA-Version), FactoryTalk View SE		120VAC	TBD	1
39	D. SERVICE	n/a	D. Service	Direct Service	Direct Service						Design support, start-up, field service, remote service				1

SECTION 2

ASHCROFT®
Trust the shield.®

1279 Duragauge® Pressure Gauge

FEATURES

- Custom dial printing options
- Micrometer adjustable pointer
- ***PLUS!***™ Performance option dampens vibration, shock and pulsation effects
- Pressure range from vacuum to 30,000 psi
- NSF-61 Compliant

TYPICAL USES

- Refineries
- Chemical and petrochemical plants
- Offshore oil rigs
- Water and wastewater pressure control
- Pulp and water
- Mining and metals
- Equipment skids
- Specialized OEM equipment
- Cryogenics



1279
4½″ dial size

Certified to NSF/ANSI/CAN 61

SPECIFICATIONS

Accuracy:	±0.5% of span (ASME B40.100 Grade 2A)		
Size:	4½″		
Range:	Vacuum, compound to 30,000 psi -15-+15psig		
Process Connection Location:	Lower, back, side, top		
Process Connection:	¼ NPT, ½ NPT, 9/16-18 UNF-2B Aminco® (high pressure connection)		
Case Style:	Solid front with pressure relief back		
Window:	Glass (STD.), acrylic, shatter proof glass, non-glare glass (OPT.)		
Movement:	Rotary, adjustable, 400 SS, Teflon™ coated		
Movement Materials:	400 SS, Teflon™ coated pinion gear and segment		
Dial:	Aluminum, white background, black scale		
Pointer:	Micrometer, adjustable, aluminum		
Weather Protection:	Case	IP Rating	Ordering Code
	Dry	Case not sealed, recommended for weather protected environment only	S
	Dry, field fillable	IP66	SH
	Liquid filled	IP66	SL
Dampening Options:	Liquid: glycerin, silicone, Halocarbon®, ***PLUS!***™ Performance		
Mounting:	Stem, surface, flush (STD.), pipe, remote (OPT.)		
Approvals:	CE, CRN, NSF-61		

WETTED COMPONENTS

Bourdon Tube	Process Connection	Joints
316L Stainless steel	316L Stainless steel	Welded
316L Stainless steel	Steel	Welded
K-Monel® 500	Monel® 400, Steel	Welded
C510 Pho. Bronze	Brass	Silver Brazed

KEY BENEFITS

- **Available with a wide variety of accessory and diaphragm seal assemblies**
- **Available with high process temperature dissipation siphons**

MIN/MAX TEMPERATURE LIMITS

Version	Ambient	Process	Storage
Dry	-20 °F to 200 °F (-29 °C to 93 °C)	-20 °F to 250 °F (-29 °C to 121 °C)	-40 °F to 250 °F (-40 °C to 121 °C)
PLUS!™	-40 °F to 150 °F (-40 °C to 66 °C)	-40 °F to 200 °F (-40 °C to 93 °C)	-40 °F to 150 °F (-40 °C to 66 °C)
Glycerin fill	20 °F to 150 °F (-7 °C to 66 °C)	20 °F to 150 °F (-7 °C to 66 °C)	0 °F to 150 °F (-18 °C to 66 °C)
Silicone fill	-40 °F to 150 °F (-40 °C to 66 °C)	-40 °F to 200 °F (-40 °C to 93 °C)	-40 °F to 150 °F (-40 °C to 66 °C)
Halocarbon® fill	-40 °F to 150 °F (-40 °C to 66°C)	-40 °F to 200 °F (-40 °C to 93 °C)	-40 °F to 150 °F (-40 °C to 66 °C)

NON-WETTED COMPONENTS

Case	Ring	Pressure Relief Back
Phenolic	Threaded, Polycarbonate (meets UL 94 V-0)	Polycarbonate (Meets UL 94 V-0)

Note: Other than discoloration of the dial and hardening of the gasketing that may occur as ambient or process temperatures exceeds 150 °F, non-liquid-filled gauges with standard glass windows, can withstand continuous operating temperatures up to 250 °F (121 °C). Liquid-filled gauges can withstand 200 °F (93 °C) but glycerin fill and acrylic window will tend to yellow. Accuracy at temperatures above or below the reference ambient temperature of 68 °F (20 °C) will be affected by approximately .4% per 25 °F. Gauges with welded joints will withstand 750 °F (400 °C), 450 °F (232 °C) with silver brazed joints for short times without rupture, although other parts of the gauge will be destroyed and calibration will be lost. For continuous use and for process or ambient temperatures above 250 °F (121 °C), a diaphragm seal or capillary or siphon is recommended.

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ASHCROFT®
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1279 Duragauge® Pressure Gauge

ORDERING CODE Example:	451279	S	SL	04	L	XND NH	V/15#
	451279	S	SH	04	L	XLL	15#
Dial Size/Model Code							
451279 - 4½″ solid front	451279						
System (tube and process connection)							
A - Bronze tube, brass process connection, Max. pressure connection 1,000 psi							
P - K-Monel® 500 tube, Monel® 400 process connection, Max. pressure 30,000 psi							
R - 316L SS tube, steel process connection, Max. pressure 20,000 psi							
S - 316 SS tube, 316L SS process connection, Max. pressure 20,000 psi (NSF-61 Compliant)		S					
Case Design							
S - Solid front case, dry							
SH - Solid front case, dry (IP66 NEMA 4X)			SH				
SL - Solid front case, liquid filled (glycerin STD.)							
Process Connection Sizes							
02 - ¼ NPT Male, N/A for ranges over 20,000 psi							
04 - ½ NPT Male, N/A for ranges over 20,000 psi				04			
09 - 9/16 18 UNF-2B, Aminco® high pressure fitting, pressures over 20,000 psi (STD.)							
AM - AND 10050-4 (¼ tubing connection)							
RW - SAE 7/16 & 20 Straight thread							
Process Connection Location							
L - Lower					L		
B - Back							
D - Side (3 o'clock)							
E - Side connection (9 o'clock)							
T - Top connection							
Options (If choosing an option(s) must include a "X") (See Table 1 on page 3 for more options)						–X__	
GV - Silicone case fill							
GX - Halocarbon® case fill							
LL - ***PLUS!***™ Performance						LL	
ND - PLUS! Performance, silicone free (glycerin and silicone filled gauges)							
NZ - ***PLUS!***™ Performance, silicone free dry gauges							
X1P - IP65 dry case (case cannot by liquid filled)							
NH - SS tag wired to case							
PD - Acrylic window (STD. with liquid filled or hermetically sealed cases)							
SG - Safety Glass							
C4 - Traceable calibration certificate							
6B - Cleaned for oxygen service							
5G - Attach one accessory to gauge. Applicable to PL02 pressure limiting valve, V01,V02,V03 valves, 1098, 1100, 1198, 2198 siphons, 7001, 7004 needle valves, 1115 capillary, 1106 pulsation dampner, 1112, PD02 pressure snubbers, MDV swivel adapter, 2265 electric warning contact							
Range (coding examples only, see range table on page 3 for all standard ranges)							
Single Scales							
15# - 15 psi							15#
1BR - 1 bar							
1KSC - 1 kg/cm²							
100KP - 100 kPa							
Dual Scales							
15#/BR - 15 psi inner scale, 1 bar outer scale							
1BR/# - 1 bar inner scale, 15 psi outer scale							

When selecting a diaphragm seal or isolation ring, refer to the Min/Max Guide for compatibility with this gauge or scan the QR code to the right.

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1279 Duragauge® Pressure Gauge

This was removed be cause the supplier mentioned that the indicator shows abs pressure

TABLE 1

CODE	OPTION
AB	Gauges calibrated to compensate for absolute pressure
C3	Material Traceability Report per EN 10204 3.1 (S and P wetted parts only)
DA	Dial marking (text marking on the dial)
D3	DuraVis™ retroreflective dial
EP	Maximum pointer (adjustable, N/A with liquid filled or hermetically sealed cases)
HY	Hydrostatic/pneumatic testing. (System with ranges 15 -400 PSI pressurized to 150% of rated system pressure for 5 minutes. Ranges 600 PSI - 10,000 PSI pressurized to 130% system pressure for 5 minutes.)
MQ	Positive Material Identification
NG	Non-glare glass (N/A with liquid fill or hermetically sealed cases)
OS	Overload stop
SG	Safety glass
SH	Red set hand, stationary
TM	2″ Pipe mounting bracket
TS	Throttle screw (STD. with liquid filled, hermetically sealed or ***PLUS!***™ Performance)
VS	Underload stop
VY	Krytox Lubricated Movement (To be ordered with SH case design for low temperature use to -65 °F/-54 °C)
56	Flush mounting ring

STANDARD PRESSURE RANGES

	psi	bar	kPa	mPa	KG (kg/cm²)
Vacuum	30IMV	N1BR	N100KP	N1MP	N1KSC
	–	N1/0.6BR	N100/60KP	0.1/0.06MP	N1/0.6KSC
Compound	V/15#	–	–	–	–
	–	N1/1.5BR	N100/150KP	N0.1/0.15MP	N1/1.5KSC
	V/30#	–	–	–	–
	–	N1/3BR	N100/300KP	N0.1/0.3MP	N1/3KSC
	V/60#	–	–	–	–
	–	N1/5BR	N100/500KP	N0.1/0.5MP	N1/5KSC
	V/100#	–	–	–	–
	–	N1/9BR	N100/900KP	N0.1/0.9MP	N1/9KSC
Positive Pressure	15#	1BR	100KP	0.1MP	1KSC
	20#	–	–	–	–
	–	1.6BR	160KP	0.16MP	1.6KSC
	30#	–	–	–	–
	–	2.5BR	250KP	0.25MP	2.5KSC
	60#	4BR	400KP	0.4MP	4KSC
	–	6BR	600KP	0.6MP	6KSC
	100#	–	–	–	–
	120#	–	–	–	–
	–	10BR	1000KP	1MP	10KSC
	160#	–	–	–	–
	200#	–	–	–	–
	–	16BR	1600KP	1.6MP	16KSC
	300#	–	–	–	–
	–	25BR	2500KP	2.5MP	25KG
	400#	–	–	–	–
	500#	–	–	–	–
	600#	40BR	4000KP	4MP	40KSC
	800#	–	–	–	–
	–	60BR	6000KP	6MP	60KSC
	1000#	–	–	–	–
	1500#	100BR	10000KP	10MP	100KG
	2000#	–	–	–	–
	–	160BR	16000KP	16MP	160KSC
	3000#	–	–	–	–
	–	250BR	25000KP	25MP	250KSC
	4000#	–	–	–	–
	5000#	–	–	–	–
	6000#	400BR	40000KP	40MP	400KSC
	8000#	–	–	–	–
	–	600BR	60000KP	60MP	600KSC
	10000#	–	–	–	–
	15000#	1000BR	100000KP	100MP	1000KSC
	20000#	-	-	-	-
	-	1600BR	-	160MP	1600KSC
	30000#	-	-	-	-

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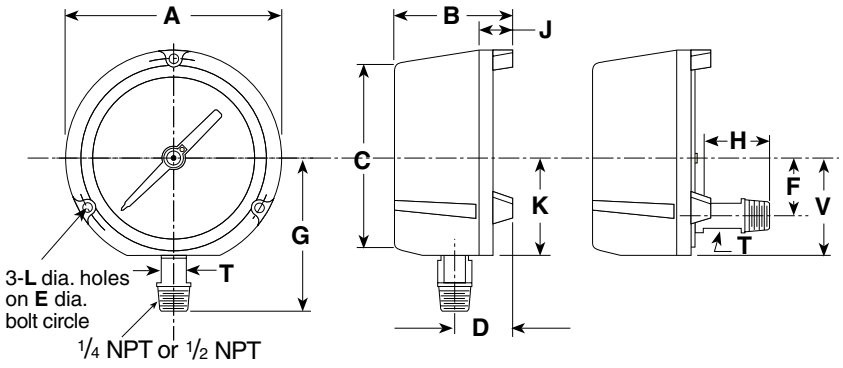
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1279 Duragauge® Pressure Gauge

DIMENSIONS in [ ] are millimeters

For reference only, consult Ashcroft for specific dimensional drawings

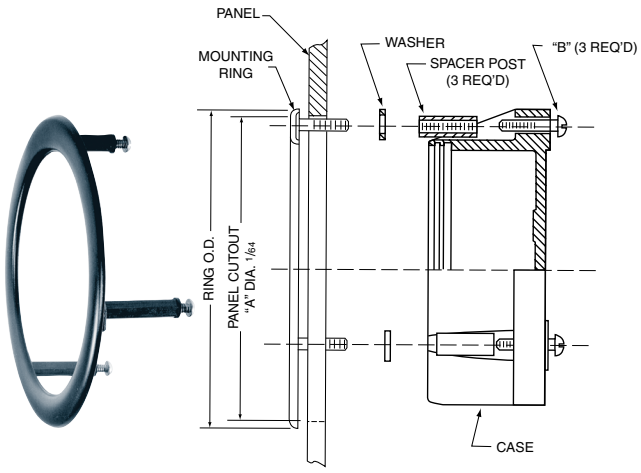
Dial Size Inches	A	B	C	D	E	F	G	H	J	K	L	T	V	Weight oz/kg
4½	5.81 [147.6]	3.36 [85.3]	5.07 [128.7]	1.60 [40.6]	5.375 [137]	1.62 [41.2]	3.92 [99.6]	0.73 [18.4]	0.94 [23.9]	2.62 [66.7]	0.218 [5.5]	0.62 [15.7]	2.62 [66.7]	2.5 (Dry) 3.5 (L.F.)



1278M Series Flush Mounting Ring

1278M Series Flush Mounting Ring. Used to flush mount gauge case 1279(*)S. Black finish (STD.); Polished SS finish (OPT.)

Gauge Size Inches	Ring O.D.	"A" DIA.	"B" Size of 3 Screws	"C" Size of Washers
4½	6 [152]	5.625 [148]	#10-24 x 1⅝	7/16 x 17/64 x 5/8



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ASHCROFT®
Trust the shield.®

Protecting our customers' people, processes and profits.

Date: August 12, 2025

Customer: PARAMOUNT SUPPLY

CERTIFICATE OF COMPLIANCE

Ashcroft certifies that the following products are manufactured in the United States of America and comply with Buy America, Build America Act (BABAA) requirements under 2 CFR Parts 184, dated October 23, 2023.

Product Part Numeration/Product Line	Description	Country of Origin
451279RSL04L30#	Pressure Gauge	US

The process to manufacture this product is complex and requires high levels of skill and expertise. This product is manufactured, tested, and inspected in our facility at 250 East Main Street, Stratford, CT 06614. Ashcroft sources components domestically whenever possible.

Paul Francoletti, Product Sales Leader – Process and Industrial Gauges



Ashcroft Inc.
250 East Main Street
Stratford, CT 06614 - 5145 U.S.A

INS-04

AIR SCOUR FLOW SENSOR

For Earth, For Life
Kubota

Submittal Transmittal

Air Scour Flow Sensor

Project Name	TAYLOR BAY BEACH CLUB WWTF UPGRADE
Project Site	8220 178TH AVENUE, LONGBRANCH, WA 98351
Engineer	Gray & Osborne, Inc 1130 RAINIER AVENUE SOUTH, SUITE 300
Submit to	Gray & Osborne, Inc
Prepared by	Shingo Kubo | Lead Project Manager KUBOTA Water and Environment U.S.A. Corporation 19910 N Creek Pkwy, Suite 100 Bothell, WA 98011
KMU Project #	KMU-OPID85
Issued Date	August 24, 2025
Package #	OPID85- INS-04-B-Air Scour Flow Sensor
Item	Tag # 01 AFM 01 01 AFM 02

Clarifications;

1. Section1 contains Kubota scope list. The subjected item for this submittal is marked in red.

2. Section2 contains the manufacture submittal and datasheet for review.

Response to 60% review comment;

1) General – Make Corrections Noted

a. Note that BABA certifications from manufacturers should be included in the final

Kubota Response: Endress Hauser instruments do not comply with BABA requirement as shown in ATTACHMENT B.

ATTACHMENT B

SCOPE OF SUPPLY COMPONENTS THAT DO NOT COMPLY WITH BABA REQUIREMENTS

Part Identification (Name)	Equipment Description and Type	Manufacturer	Number of Units	Total Lump Sum Equipment Cost for Line Item
Kubota SMU Equipment	FS150 SMU Units + Associated Lifting Tool	Kubota	4 SMUs 1 Lifting Tool + Chains	$80,400.00
SMU Basin Associated Endress + Hauser Instrumentation	1. Air Pressure Transmitters 2. Blower Flow Meters 3. Permeate Flow Meter 4. Pump Pressure Transmitter 5. Level Transmitter	Endress + Hauser	Type 1 - QTY 3 Type 2 - QTY 2 Type 3 - QTY 1 Type 4 - QTY 2 Type 5 - QTY 2	$33,896.00
SMU Basin Hach Instrumentation	1. Air Pressure Transmitters 2. Blower Flow Meters 3. Permeate Flow Meters	Hach	Type 1 - QTY 1 Type 2 - QTY 1 Type 3 - QTY 1	$12,633.00
Kubota Standard CIP System	Kubota CIP system based around Mazzei injector, rotometer and flow control valve	Various	1 System of Supply	$18,500.00
PVC Isolation Valves + Check Valves	3 inch PVC Ball Valves 3 inch PVC Check Valves	Asahi	11 Ball Valves 3 Check Vavles	$11,072.00

b. Note that manufacturer services should be included in the final submittal.

Kubota Response: Manufacturer service is included per the specifications. For the items that Kubota is certified to provide service, Kubota will provide it.

16) INS-04-A-Air Scour Flow Sensor – Make Corrections Noted

a. The model number listed is acceptable. Please edit the PDF to indicated only those items, models, or series of equipment that are being supplied and cross out all extraneous material per 01300.

Kubota Response: See section 2 for the equipment datasheet with cross out.

b. The sensor housing should be 316 stainless steel. The unit appears to be aluminum per submittal pg.8.

Kubota Response: Kubota has switched the model to E+H t-mass I500 which has a sensor housing made of 1.4409 (CF3M). 1.4409 (CF3M) is equivalent to 316L stainless steel. However, this model has a 9" long sensor stick so that the contractor needs to pay attention for installation to avoid trip hazard and the sensor alignment. Kubota will provide an external Flow Conditioner Plate for better reading (previous model had it on the integrated flange) and the contractor needs to install per the O&M manual.

For Earth, For Life
Kubota

SECTION 1

KUBOTA Water and Environment U.S.A. Corporation
19910 N Creek Pkwy, Suite 100 Bothell, WA 98011| Phone: 425 898 2858 | Fax: 425-898-2853

No	Equipment Location	Tag	Category	Function	Name	Type	Chosen Size/Capacity	Unit	Material	Manufacturer	Model/ Specification	Motor HP	Voltage	FLA	QTY
	MBR Equipment	**x**													
1	MBR	02 MBR 01 02 MBR 02 02 MBR 03 02 MBR 04	SMU	Membrane Filtration	MBR SMU	Flat Plate			304SS	KUBOTA	FS150				4
2	MBR	n/a	SMU	SMU Maintenance	MBR SMU Lifting Tool	Lifting Tool			CS, SS	KUBOTA	TG150				1
3	MBR	n/a	SMU	SMU Maintenance	MBR SMU Lifting Chain	Lifting Tool			304SS	KUBOTA	CS30M				4
4	MBR	02 MOV 03 02 MOV 04	Auto Valve	Diffuser Cleaning	MBR Diffuser Cleaning Valve	ON/OFF Plug	3	inch	CI/CI	Auma/Pratt	SQ12.2-AC01.2/S601 w/extention stem	1/12	120 VAC	2.9	2
5	MBR	n/a	Other Valve	Isolation Valve	SMU Air Isolation Valve(inlet)	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S30				4
6	MBR	n/a	Other Valve	Isolation Valve	SMU Air Isolation Valve(outlet)	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S30				4
7	MBR	BV281 BV282 BV283 BV284	Other Valve	Isolation Valve	SMU PRMT Isolation Valve	Manual Butterfly	2	inch	DI, EPDM, Nylon Coat	Bray	S30				4
8	MBR	n/a	Other Valve	Manual Valves	Isolation Valves for CIP injection	Manual Ball	1	inch	PVC	ASAHI	Type21 True Union				4
9	MBR	02 LS 03 02 LS 04 02 LS 05 02 LS 06	Gauge, Switch	Level Measurement	MBR Level Switch	Float			PP, PU	Conery	2902-B8S1 w/ counter weight and brackets		Loop power		4
10	MBR	n/a	Fabrication	Fabrication	MBR SMU Guide & Stabilizer + Seismic Bracing				304SS	TBD					4
11	MBR	n/a	Fabrication	Fabrication	MBR SMU Fasteners				304SS	TBD					40
12	MBR	n/a	Fabrication	Fabrication	MBR In-Basin Pipe&Supports (Permeate Drop Pipe)				PVC	TBD					4
13	MBR	n/a	Fabrication	Fabrication	MBR In-Basin Pipe&Supports (Air Drop Pipe)				304SS	TBD					8
	Permeate (PRMT) Control Equipment	**x**													
14	PRMT	01 PMP 01 01 PMP 02 01 PMP 03	Permeate Pump	Permeate Extraction	PRMT Pump	Rotary Lobe	45	gpm		Boerger	AN 70 w/ piggyback mount	5	460 VAC	6.6	3
15	PRMT	PI169 PI170 PI171	Gauge, Switch	Pressure Gauge	PRMT Pump Pressuge Gauge(Inlet)		-15 - +15	psig	SS	Ashcroft or equivalent	1279 w/ grycelin filled				3
16	PRMT	PI172 PI173 PI174	Gauge, Switch	Pressure Gauge	PRMT Pump Pressuge Gauge (Inlet)		-15 - +15	psig	SS	Ashcroft or equivalent	1279 w/ grycelin filled				3
17	PRMT	01 PTR 01 01 PTR 02	Pressure Sensor	TMP Measurement	PRMT Pump Pressure Transmitter	Diaphragm	-15 - +15	psi	SS	Endress & Hauser	Cerabar PMCB51		Loop power		2
18	PRMT	01 MFM 01 01 MFM 02	Flow Sensor	Flow Measurement	PRMT Flow Meter	Electromagnetic	3	inch	PU	Endress & Hauser	Promag W 400		24VDC		2
19	MBR	n/a	Other Valve	Isolation Valve	MBR PRMT Pump isolation valve	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S30				8
20	MBR	CV261 CV261 CV261	Other Valve	Check valve	MBR PRMT Pump discharge check valve	Manual ball	3	inch	PVC, EPDM	ASAHI	True Union Ball Check				3
21	PRMT	01 TM 01	Other Instrument	Turbidity Measurement	PRMT Turbidity Meter	Laser	0-5	NTU		HACH	TU5300sc				1
22	PRMT	01 TM 01	Other Instrument	Turbidity Measurement	PRMT Turbidity Transmitter					HACH	SC4500		24VDC		1
23	PRMT	n/a	Other Instrument	Turbidity Measurement	Turbidity Meter Maintenance Kit					HACH					1
	Return Activated Sludge (RAS) Control	**x**													
24	MBR	Relocated from MBR 02 SLS02 02 SLS03	Other Instrument	Level Measurement	MBR Level Sensor	Hydrostatic	15	ft	SS	Endress & Hauser	Waterpilot FMX21 w/ brackets		Loop power		2
	MBR Blower	**x**													
25	MBR BLW	01 MSB 01 01 MSB 02 01 MSB 03	Blower	Blower	MBR Blower	Positive Displacement	114	scfm	CI	Aerzen	GM 4S DN 80	5	460 VAC	6.6	3

No	Equipment Location	Tag	Category	Function	Name	Type	Chosen Size/Capacity	Unit	Material	Manufacturer	Model/ Specification	Motor HP	Voltage	FLA	QTY
26	MBR BLW	n/a	Option	Noise Suppression	MBR Blower Sound Enclosure	With Blower									3
27	MBR BLW	n/a	Option	Blower Temperature	MBR Blower Temperature Gauge	With Blower									3
28	MBR BLW	n/a	Option	Blower Pressure	MBR Blower Pressure Gauge	With Blower									3
29	MBR BLW	n/a	Option	Blower Temperature	MBR Blower Temperature Switch	With Blower									3
30	MBR BLW	01 AFM 01 01 AFM 02	Flow Sensor	Air Flow Measurement	MBR Blower Flow Meter	Thermal Mass	3	inch	PU	Endress & Hauser	t-mass I 300, w/ flow conditioner plate		24VDC		2
31	MBR BLW	n/a	Other Valve	Manual Valves	Air Scour Blower Isolation Valves	Manual Butterfly	3	inch	DI, FKM, SS Disk	Bray	S30				4
	Clean-In-Place Equipment	**x**													
32	SMU CIP	n/a	Chemical Injection	Chemical Injection	SMU CIP System PVC pipes		1	inch	PVC	KUBOTA	Loose ship parts shown on xxx				1
33	SMU CIP	n/a	Flow Sensor	Flow Measurement	CIP solution Flow Meter	Electromagnetic	1	inch	PU				24 VDC		1
34	SMU CIP	n/a	Flow Sensor	Flow Measurement	CIP shelf chenical Flow Meter	Electromagnetic	3/8	inch	PU	Keyence	FD-Q10C		24VDC		1
35	SMU CIP	n/a	Auto Valve	Flow Control	CIP Flow Control Valve	ON/OFF Ball	1	inch	DI	ASAHI	S19-120VAC--1"-C20/S20		120VAC	0.18	1
36	SMU CIP	n/a	Other Valve	Manual Valves	Isolation Valves on CIP Station	Manual Ball	1, 0.5	inch	PVC	ASAHI	Type21 True Union				1
37	SMU CIP	n/a	Other Valve	Manual Valves	Pressure reducing valve	Pressure Reducing	1.5	inch	CI	Zurn	ZW209				1
	System Control Equipment	**x**													
38	CONTROL	n/a	Control Panel	Control Panel	Control Panel	OIT, PLC					NEMA 4/12, 72" x 72" x 18" floor mount enclosure (estimated size) , Allen Bradley 1756-L81E PLC (BABA-Version), FactoryTalk View SE		120VAC	TBD	1
39	D. SERVICE	n/a	D. Service	Direct Service	Direct Service						Design support, start-up, field service, remote service				1

SECTION 2

TI01503D/06/EN/03.23-00
71620265
2023-07-28

Technical Information
Proline t-mass I 500

Thermal mass flowmeter



Insertion flowmeter with long-term stability as remote version with up to 4 I/Os

Application

- Measuring principle is characterized by a high operable flow range and direct mass flow measurement
- Measurement of utility and process gases as well as gas mixtures in circular piping or rectangular ducts

Device properties

- Insertion version for DN 80 to 1500 (3 to 60")
- Bidirectional measurement; high measuring performance
- Patented drift-free sensor with SIL 2
- Remote version with up to 4 I/Os
- Backlit display with touch control and WLAN access
- Standard cable between sensor and transmitter

Your benefits

- Flexible, convenient programming based on 21 standard gases or freely definable gas mixtures thereof
- High level of process control – premium measurement accuracy and repeatability
- Reliable monitoring – detection of process disturbances and reverse flow
- Flexible installation – suitable for large dimensional range and circular pipes or rectangular ducts
- Full access to process and diagnostic information – numerous, freely combinable I/Os and fieldbuses
- Reduced complexity and variety – freely configurable I/O functionality
- Integrated verification – Heartbeat Technology

Endress+Hauser
People for Process Automation

Configuration summary

Mat. no.	Description Order code	Quantity	Unit
71430061	t-mass I 500, 6I5BL1, 235mm 9" 6I5BL1-CNIBAAAAGAALBDSANA2AAKA2+JAPD	1	ST

010	Approval; Transmitter; Sensor:	CN	CSA C/US; Cl.I Div.2, NI, Gr.A-D; Cl.I,II,III, Div.1, Gr.A-G
015	Power Supply:	I	AC 100...240V/DC 24V
020	Output; Input 1:	BA	4-20mA HART
021	Output; Input 2:	A	W/o;
022	Output; Input 3:	A	W/o;
023	Output; Input 4:	A	W/o;
030	Display; Operation:	G	4-line illum.; touch control + WLAN
035	Integrated ISEM Electronic:	A	Sensor
041	Transmitter Housing:	A	Alu, coated
042	Sensor Junction Housing:	L	Cast, stainless
045	Cable, Sensor Connection:	B	20m/60ft digital
050	Electrical Connection:	D	Thread NPT1/2
060	Sensor Version; Sensor; Insertion Tube:	SA	Unidirectional; stainl. steel; stainl. steel
070	Process Connection:	NA2	1" NPT, compression fitting
075	Seal:	AA	PEEK, -40...+ 140oC
080	Flow Calibration:	K	5-point, traceable ISO/IEC 17025
480	Device Model:	A2	2
580	>>Test, Certificate:	JA	Inspection certificate 3.1, EN10204 (material certificate wetted parts)
620	>>Accessory Enclosed:	PD	Mounting boss, 1" NPT

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About this document

Symbols

Electrical symbols

Symbol	Meaning
	Direct current
	Alternating current
	Direct current and alternating current
	**Ground connection** A grounded terminal which, as far as the operator is concerned, is grounded via a grounding system.
	**Potential equalization connection (PE: protective earth)** Ground terminals that must be connected to ground prior to establishing any other connections. The ground terminals are located on the interior and exterior of the device: ▪ Interior ground terminal: potential equalization is connected to the supply network. ▪ Exterior ground terminal: device is connected to the plant grounding system.

Communication-specific symbols

Symbol	Meaning
	**Wireless Local Area Network (WLAN)** Communication via a wireless, local network.
	**LED** Light emitting diode is off.
	**LED** Light emitting diode is on.
	**LED** Light emitting diode is flashing.

Symbols for certain types of information

Symbol	Meaning
	**Permitted** Procedures, processes or actions that are permitted.
	**Preferred** Procedures, processes or actions that are preferred.
	**Forbidden** Procedures, processes or actions that are forbidden.
	**Tip** Indicates additional information.
	Reference to documentation
	Reference to page
	Reference to graphic
	Visual inspection

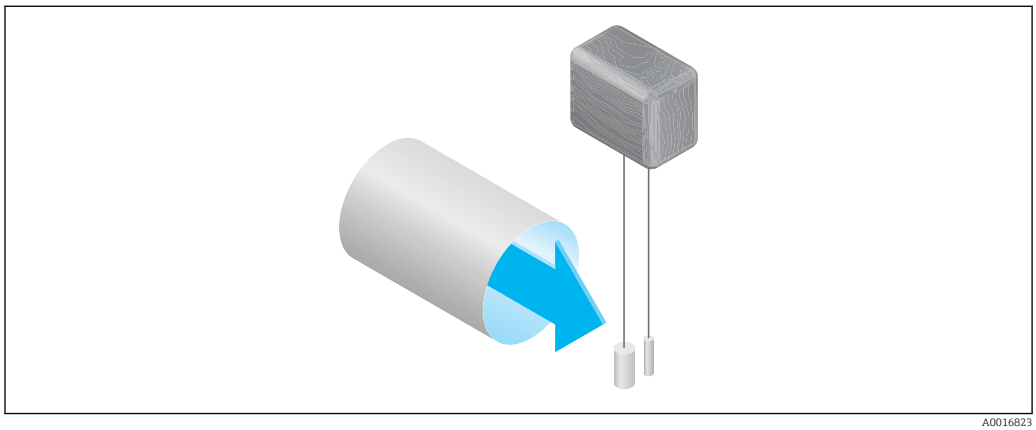
Symbols in graphics

Symbol	Meaning
1, 2, 3, ...	Item numbers
1., 2., 3., ...	Series of steps
A, B, C, ...	Views
A-A, B-B, C-C, ...	Sections
	Hazardous area
	Safe area (non-hazardous area)
	Flow direction

Function and system design

Measuring principle

The thermal measuring principle is based on the cooling of a heated resistance thermometer (PT100) from which heat is extracted by the passing medium.



A0016823

The medium passes two PT100 resistance thermometers in the measurement section. One of these is used in the conventional way as a temperature sensor, while the other serves as a heating element. The temperature sensor monitors and records the effective process temperature while the heated resistance thermometer is kept at a constant differential temperature (compared to the measured process temperature) by controlling the electrical current used by the heating element. The greater the mass flow passing over the heated resistance thermometer, the greater the extent to which cooling takes place and therefore the stronger the current required to maintain a constant differential temperature. This means that the heat current measured is an indicator of the mass flow rate of the medium.

Gas Engine

The integrated Gas Engine functionality ensures maximum measuring performance for flow measurement. The Gas Engine developed by Endress+Hauser is a software-based database of typical standard gases and their specific properties. The Gas Engine calculates the properties of gas mixtures based on the percentage shares of up to 8 gas components.

The Gas Engine functionality enables:
- Calibration with air; no need for expensive and complex calibration with real gas
- Precise conversion of air to other gases; no recalibration required
- Exact measurement of single gases and also of gas mixtures
- Dynamic correction of pressure and temperature changes

The device can be configured for 21 freely selectable gases and water vapor.

Gases available for selection:

- Ammonia
- Argon
- Butane
- Chlorine
- Hydrogen chloride
- Ethane
- Ethylene
- Helium
- Carbon dioxide
- Carbon monoxide
- Krypton
- Air
- Methane
- Neon
- Ozone [1)]
- Propane
- Oxygen
- Hydrogen sulfide
- Nitrogen
- Hydrogen
- Xenon

1) Can only be selected as an individual gas or as a gas mixture with oxygen.

Mixtures of these gases, e.g. natural gas, can be programmed easily and quickly on the basis of the percentage shares.

For other gases, contact the Endress+Hauser sales organization responsible for your area.

Bidirectional measurement and reverse flow detection

Conventional thermal mass flowmeters cannot distinguish between forward and reverse flows. They always record flow in both directions with the same algebraic sign. Endress+Hauser's thermal flowmeter is available in this conventional unidirectional design, or as a bidirectional flowmeter. Both versions feature sensors that are protected in stainless steel. The bidirectional version can distinguish between the two flow directions and measure and totalize the flow in both directions with the same degree of accuracy.

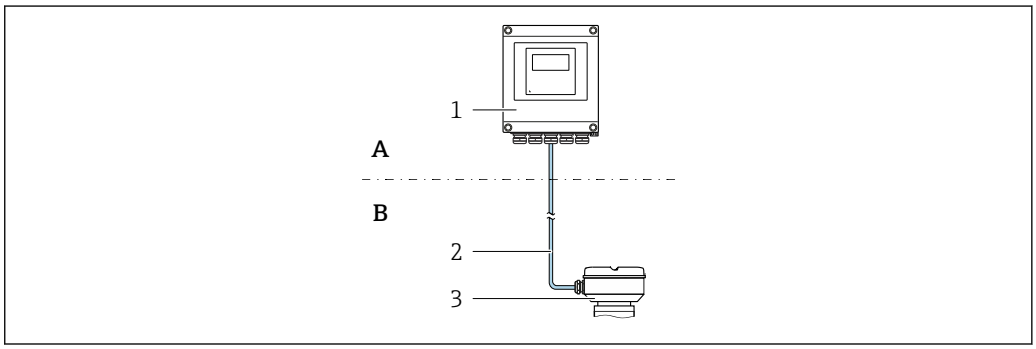
The version to detect reverse flow only measures flow in the positive direction. The reverse flow is detected by the device but is not totalized.

Measuring system

The measuring system consists of a transmitter and a sensor. The transmitter and sensor are mounted in physically separate locations. They are interconnected by connecting cables.

Proline 500 – digital transmitter

For use in applications not required to meet special requirements due to ambient or operating conditions.



A Non-hazardous area or Zone 2; Class I, Division 2
B Non-hazardous area or Zone 2; Class I, Division 2 or Zone 1; Class I, Division 1
1 Transmitter
2 Connecting cable: cable, separate, standard
3 Sensor connection housing with integrated ISEM

- Electronics in the transmitter housing, ISEM (intelligent sensor electronics module) in the sensor connection housing
- Signal transmission: digital

Order code for "Integrated ISEM electronics", option A "Sensor"

Connecting cable

Connecting cables can be ordered in various lengths → 📄 80.

- Length:
  - Zone 2; Class I, Division 2: max. 300 m (1 000 ft)
  - Zone 1; Class I, Division 1: max. 150 m (500 ft)
- Standard cable with common shield (pair-stranded)
- Not sensitive to external EMC interference.

Hazardous area

Use in: Zone 2; Class I, Division 2

Mixed installation is possible:
- Sensor: Zone 1; Class I, Division 1
- Transmitter: Zone 2; Class I, Division 2

Housing versions and materials

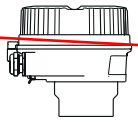
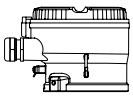
- Transmitter housing
  - Aluminum, coated: aluminum, AlSi10Mg, coated
  - Material: polycarbonate
- Material of window in transmitter housing
  - Aluminum, coated: glass
  - Material: polycarbonate

Configuration

- External operation via 4-line, illuminated graphic local display (LCD) with touch control and guided menus ("Make-it-run" wizards) for application-specific commissioning.
- Via service interface or WLAN connection:
  - Operating tools (e.g. FieldCare, DeviceCare)
  - Web server (access via Web browser, e.g. Microsoft Internet Explorer, Microsoft Edge)

Sensor connection housing

Different versions of the connection housing are available.

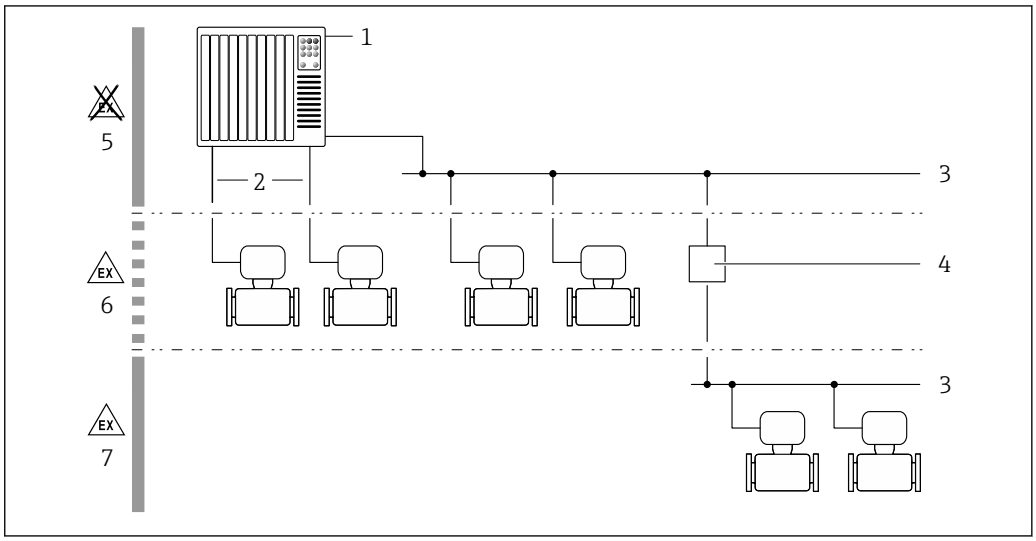
	Order code for "Sensor connection housing", option A, "Aluminum, coated": Aluminum, AlSi10Mg, coated
	Order code for "Sensor connection housing", option L, "Cast, stainless": 1.4409 (CF3M) similar to 316L

Sensor

t-mass I

	Insertion version:
	▪ Sensor lengths: 235 mm (9 ")/335 mm (13 ")/435 mm (17 ")/ 608 mm (24 ") for DN 80 to 1500 (3 to 60")
	▪ Materials (in contact with medium):
	  ▪ Insertion tube: stainless steel 1.4404 (316/316L)
	  ▪ Sensing element:
	  Stainless steel 1.4404 (316/316L)
	  Alloy C22, 2.4602 as version for corrosive gases
	  ▪ Exception: connecting part to transmitter (not in contact with medium): 1.4301 (304)

Equipment architecture



1 *Possibilities for integrating measuring devices into a system*

1 Control system (e.g. PLC)
2 Connecting cable (0/4 to 20 mA HART etc.)
3 Fieldbus
4 Coupler
5 Non-hazardous area
6 Hazardous area: Zone 2; Class I, Division 2
7 Hazardous area: Zone 1; Class I, Division 1

Reliability

IT security

Our warranty is valid only if the product is installed and used as described in the Operating Instructions. The product is equipped with security mechanisms to protect it against any inadvertent changes to the settings.

IT security measures, which provide additional protection for the product and associated data transfer, must be implemented by the operators themselves in line with their security standards.

Device-specific IT security

The device offers a range of specific functions to support protective measures on the operator's side. These functions can be configured by the user and guarantee greater in-operation safety if used correctly. The following list provides an overview of the most important functions:

Function/interface	Factory setting	Recommendation
Write protection via hardware write protection switch → 🖹 10	Not enabled	On an individual basis following risk assessment
Access code (also applies to web server login or FieldCare connection) → 🖹 10	Not enabled (0000)	Assign a customized access code during commissioning
WLAN (order option in display module)	Enabled	On an individual basis following risk assessment
WLAN security mode	Enabled (WPA2-PSK)	Do not change
WLAN passphrase (Password) → 🖹 10	Serial number	Assign an individual WLAN passphrase during commissioning
WLAN mode	Access point	On an individual basis following risk assessment
Web server → 🖹 10	Enabled	On an individual basis following risk assessment
CDI-RJ45 service interface→ 🖹 10	–	On an individual basis following risk assessment

Protecting access via hardware write protection

Write access to the parameters of the device via the local display, web browser or operating tool (e.g. FieldCare, DeviceCare) can be disabled via a write protection switch (DIP switch on the main electronics module). When hardware write protection is enabled, only read access to the parameters is possible.

Hardware write protection is disabled when the device is delivered.

Protecting access via a password

Different passwords are available to protect write access to the device parameters or access to the device via the WLAN interface.

- User-specific access code
  Protect write access to the device parameters via the local display, web browser or operating tool (e.g. FieldCare, DeviceCare). Access authorization is clearly regulated through the use of a user-specific access code.
- WLAN passphrase
  The network key protects a connection between an operating unit (e.g. notebook or tablet) and the device via the WLAN interface which can be ordered as an option.
- Infrastructure mode
  When the device is operated in infrastructure mode, the WLAN passphrase corresponds to the WLAN passphrase configured on the operator side.

User-specific access code

Write access to the device parameters via the local display, web browser or operating tool (e.g. FieldCare, DeviceCare) can be protected by the modifiable, user-specific access code.

WLAN passphrase: Operation as WLAN access point

A connection between an operating unit (e.g. notebook or tablet) and the device via the WLAN interface, which can be ordered as an optional extra, is protected by the network key. The WLAN authentication of the network key complies with the IEEE 802.11 standard.

When the device is delivered, the network key is pre-defined depending on the device. It can be changed via the **WLAN settings** submenu in the **WLAN passphrase** parameter.

Infrastructure mode

A connection between the device and WLAN access point is protected by means of an SSID and passphrase on the system side. Please contact the relevant system administrator for access.

General notes on the use of passwords

- The access code and network key supplied with the device should be changed during commissioning for safety reasons.
- Follow the general rules for generating a secure password when defining and managing the access code and network key.
- The user is responsible for the management and careful handling of the access code and network key.

Access via web server

The device can be operated and configured via a web browser using the integrated web server. The connection is established via the service interface (CDI-RJ45) or the WLAN interface.

The web server is enabled when the device is delivered. The web server can be disabled via the **Web server functionality** parameter if necessary (e.g. after commissioning).

The device and status information can be hidden on the login page. This prevents unauthorized access to the information.

For detailed information on device parameters, see:
"Description of Device Parameters" document .

Access via service interface (CDI-RJ45)

The device can be connected to a network via the service interface (CDI-RJ45). Device-specific functions guarantee the secure operation of the device in a network.

The use of relevant industrial standards and guidelines that have been defined by national and international safety committees, such as IEC/ISA62443 or the IEEE, is recommended. This includes organizational security measures such as the assignment of access authorization as well as technical measures such as network segmentation.

Input

Measured variable

Measured process variables

- Mass flow
- Temperature

Calculated process variables

- Corrected volume flow
- Volume flow
- FAD volume flow
- Flow velocity
- Calorific value
- 2nd temperature heat difference
- Heat flow
- Energy flow
- Density

Process variables available for order

Order code for "Sensor version":
- Option SB "Bidirectional" measures the flow in both directions (»positive« and »negative« flow) and totalizes the flow in both directions. The device is calibrated in both directions.
- Option SC "Reverse flow detection" only measures the flow in the positive direction. The reverse flow is detected by the device but is not totalized. The device is only calibrated in the positive forward flow direction.

Order code for "Application package":
Option EV "Second gas group" enables the configuration of two different standard gases/gas mixtures in the device and allows the user to switch from one gas group to another using the status input or (if available) via bus communication.

Measuring range

The available measuring range depends on the choice of gas and size of the pipe. Each measuring device is calibrated individually with air under reference operating conditions. No recalibration is required in the case of customer-specific gases, as the device's Gas Engine → 🖹 6 functionality converts from air to these gases.

The measuring ranges calibrated for air are indicated in the following section. For information on other gases and process conditions, contact your sales organization or use the Applicator selection software.

SI units

- Order code for "Sensor version; sensor; insertion tube", option SA "Unidirectional; stainless steel; stainless steel"
- Order code for "Sensor version; sensor; insertion tube", option HA "Unidirectional; Alloy; stainless steel"

DN [mm]	Full scale value [kg/h] (Air, 20°C, 1.013 bar a)		Full scale value [Nm3/h] (Air, 0°C, 1.013 bar a)	
	Minimum	Maximum	Minimum	Maximum
80	21	2086	16	1613
100	33	3260	25	2521
150	73	7335	57	5672
200	130	13040	101	10084
250	204	20375	158	15757
300	293	29340	227	22689
400	522	52160	403	40337
500	815	81500	630	63026
600	1174	117360	908	90758
700	1597	159740	1235	123531

DN [mm]	Full scale value [kg/h] (Air, 20°C, 1.013 bar a)		Full scale value [Nm3/h] (Air, 0°C, 1.013 bar a)	
	Minimum	Maximum	Minimum	Maximum
1000	3260	326000	2521	252105
1500	7335	733501	5672	567236

- Order code for "Sensor version; sensor; insertion tube:", option SB "Bidirectional; stainless steel; stainless steel"
- Order code for "Sensor version; sensor; insertion tube:", option SC "Reverse flow detection; stainless steel; stainless steel"

DN [mm]	Full scale value [kg/h] (Air, 20°C, 1.013 bar a)		Full scale value [Nm3/h] (Air, 0°C, 1.013 bar a)	
	Minimum	Maximum	Minimum	Maximum
80	13	1310	10	1012
100	23	2310	17	1786
150	47	4750	36	3673
200	84	8475	65	6553
250	132	13250	102	10246
300	190	19000	146	14692
400	337	33750	260	26099
500	530	53000	409	40986
600	762	76250	589	58966
700	1038	103820	802	80286
1000	2119	211900	1638	163868
1500	4767	476750	3686	368683

US units

- Order code for "Sensor version; sensor; insertion tube", option SA "Unidirectional; stainless steel; stainless steel"
- Order code for "Sensor version; sensor; insertion tube", option HA "Unidirectional; Alloy; stainless steel"

DN [in]	Full scale value [lb/h] (Air, 68°F, 14.7 psi a)		Full scale value [SCFM] (Air, 59°F, 14.7 psi a)	
	Minimum	Maximum	Minimum	Maximum
3	42	4173	9	909
4	74	7419	16	1616
6	167	16693	36	3636
8	297	29677	65	6464
10	464	46371	101	10100
12	668	66774	145	14544
16	1187	118709	259	25856
20	1855	185482	404	40400
24	2671	267094	582	58176
28	3635	363545	792	79184
40	7419	741929	1616	161600
60	16693	1669340	3636	363600

- Order code for "Sensor version; sensor; insertion tube:", option SB "Bidirectional; stainless steel; stainless steel"
- Order code for "Sensor version; sensor; insertion tube:", option SC "Reverse flow detection; stainless steel; stainless steel"

DN [in]	Full scale value [lb/h] (Air, 68°F, 14.7 psi a)		Full scale value [SCFM] (Air, 59°F, 14.7 psi a)	
	Minimum	Maximum	Minimum	Maximum
3	29	2 981	6	648
4	52	5 257	11	1 144
6	108	10 810	23	2 354
8	192	19 287	42	4 200
10	301	30 155	65	6 567
12	432	43 241	94	9 417
16	768	76 810	167	16 729
20	1 206	120 620	262	26 272
24	1 735	173 533	377	37 797
28	2 362	236 279	514	51 463
40	4 822	482 253	1 050	105 039
60	10 850	1 085 012	2 363	236 326

The flow rates listed are only representative for the calibrated conditions and do not necessarily reflect the measuring capacity of the measuring device under operating conditions and the actual pipe internal diameters present on site. To make sure that the correct device version and sizing is selected to suit the application, contact the sales organization or use the Applicator selection software.

Special applications

High gas flow velocities (>70 m/s)

In the case of high gas flow velocities, it is advisable to read in the process pressure dynamically or to enter the pressure as accurately as possible, as a velocity-dependent correction is performed.

Light gases (hydrogen, helium)

- The reliable measurement of light gases can be difficult due to their very high thermal conductivity. Depending on the application, the flow rates of light gases are often particularly slow and the flow profiles are not sufficiently developed. The flows are frequently in the laminar flow range, while turbulent flow would actually be needed for optimum measurement.
- Despite loss of accuracy and linearity in applications with light gases and low flow rates, the device measures with a good degree of repeatability and is therefore suitable for monitoring flow conditions (e.g. leak detection).
- The recommended inlet runs must be doubled for light gases.→ 41

Operable flow range

- 200:1 with factory calibration
- Up to 1000:1 with application-specific adjustment

Input signal

Output and input variants → 16

External values

The measuring device provides interfaces which allow values measured externally → 15 to be transmitted to the measuring device:

- Analog inputs 4-20 mA
- Digital inputs

Pressure values can be transmitted as absolute or gauge pressure. For gauge pressure, the atmospheric pressure must be known or specified by the customer.

HART protocol

The measured values are written from the automation system to the measuring device via the HART protocol. The pressure transmitter must support the following protocol-specific functions:
- HART protocol
- Burst mode

Current input

The measured values are written from the automation system to the measuring device via the current input → 15.

Digital communication

The measured values can be written by the automation system via:
Modbus RS485

Current input 0/4 to 20 mA

Current input	0/4 to 20 mA (active/passive)
Current span	▪ 4 to 20 mA (active) ▪ 0/4 to 20 mA (passive)
Resolution	1 µA
Voltage drop	Typically: 0.6 to 2 V for 3.6 to 22 mA (passive)
Maximum input voltage	≤ 30 V (passive)
Open-circuit voltage	≤ 28.8 V (active)
Possible input variables	▪ Pressure ▪ Temperature ▪ Mol-% (gas analyzer) ▪ External reference flow rate (in-situ adjustment)

Status input

Maximum input values	▪ DC −3 to 30 V ▪ If status input is active (ON): R_i >3 kΩ
Response time	Configurable: 5 to 200 ms
Input signal level	▪ Low signal: DC −3 to +5 V ▪ High signal: DC 12 to 30 V
Assignable functions	▪ Off ▪ Reset the individual totalizers separately ▪ Reset all totalizers ▪ Flow override ▪ Second gas group ▪ Zero point adjustment

Output

Output and input variants

Depending on the option selected for output/input 1, different options are available for the other outputs and inputs. Only one option can be selected for each output/input 1 to 4. The following tables must be read vertically (↓).

Example: If the option BA "4–20 mA HART" was selected for output/input 1, one of the options A, B, D, E, H, I or J is available for output 2 and one of the options A, B, D, E, H, I or J is available for output 3 and 4.

Output/input 1 and options for output/input 2

Options for output/input 3 and 4 → 17

Order code for "Output; input 1" (020) →	Possible options												
Current output 4 to 20 mA HART	**BA**												
Current output 4 to 20 mA HART Ex i passive	↓	**CA**											
Current output 4 to 20 mA HART Ex i active		↓	**CC**										
~~Modbus RS485~~								↓	**MA**				
Order code for "Output; input 2" (021) →	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
~~Not used~~	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**
Current output 4 to 20 mA	**B**			**B**		**B**	**B**		**B**	**B**	**B**	**B**	
User-configurable input/output [1]	**D**			**D**		**D**	**D**		**D**	**D**	**D**	**D**	
Pulse/frequency/switch output	**E**			**E**		**E**	**E**		**E**	**E**	**E**	**E**	
Relay output	**H**			**H**		**H**	**H**		**H**	**H**	**H**	**H**	
Current input 0/4 to 20 mA	**I**			**I**		**I**	**I**		**I**	**I**	**I**	**I**	
Status input	**J**			**J**		**J**	**J**		**J**	**J**	**J**	**J**	

1) A specific input or output can be assigned → 21 to a user-configurable input/output.

Output/input 1 and options for output/input 3 and 4

Options for output/input 2 → 16

Order code for "Output; input 1" (020) →	**Possible options**												
Current output 4 to 20 mA HART	**BA**												
Current output 4 to 20 mA HART Ex i passive	↓	**CA**											
Current output 4 to 20 mA HART Ex i active		↓	**CC**										
Modbus RS485								↓	**MA**				
Order code for "Output; input 3" (022), "Output; input 4" (023) [1] →	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Not used	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**
Current output 4 to 20 mA	**B**					**B**			**B**	**B**	**B**	**B**	
User-configurable input/output	**D**					**D**			**D**	**D**	**D**	**D**	
Pulse/frequency/switch output	**E**					**E**			**E**	**E**	**E**	**E**	
Relay output	**H**					**H**			**H**	**H**	**H**	**H**	
Current input 0/4 to 20 mA	**I**					**I**			**I**	**I**	**I**	**I**	
Status input	**J**					**J**			**J**	**J**	**J**	**J**	

1) The order code for "Output; input 4" (023) is only available for the Proline 500-digital transmitter, order code for "Integrated ISEM electronics", option A.

Output signal

Current output 4 to 20 mA HART

Order code	"Output; input 1" (20): Option BA: current output 4 to 20 mA HART
Signal mode	Can be set to: ▪ Active ▪ Passive
Current range	Can be set to: ▪ 4 to 20 mA NAMUR ▪ 4 to 20 mA US ▪ 4 to 20 mA ▪ 0 to 20 mA (only if the signal mode is active) ▪ Fixed current
Open-circuit voltage	DC 28.8 V (active)
Maximum input voltage	DC 30 V (passive)
Load	250 to 700 Ω
Resolution	0.38 µA
Damping	Configurable: 0 to 999.9 s
Assignable measured variables	▪ Mass flow ▪ Volume flow ▪ Corrected volume flow ▪ FAD volume flow ▪ Flow velocity ▪ Temperature ▪ Energy flow ▪ Pressure ▪ Density ▪ Heat flow ▪ Electronics temperature ▪ 2nd temperature heat difference For SIL (application package), only mass flow

Current output 4 to 20 mA HART Ex i

Order code	"Output; input 1" (20) choose from: ▪ Option CA: current output 4 to 20 mA HART Ex i passive ▪ Option CC: current output 4 to 20 mA HART Ex i active
Signal mode	Depends on the selected order version.
Current range	Can be set to: ▪ 4 to 20 mA NAMUR ▪ 4 to 20 mA US ▪ 4 to 20 mA ▪ 0 to 20 mA (only if the signal mode is active) ▪ Fixed current
Open-circuit voltage	DC 21.8 V (active)
Maximum input voltage	DC 30 V (passive)
Load	▪ 250 to 400 Ω (active) ▪ 250 to 700 Ω (passive)
Resolution	0.38 µA

Damping	Configurable: 0 to 999.9 s
Assignable measured variables	▪ Mass flow ▪ Volume flow ▪ Corrected volume flow ▪ FAD volume flow ▪ Flow velocity ▪ Temperature ▪ Energy flow ▪ Pressure ▪ Density ▪ Heat flow ▪ Electronics temperature ▪ 2nd temperature heat difference For SIL (application package), only mass flow

Modbus RS485

Physical interface	RS485 in accordance with EIA/TIA-485 standard
Terminating resistor	Integrated, can be activated via DIP switches

Current output 4 to 20 mA

Order code	"Output; input 2" (21), "Output; input 3" (022) or "Output; input 4" (023): Option B: current output 4 to 20 mA
Signal mode	Can be set to: ▪ Active ▪ Passive
Current span	Can be set to: ▪ 4 to 20 mA NAMUR ▪ 4 to 20 mA US ▪ 4 to 20 mA ▪ 0 to 20 mA (only if the signal mode is active) ▪ Fixed current
Maximum output values	22.5 mA
Open-circuit voltage	DC 28.8 V (active)
Maximum input voltage	DC 30 V (passive)
Load	0 to 700 Ω
Resolution	0.38 µA
Damping	Configurable: 0 to 999.9 s
Assignable measured variables	▪ Mass flow ▪ Volume flow ▪ Corrected volume flow ▪ FAD volume flow ▪ Flow velocity ▪ Temperature ▪ Energy flow ▪ Pressure ▪ Density ▪ Heat flow ▪ Electronics temperature ▪ 2nd temperature heat difference For SIL (application package), only mass flow

Pulse/frequency/switch output

Function	Can be configured as pulse, frequency or switch output
Version	Open collector Can be set to: ▪ Active ▪ Passive ▪ Passive NAMUR
Maximum input values	DC 30 V, 250 mA (passive)
Open-circuit voltage	DC 28.8 V (active)
Voltage drop	For 22.5 mA: ≤ DC 2 V
Pulse output	
Maximum input values	DC 30 V, 250 mA (passive)
Maximum output current	22.5 mA (active)
Open-circuit voltage	DC 28.8 V (active)
Pulse width	Configurable: 0.05 to 2 000 ms
Maximum pulse rate	10 000 Impulse/s
Pulse value	Configurable
Assignable measured variables	▪ Mass flow ▪ Volume flow ▪ Corrected volume flow ▪ FAD volume flow ▪ Energy flow ▪ Heat flow For SIL (application package), only mass flow
Frequency output	
Maximum input values	DC 30 V, 250 mA (passive)
Maximum output current	22.5 mA (active)
Open-circuit voltage	DC 28.8 V (active)
Output frequency	Configurable: end value frequency 2 to 10 000 Hz (f_{max} = 12 500 Hz)
Damping	Configurable: 0 to 999.9 s
Pulse/pause ratio	1:1
Assignable measured variables	▪ Mass flow ▪ Volume flow ▪ Corrected volume flow ▪ FAD volume flow ▪ Flow velocity ▪ Temperature ▪ Energy flow ▪ Pressure ▪ Density ▪ Heat flow ▪ Electronic temperature ▪ 2nd temperature heat difference For SIL (application package), only mass flow
Switch output	
Maximum input values	DC 30 V, 250 mA (passive)
Open-circuit voltage	DC 28.8 V (active)
Switching behavior	Binary, conductive or non-conductive
Switching delay	Configurable: 0 to 100 s

Number of switching cycles	Unlimited

Assignable functions	▪ Off
	▪ On
	▪ Diagnostic behavior
	▪ Limit value
	  ▪ Off
	  ▪ Mass flow
	  ▪ Volume flow
	  ▪ Corrected volume flow
	  ▪ FAD volume flow
	  ▪ Heat flow
	  ▪ Energy flow
	  ▪ Flow velocity
	  ▪ Density
	  ▪ Calorific value
	  ▪ Temperature
	  ▪ 2nd temperature heat difference
	  ▪ Totalizer 1-3
	  ▪ Electronic temperature
	▪ Flow direction monitoring
	▪ Status
	Low flow cut off

Relay output

Function	Switch output
Version	Relay output, galvanically isolated
Switching behavior	Can be set to: ▪ NO (normally open), factory setting ▪ NC (normally closed)
Maximum switching capacity (passive)	▪ DC 30 V, 0.1 A ▪ AC 30 V, 0.5 A

Assignable functions	▪ Off
	▪ On
	▪ Diagnostic behavior
	▪ Limit value
	  ▪ Off
	  ▪ Mass flow
	  ▪ Volume flow
	  ▪ Corrected volume flow
	  ▪ FAD volume flow
	  ▪ Heat flow
	  ▪ Energy flow
	  ▪ Flow velocity
	  ▪ Density
	  ▪ Temperature
	  ▪ 2nd temperature heat difference
	  ▪ Totalizer 1-3
	  ▪ Electronics temperature
	▪ Flow direction monitoring
	▪ Status
	Low flow cut off

User-configurable input/output

One specific input or output is assigned to a user-configurable input/output (configurable I/O) during device commissioning.

The following inputs and outputs are available for assignment:
- Choice of current output: 4 to 20 mA (active), 0/4 to 20 mA (passive)
- Pulse/frequency/switch output
- Choice of current input: 4 to 20 mA (active), 0/4 to 20 mA (passive)
- Status input

The technical values correspond to those of the inputs and outputs described in this section.

Signal on alarm

Depending on the interface, failure information is displayed as follows:

HART current output

Device diagnostics	Device condition can be read out via HART Command 48

Modbus RS485

Failure mode	Choose from: ▪ NaN value instead of current value ▪ Last valid value

Current output 0/4 to 20 mA

4 to 20 mA

Failure mode	Choose from: ▪ 4 to 20 mA in accordance with NAMUR recommendation NE 43 ▪ 4 to 20 mA in accordance with US ▪ Min. value: 3.59 mA ▪ Max. value: 22.5 mA ▪ Definable value between: 3.59 to 22.5 mA ▪ Actual value ▪ Last valid value

0 to 20 mA

Failure mode	Choose from: ▪ Maximum alarm: 22 mA ▪ Definable value between: 0 to 20.5 mA

Pulse/frequency/switch output

Pulse output	
Fault mode	Choose from: ▪ Actual value ▪ No pulses
Frequency output	
Fault mode	Choose from: ▪ Actual value ▪ 0 Hz ▪ Definable value between: 2 to 12 500 Hz
Switch output	
Fault mode	Choose from: ▪ Current status ▪ Open ▪ Closed

Relay output

Failure mode	Choose from: ▪ Current status ▪ Open ▪ Closed

Local display

Plain text display	With information on cause and remedial measures
Backlight	Red lighting indicates a device error.

Status signal as per NAMUR recommendation NE 107

Interface/protocol

- Via digital communication:
  - HART protocol
  - Modbus RS485
- Via service interface
  - CDI-RJ45 service interface
  - WLAN interface

Plain text display	With information on cause and remedial measures

Additional information on remote operation → 70

Web browser

Plain text display	With information on cause and remedial measures

Light emitting diodes (LED)

Status information	Status indicated by various light emitting diodes The following information is displayed depending on the device version: ▪ Supply voltage active ▪ Data transmission active ▪ Device alarm/error has occurred

Load

Output signal → 18

Ex connection data

Safety-related values

Order code "Output; input 1"	Output type	Safety-related values "Output; input 1"	
		26 (+)	27 (–)
Option **BA**	Current output 4 to 20 mA HART	U_N = 30 V_{DC} U_M = 250 V_{AC}	
Option **MA**	Modbus RS485	U_N = 30 V_{DC} U_M = 250 V_{AC}	

Order code "Output; input 2"; "Output; input 3" "Output; input 4"	Output type	Safety-related values					
		Output; input 2		Output; input 3		Output; input 4	
		24 (+)	25 (–)	22 (+)	23 (–)	20 (+)	21 (–)
Option **B**	Current output 4 to 20 mA	U_N = 30 V_{DC} U_M = 250 V_{AC}					
Option **D**	User-configurable input/ output	U_N = 30 V_{DC} U_M = 250 V_{AC}					
Option **E**	Pulse/frequency/switch output	U_N = 30 V_{DC} U_M = 250 V_{AC}					

Order code "Output; input 2"; "Output; input 3" "Output; input 4"	Output type	Safety-related values					
		Output; input 2		Output; input 3		Output; input 4	
		24 (+)	25 (–)	22 (+)	23 (–)	20 (+)	21 (–)
Option **H**	Relay output	U_N = 30 V_{DC} I_N =100 mA_{DC}/500 mA_{AC} U_M = 250 V_{AC}					
Option **I**	Current input 4 to 20 mA	U_N = 30 V_{DC} U_M = 250 V_{AC}					
Option **J**	Status input	U_N = 30 V_{DC} U_M = 250 V_{AC}					

Low flow cut off

The switch points for low flow cut off are user-selectable.

Galvanic isolation

The outputs are galvanically isolated:
- from the power supply
- from one another
- from the potential equalization (PE) terminal

Protocol-specific data

HART

Manufacturer ID	0x11
Device type ID	0x1160
HART protocol revision	7
Device description files (DTM, DD)	Information and files under: www.endress.com
HART load	Min. 250 Ω
System integration	Information on system integration: Operating Instructions . ▪ Measured variables via HART protocol ▪ Burst Mode functionality

Modbus RS485

Protocol	Modbus Applications Protocol Specification V1.1
Response times	▪ Direct data access: typically 25 to 50 ms ▪ Auto-scan buffer (data range): typically 3 to 5 ms
Device type	Slave
Slave address range	1 to 247
Broadcast address range	0
Function codes	▪ 03: Read holding register ▪ 04: Read input register ▪ 06: Write single registers ▪ 08: Diagnostics ▪ 16: Write multiple registers ▪ 23: Read/write multiple registers
Broadcast messages	Supported by the following function codes: ▪ 06: Write single registers ▪ 16: Write multiple registers ▪ 23: Read/write multiple registers

Supported baud rate	▪ 1 200 BAUD ▪ 2 400 BAUD ▪ 4 800 BAUD ▪ 9 600 BAUD ▪ 19 200 BAUD ▪ 38 400 BAUD ▪ 57 600 BAUD ▪ 115 200 BAUD
Data transmission mode	▪ ASCII ▪ RTU
Data access	Each device parameter can be accessed via Modbus RS485. For Modbus register information
System integration	Information regarding system integration: Operating Instructions . ▪ Modbus RS485 information ▪ Function codes ▪ Register information ▪ Response time ▪ Modbus data map

Power supply

Terminal assignment

Transmitter: supply voltage, input/outputs

HART

Supply voltage		Input/output 1		Input/output 2		Input/output 3		Input/output 4	
1 (+)	2 (–)	26 (+)	27 (–)	24 (+)	25 (–)	22 (+)	23 (–)	20 (+)	21 (–)
		The terminal assignment depends on the specific device version ordered → 16.							

Modbus RS485

Supply voltage		Input/output 1		Input/output 2		Input/output 3		Input/output 4	
1 (+)	2 (–)	26 (B)	27 (A)	24 (+)	25 (–)	22 (+)	23 (–)	20 (+)	21 (–)
		The terminal assignment depends on the specific device version ordered → 16.							

Transmitter and sensor connection housing: connecting cable

The sensor and transmitter, which are mounted in separate locations, are interconnected by a connecting cable. The cable is connected via the sensor connection housing and the transmitter housing.

Terminal assignment and connection of the connecting cable:
Proline 500 – digital → 27

Available device plugs

Device plugs may not be used in hazardous areas!

Device plug for connecting to the service interface:
Order code for "Accessory mounted"
Option **NB**, RJ45 M12 adapter (service interface) → 26

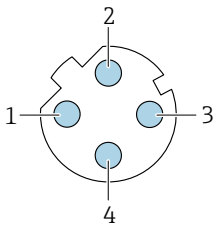
Order code for "Accessory mounted", option NB "Adapter RJ45 M12 (service interface)"

Order code "Accessory mounted"	Cable entry/coupling → 27	
	Cable entry 2	Cable entry 3
NB	Plug M12 × 1	–

Pin assignment, device plug

Service interface

Order code for "Accessories mounted", option **NB**: Adapter RJ45 M12 (service interface)



Pin		Assignment
1	+	Tx
2	+	Rx
3	-	Tx
4	-	Rx
Coding		**Plug/socket**
D		Socket

Recommended plug:
- Binder, series 763, part no. 99 3729 810 04
- Phoenix, part no. 1543223 SACC-M12MSD-4Q

Supply voltage

Order code "Power supply"	Terminal voltage		Frequency range
Option **D**	DC 24 V	±20%	–
Option **E**	AC 100 to 240 V	−15…+10%	50/60 Hz, ±4 Hz
Option **I**	DC 24 V	±20%	–
	AC 100 to 240 V	−15…+10%	50/60 Hz, ±4 Hz

Power consumption

Transmitter

Max. 10 W (active power)

switch-on current	Max. 36 A (<5 ms) as per NAMUR Recommendation NE 21

Current consumption

Transmitter

- Max. 400 mA (24 V)
- Max. 200 mA (110 V, 50/60 Hz; 230 V, 50/60 Hz)

Power supply failure

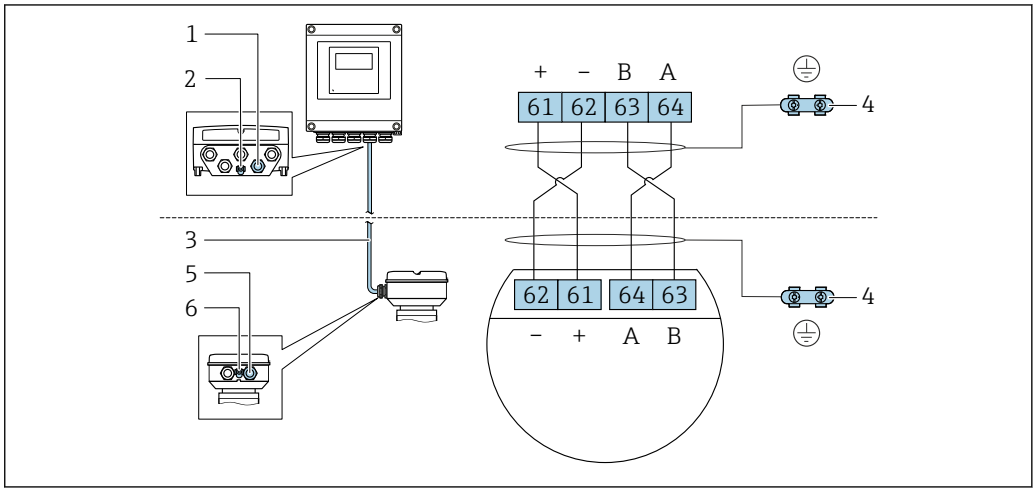
- Totalizers stop at the last value measured.
- Depending on the device version, the configuration is retained in the device memory or in the pluggable data memory (HistoROM DAT).
- Error messages (incl. total operated hours) are stored.

Overcurrent protection element

The device must be operated with a dedicated circuit breaker, as it does not have an ON/OFF switch of its own.
- The circuit breaker must be easy to reach and labeled accordingly.
- Permitted nominal current of the circuit breaker: 2 A up to maximum 10 A.

Electrical connection

Connection of connecting cable: Proline 500 – digital

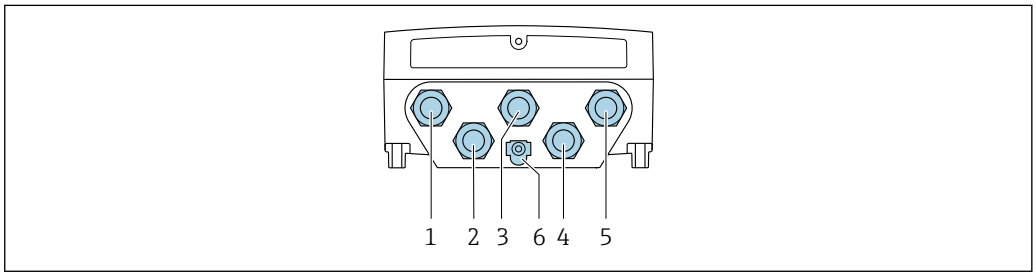


1 *Cable entry for cable on transmitter housing*
2 *Terminal connection for potential equalization (PE)*
3 *Connecting cable ISEM communication*
4 *Grounding via ground connection; in the version with a device plug, grounding is ensured through the plug itself*
5 *Cable entry for cable or connection of device plug on sensor connection housing*
6 *Terminal connection for potential equalization (PE)*

Transmitter connection

- Terminal assignment → 25
- Device plug pin assignment → 26

Transmitter connection: Proline 500 – digital



1 *Terminal connection for supply voltage*
2 *Terminal connection for signal transmission, input/output*
3 *Terminal connection for signal transmission, input/output*
4 *Terminal connection for connecting cable between sensor and transmitter*
5 *Terminal connection for signal transmission, input/output; optional: connection for external WLAN antenna*
6 *Terminal connection for potential equalization (PE)*

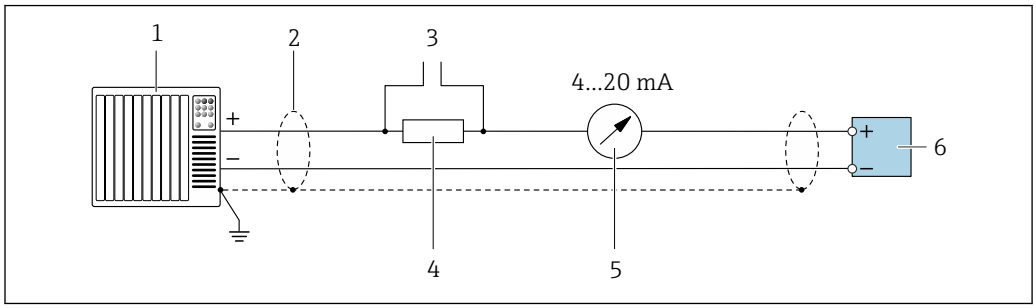
An adapter for the RJ45 to the M12 plug is optionally available:
Order code for "Accessories", option **NB**: "Adapter RJ45 M12 (service interface)"

The adapter connects the service interface (CDI-RJ45) to an M12 plug mounted in the cable entry. The connection to the service interface can thus be established via an M12 plug without opening the device.

Network connection (DHCP client) via service interface (CDI-RJ45) → 71

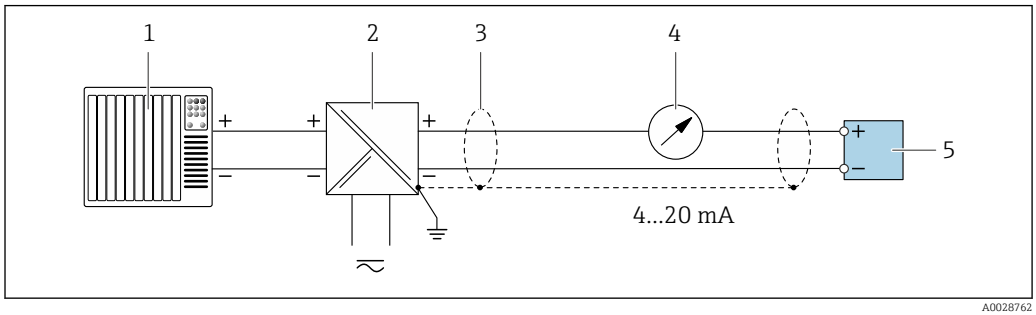
Connection examples

Current output 4 to 20 mA HART



2 Connection example for 4 to 20 mA HART current output (active)

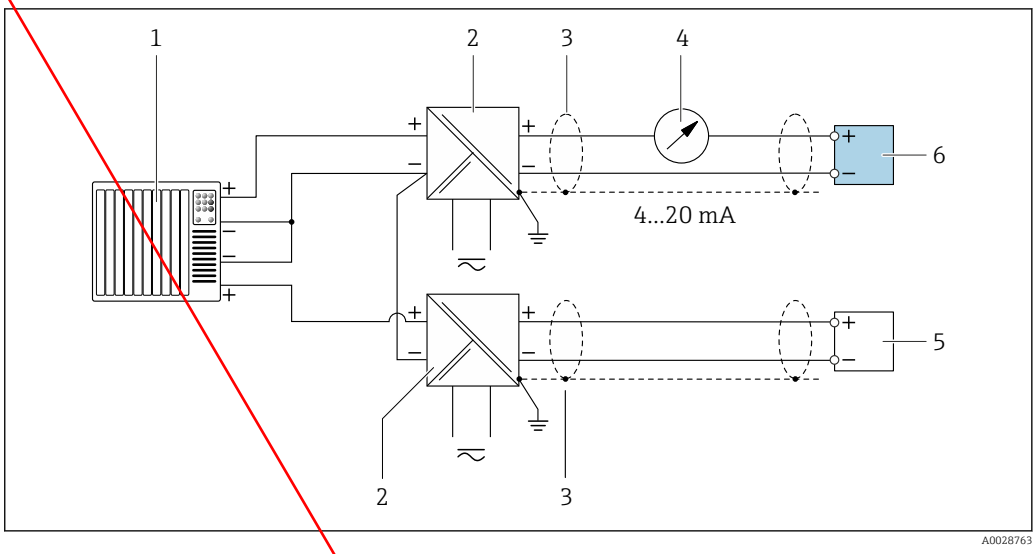
1 *Automation system with current input (e.g. PLC)*
2 *Ground cable shield at one end. The cable shield must be grounded at both ends to comply with EMC requirements; observe cable specifications → 32*
3 *Connection for HART operating devices → 70*
4 *Resistor for HART communication (≥ 250 Ω): observe maximum load → 18*
5 *Analog display unit: observe maximum load → 18*
6 *Transmitter*



3 Connection example for 4 to 20 mA HART current output (passive)

1 *Automation system with current input (e.g. PLC)*
2 *Power supply*
3 *Ground cable shield at one end. The cable shield must be grounded at both ends to comply with EMC requirements; observe cable specifications → 32*
4 *Analog display unit: observe maximum load → 18*
5 *Transmitter*

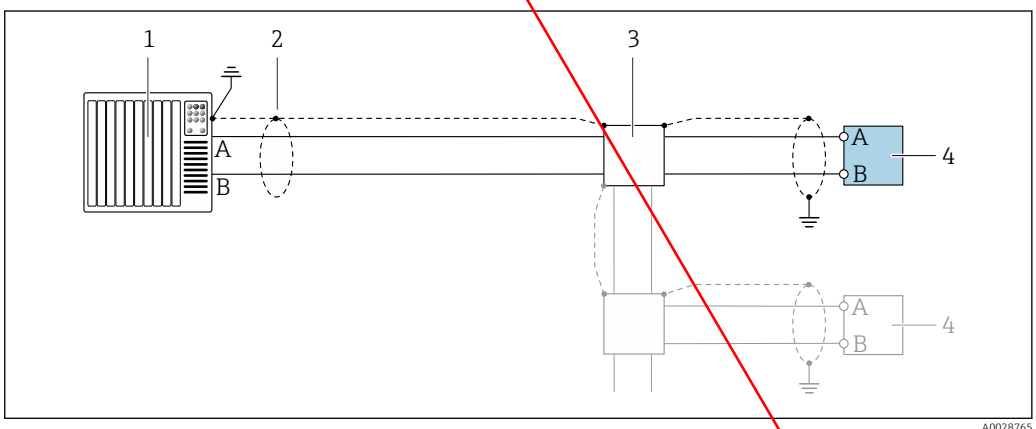
HART input



4 *Connection example for HART input with a common negative (passive)*

1 *Automation system with HART output (e.g. PLC)*
2 *Active barrier for power supply (e.g. RN221N)*
3 *Ground cable shield at one end. The cable shield must be grounded at both ends to comply with EMC requirements; observe cable specifications*
4 *Analog display unit: observe maximum load → 18*
5 *Pressure measuring device (e.g. Cerabar M, Cerabar S): observe requirements*
6 *Transmitter*

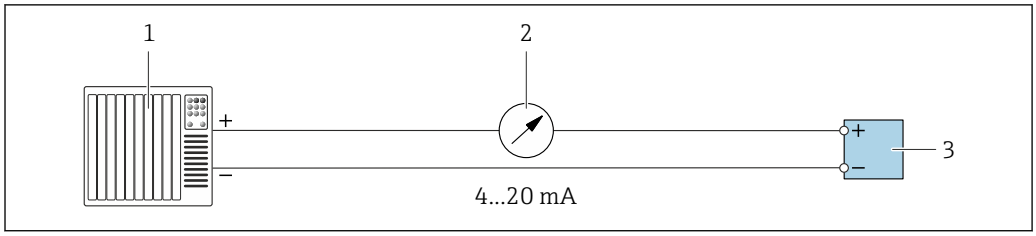
Modbus RS485



5 *Connection example for Modbus RS485, non-hazardous area and Zone 2; Class I, Division 2*

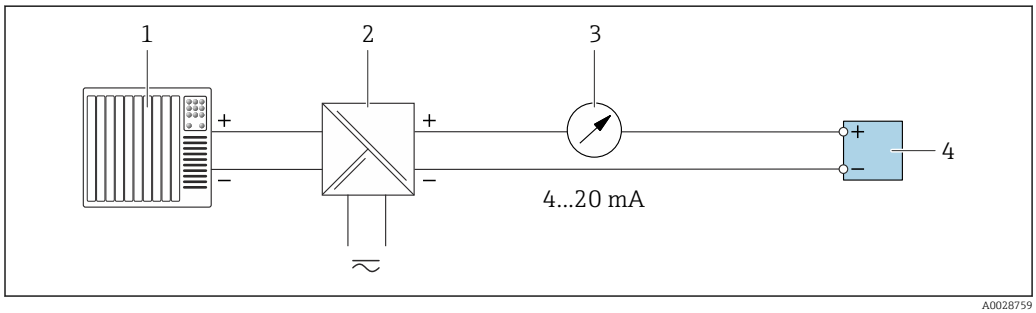
1 *Control system (e.g. PLC)*
2 *Cable shield provided at one end. The cable shield must be grounded at both ends to comply with EMC requirements; observe cable specifications*
3 *Distribution box*
4 *Transmitter*

Current output 4-20 mA



6 Connection example for 4-20 mA current output (active)

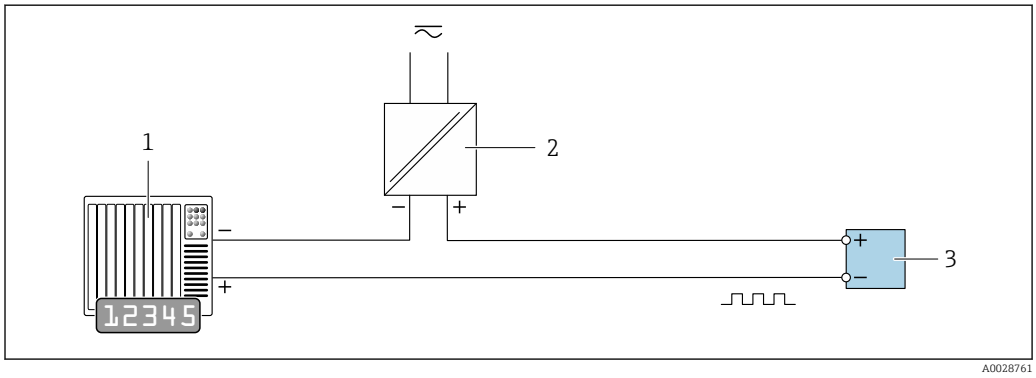
1 Automation system with current input (e.g. PLC)
2 Analog display unit: observe maximum load → 18
3 Transmitter



7 Connection example for 4-20 mA current output (passive)

1 Automation system with current input (e.g. PLC)
2 Active barrier for power supply (e.g. RN221N)
3 Analog display unit: observe maximum load → 18
4 Transmitter

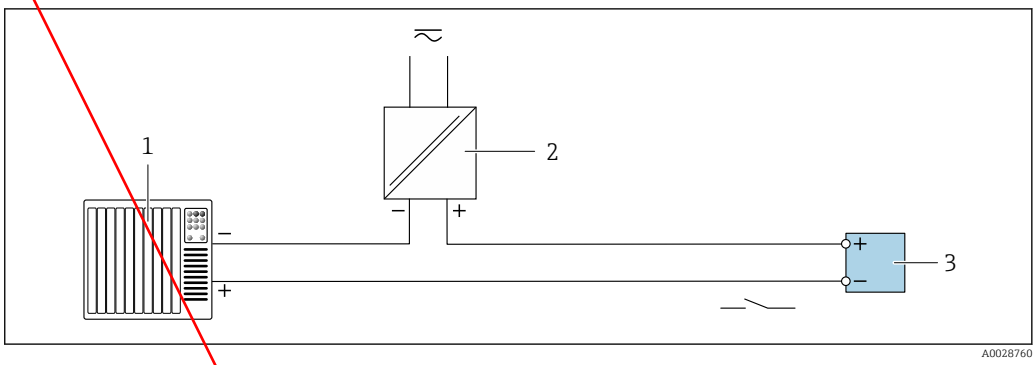
Pulse/frequency output



8 Connection example for pulse/frequency output (passive)

1 Automation system with pulse/frequency input (e.g. PLC with 10 kΩ pull-up or pull-down resistor)
2 Power supply
3 Transmitter: observe input values → 20

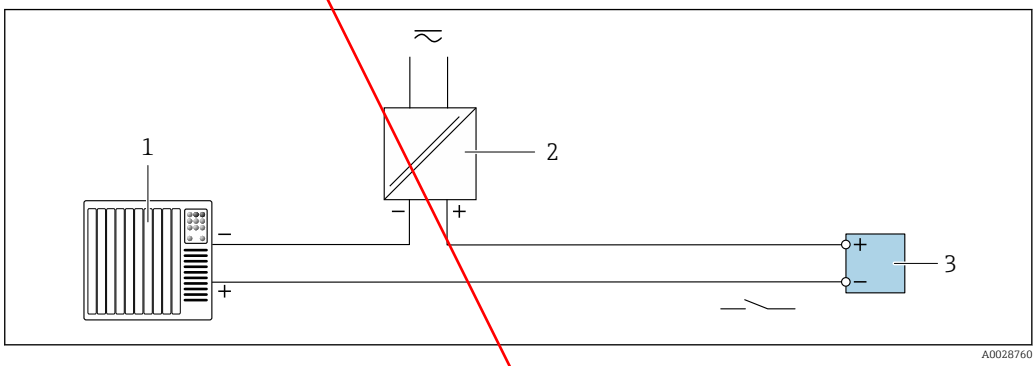
Switch output



9 Connection example for switch output (passive)

1 Automation system with switch input (e.g. PLC with a 10 kΩ pull-up or pull-down resistor)
2 Power supply
3 Transmitter: observe input values → 20

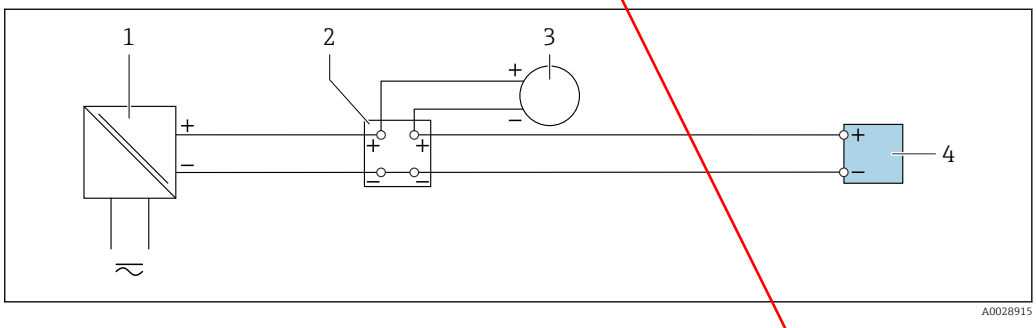
Relay output



10 Connection example for relay output (passive)

1 Automation system with relay input (e.g. PLC)
2 Power supply
3 Transmitter: observe input values → 21

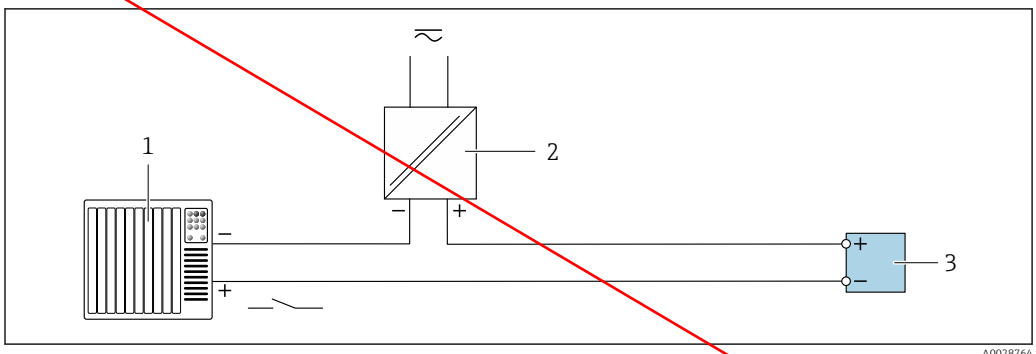
Current input



11 Connection example for 4 to 20 mA current input

1 Power supply
2 Terminal box
3 External measuring device (to read in pressure or temperature, for instance)
4 Transmitter

Status input



12 *Connection example for status input*

1 Automation system with status output (e.g. PLC)
2 Power supply
3 Transmitter

Terminals

Spring-loaded terminals: Suitable for strands and strands with ferrules.
Conductor cross-section 0.2 to 2.5 mm² (24 to 12 AWG).

Cable entries

- Cable gland: M20 × 1.5 with cable Ø 6 to 12 mm (0.24 to 0.47 in)
- Thread for cable entry:
  - NPT ½"
  - G ½"
  - M20

Cable specification

Permitted temperature range

- The installation guidelines that apply in the country of installation must be observed.
- The cables must be suitable for the minimum and maximum temperatures to be expected.

Power supply cable (incl. conductor for the inner ground terminal)

Standard installation cable is sufficient.

Protective grounding cable for the outer ground terminal

Conductor cross-section < 2.1 mm² (14 AWG)

The use of a cable lug enables the connection of larger cross-sections.

The grounding impedance must be less than 2 Ω.

Signal cable

Current output 4 to 20 mA HART

A shielded cable is recommended. Observe grounding concept of the plant.

Modbus RS485

The EIA/TIA-485 standard specifies two types of cable (A and B) for the bus line which can be used for every transmission rate. Cable type A is recommended.

Cable type	A
Characteristic impedance	135 to 165 Ω at a measuring frequency of 3 to 20 MHz
Cable capacitance	< 30 pF/m
Wire cross-section	> 0.34 mm² (22 AWG)
Cable type	Twisted pairs
Loop resistance	≤110 Ω/km

Signal damping	Max. 9 dB over the entire length of the cable cross-section
Shield	Copper braided shielding or braided shielding with foil shield. When grounding the cable shield, observe the grounding concept of the plant.

Current output 0/4 to 20 mA

Standard installation cable is sufficient

Pulse /frequency /switch output

Standard installation cable is sufficient

Relay output

Standard installation cable is sufficient.

Current input 0/4 to 20 mA

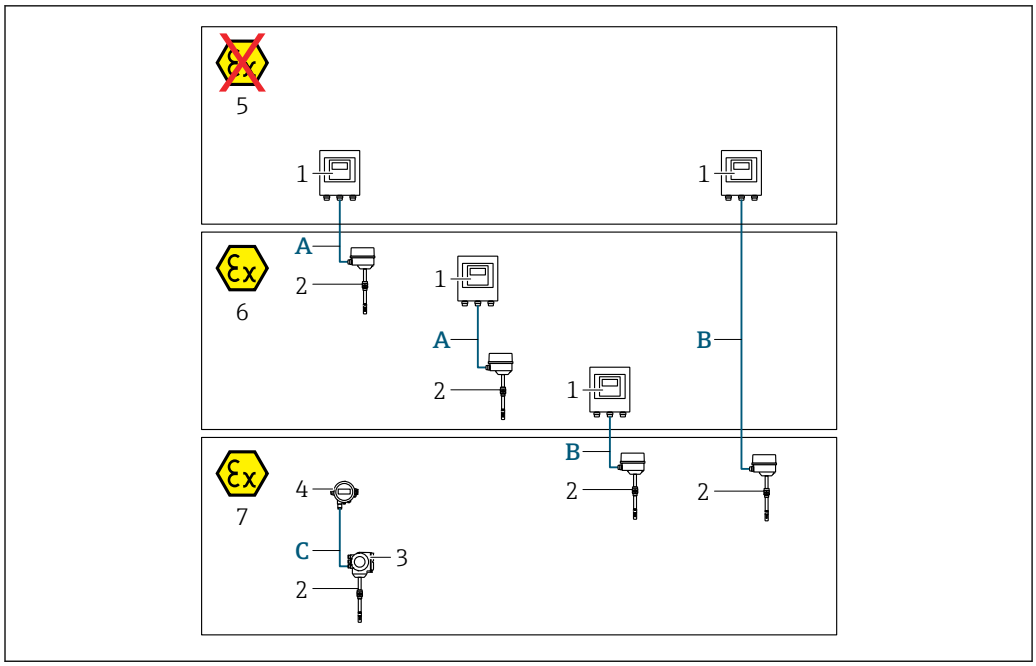
Standard installation cable is sufficient

Status input

Standard installation cable is sufficient

Choice of connecting cable between the transmitter and sensor

Depends on the type of transmitter and the installation zones



1 *Proline 500 – digital transmitter*
2 *Sensor t-mass*
3 *Proline 300 transmitter*
4 *Remote display (DKX001)*
5 *Non-hazardous area*
6 *Hazardous area: Zone 2; Class I, Division 2*
7 *Hazardous area: Zone 1; Class I, Division 1*
A *Standard cable to transmitter 500 – digital*
Transmitter installed in the non-hazardous area or hazardous area: Zone 2; Class I, Division 2/sensor installed in the hazardous area: Zone 2; Class I, Division 2
B *Standard cable to transmitter 500 – digital* → 🖹 *35*
Transmitter installed in the hazardous area: Zone 2; Class I, Division 2/sensor installed in the hazardous area: Zone 1; Class I, Division 1
C *Standard cable to remote display*
Transmitter 300 and remote display installed in the hazardous area: Zone 1; Class I, Division 1

For applications with operation in Zone 1; Class 1, Division 1, we recommend the use of the compact version with the remote display. In this case, the display of the Proline 300 transmitter is a blind version without local operation.

A: Connecting cable between sensor and transmitter: Proline 500 – digital

Standard cable

A standard cable with the following specifications can be used as the connecting cable.

Design	4 cores; uninsulated stranded CU wires; with common shield
Shielding	Tin-plated copper braid, optical cover ≥ 85 %
Loop resistance	Power supply line (+, –): maximum 10 Ω
Cable length	Maximum 300 m (900 ft), see the following table.
Device plug, side 1	M12 socket, 5-pin, A-coded.
Device plug, side 2	M12 plug, 5-pin, A-coded.

Cross-section	Cable length [max.]
0.34 mm² (AWG 22)	80 m (240 ft)
0.50 mm² (AWG 20)	120 m (360 ft)
0.75 mm² (AWG 18)	180 m (540 ft)

Cross-section	Cable length [max.]
1.00 mm² (AWG 17)	240 m (720 ft)
1.50 mm² (AWG 15)	300 m (900 ft)

Optionally available connecting cable

Design	2 × 2 × 0.34 mm² (AWG 22) PVC cable [1] with common shield (2 pairs, uninsulated stranded CU wires; pair-stranded)
Flame resistance	According to DIN EN 60332-1-2
Oil-resistance	According to DIN EN 60811-2-1
Shielding	Tin-plated copper braid, optical cover ≥ 85 %
Operating temperature	When mounted in a fixed position: −50 to +105 °C (−58 to +221 °F); when cable can move freely: −25 to +105 °C (−13 to +221 °F)
Available cable length	Fixed: 20 m (60 ft); variable: up to maximum 50 m (150 ft)

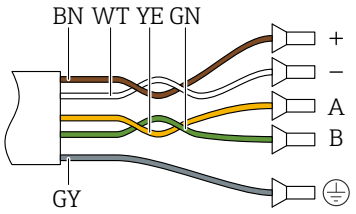
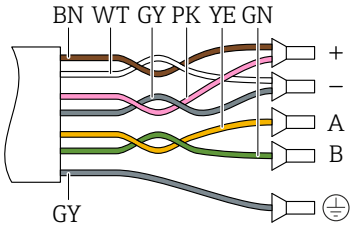
1) UV radiation can impair the cable outer sheath. Protect the cable from direct sunshine where possible.

B: Connecting cable between sensor and transmitter: Proline 500 - digital

Standard cable

A standard cable with the following specifications can be used as the connecting cable.

Design	4, 6, 8 cores (2, 3, 4 pairs); uninsulated stranded CU wires; pair-stranded with common shield
Shielding	Tin-plated copper braid, optical cover ≥ 85 %
Capacitance C	Maximum 760 nF IIC, maximum 4.2 µF IIB
Inductance L	Maximum 26 µH IIC, maximum 104 µH IIB
Inductance/resistance ratio (L/R)	Maximum 8.9 µH/Ω IIC, maximum 35.6 µH/Ω IIB (e.g. according to IEC 60079-25)
Loop resistance	Power supply line (+, −): maximum 5 Ω
Cable length	Maximum 100 m (300 ft), see the following table.

Cross-section	Cable length [max.]	Termination
2 x 2 x 0.50 mm² (AWG 20)	50 m (150 ft)	2 x 2 x 0.50 mm² (AWG 20)  ▪ +, – = 0.5 mm² ▪ A, B = 0.5 mm²
3 x 2 x 0.50 mm² (AWG 20)	100 m (300 ft)	3 x 2 x 0.50 mm² (AWG 20)  ▪ +, – = 1.0 mm² ▪ A, B = 0.5 mm²

Optionally available connecting cable

Connecting cable for	Zone 1; Class I, Division 1
Standard cable	2 × 2 × 0.5 mm² (AWG 20) PVC cable [1] with common shield (2 pairs, pair-stranded)
Flame resistance	According to DIN EN 60332-1-2
Oil-resistance	According to DIN EN 60811-2-1
Shielding	Tin-plated copper braid, optical cover ≥ 85 %
Operating temperature	When mounted in a fixed position: −50 to +105 °C (−58 to +221 °F); when cable can move freely: −25 to +105 °C (−13 to +221 °F)
Available cable length	Fixed: 20 m (60 ft); variable: up to maximum 50 m (150 ft)

1) UV radiation can impair the cable outer sheath. Protect the cable from direct sunshine where possible.

Overvoltage protection

Mains voltage fluctuations	→ 🖹 26
Overvoltage category	Overvoltage category II
Short-term, temporary overvoltage	Up to 1200 V between cable and ground, for max. 5 s
Long-term, temporary overvoltage	Up to 500 V between cable and ground

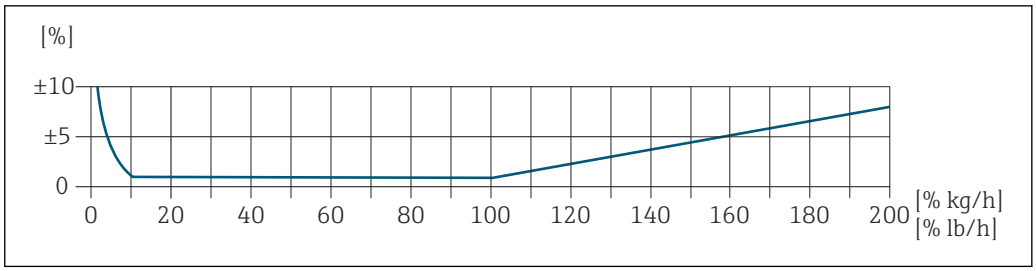
Performance characteristics

Reference operating conditions

- Error limits based on ISO 11631
- Dry air with +20 to +30 °C (+68 to +86 °F) at 0.8 to 1.5 bar (12 to 22 psi)
- Specifications as per calibration protocol
- Accuracy based on accredited calibration rigs that are traced to ISO 17025.

To obtain measured errors, use the *Applicator* sizing tool → 83

Maximum measured error



A0042739

Calibrated measuring range

The measuring accuracy is specified in relation to the mass flow and divided into two ranges:
- ±1.0 % of the current measured value for 100% to 10% of the calibrated measuring range (under reference operating conditions)
- ±0.10 % of the calibrated full scale value for 10% to 1% of the calibrated measuring range (under reference operating conditions)

The measuring device is calibrated and adjusted on an accredited and traceable calibration rig and its accuracy is certified in a calibration report [1] (5 control points).

Order code for "Calibration flow":
- Option G "Factory calibration": calibration report (5 control points)
- Option K "Traceable ISO/IEC17025": Swiss Calibration Services (SCS) calibration report (5 control points) which confirms traceability to the national calibration standard

For information on calibrated measuring ranges and maximum full scale values → 12

Extended measuring range

The device has an extended measuring range that goes beyond the maximum calibrated value (100%). Here, the last measured values in the calibrated range are taken and then extrapolated. The end of the extrapolated range is only reached once the productive energy of the sensor is exceeded and/or the Mach number is greater than listed below.

Mach number	Order code
0.2	▪ Order code for "Sensor version; sensor; insertion tube:", option SB "Bidirectional; stainless steel; stainless steel" ▪ Order code for "Sensor version; sensor; insertion tube:", option SC "Reverse flow detection; stainless steel; stainless steel"
0.4	▪ Order code for "Sensor version; sensor; insertion tube:", option SA "Unidirectional; stainless steel; stainless steel" ▪ Order code for "Sensor version; sensor; insertion tube:", option HA "Unidirectional; Alloy; stainless steel"

The accuracy is specified in relation to the mass flow.
±1.0% ±(current measured value in % -100%) × 0.07 for 100% to 200% of the calibrated measuring range (under reference operating conditions)

1) Two calibration reports for the order code for "Sensor version; sensor; insertion tube:", option SB "Bidirectional; stainless steel; stainless steel"

Accuracy of outputs

The outputs have the following base accuracy specifications.

Current output

Accuracy	±5 µA

Pulse/frequency output

o.r. = of reading

Accuracy	Max. ±50 ppm o.r. (over the entire ambient temperature range)

Repeatability

±0.25 % of the display value for velocities above 1.0 m/s (3.3 ft/s)

Response time

Typically < 3 s for 63 % of a step change (in both directions)

Influence of ambient temperature

Current output

Temperature coefficient	Max. 1 µA/°C

Pulse/frequency output

Temperature coefficient	No additional effect. Included in accuracy.

Influence of medium temperature

Air: 0.02 % per °C (0.036 % per °F) of the process temperature change in relation to the reference temperature

Influence of medium pressure

Air: 0.3 % per bar (0.02 % per psi) of the process pressure change (from the set process pressure)

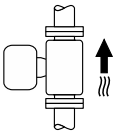
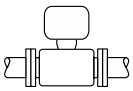
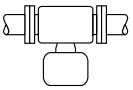
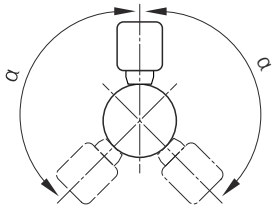
Mounting

As a prerequisite for correct flow measurement, thermal measuring devices require a fully developed flow profile. For this reason, please pay attention to the following points and document sections when installing the device:

- Avoid flow disturbances, as the thermal measuring principle reacts sensitively to them.
- Give priority to dry gases.
- Take measures to avoid or remove condensation (e.g. condensation trap, thermal insulation etc.).

Orientation

The direction of flow must match the direction of the arrow on the sensor. In the case of the bidirectional sensor, the arrow points in the positive direction. When performing bidirectional measurement, the sensing element must be installed with an accuracy of 3°.

Orientation		Recommendation
Vertical orientation	 A0015591	✓ 1)
Horizontal orientation, transmitter head up	 A0015589	✓✓
Horizontal orientation, transmitter head down	 A0015590	✓ 2)
Horizontal orientation, transmitter head at side	 A0015592	✓
Inclined orientation, transmitter head down	 A0015773	✓ 2)

1) In the case of saturated or impure gases, vertical orientation is preferred in order to minimize condensation or contamination. For bidirectional sensors, select horizontal orientation.
2) Select inclined orientation (α = approx. 135°) for very wet or water-saturated gas (e.g. digester gas, undried compressed air), or if deposits or condensate are constantly present.

Installation instructions

For mechanical reasons and to protect the pipe, support is recommended for heavy sensors (e.g. when installing a hot tap).

Pipes

The measuring device must be professionally installed, and the following points must be observed:

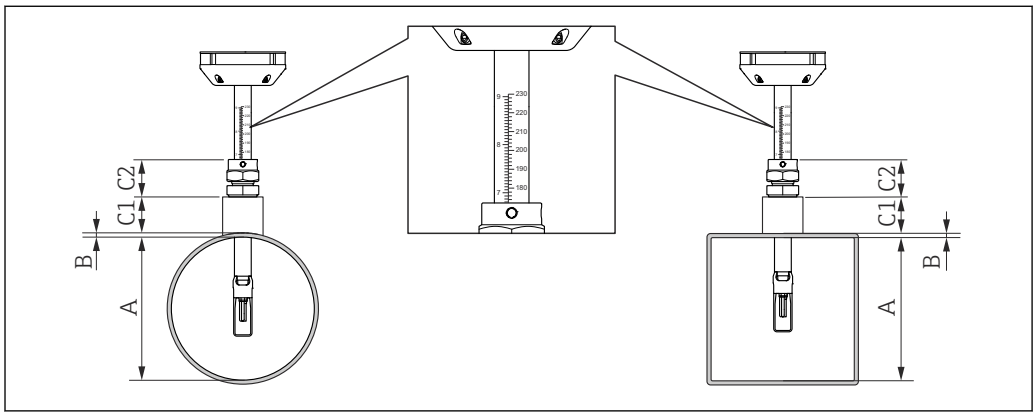
- Weld pipes professionally.
- Use seals of the correct size.
- Align flanges and seals correctly.
- Remove protection cap from sensing element.
- Following installation, the pipe must be free from dirt and particles in order to avoid damage to the sensors.
- For further information → ISO standard 14511.

Insertion depth

The minimum length of the insertion version can be determined using the Endress+Hauser Applicator program or with the calculation formula below. The calculated necessary insertion depth must be within the adjusting range of the selected insertion version.

NOTICE

Metal ferrules undergo plastic deformation during the initial installation.
As a result the insertion depth is fixed after initial installation and the ferrules can no longer be replaced.
- ► Pay attention to information on preconditions and on determining the insertion depth.
- ► Check the insertion depth closely before tightening the ferrules.



13 *Determine the dimensions A, B, C1 and C2*

A In the case of a circular pipe: the pipe internal diameter (DN); in the case of a duct: the inner dimension
B Thickness of pipe wall or of duct wall
C1 Mounting kit
C2 Sensor's compression fitting

Calculating the insertion depth

Insertion depth = (0.3· A) + B + (C1 + C2)

The insertion depth must be at least 100mm.

Determining dimensions C1 and C2

If only Endress+Hauser mounting bosses are used

Mounting boss 1" NPT	C1 + C2 = 112 mm (4.409 in)
Mounting boss G1"	C1 + C2 = 106 mm (4.173 in)
Mounting boss ¾" NPT	C1 + C2 = 108 mm (4.252 in)
Mounting boss G¾"	C1 + C2 = 105 mm (4.134 in)

If a cold/hot tap is used, use dimension "L" → 54 instead of "C1".

Use Applicator to determine dimensions C1 and C2 if using other E+H mounting kits (e.g. cold/hot taps).

If not exclusively using Endress+Hauser mounting bosses

C1	Length of pipe connection used
C2 (compression fitting with 1" NPT thread)	52 mm (2.047 in)
C2 (compression fitting with G1" thread)	46 mm (1.811 in)
C2 (compression fitting with ¾" NPT thread)	48 mm (1.889 in)
C2 (compression fitting with G¾" thread)	45 mm (1.772 in)

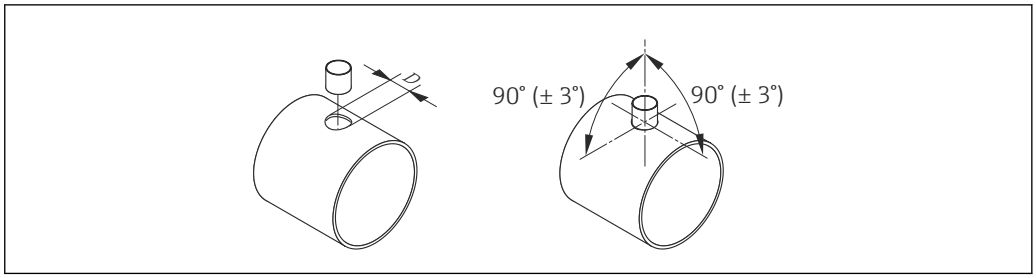
Selecting the length of the insertion version

Select the length of the insertion version using the calculated insertion depth and the following table. The insertion depth must be within the adjusting range of the insertion version.

Length of insertion tube		Adjusting range (insertion depth)	
[mm]	[in]	[mm]	[in]
235	9	100 to 235	3.9 to 9.3
335	13	100 to 335	3.9 to 13.2
435	17	100 to 435	3.9 to 17.1
608	24	100 to 608	3.9 to 23.9

Installation conditions for nipples

Suitable support brackets must be used if installing in rectangular air ducts (or pipes with thin walls).



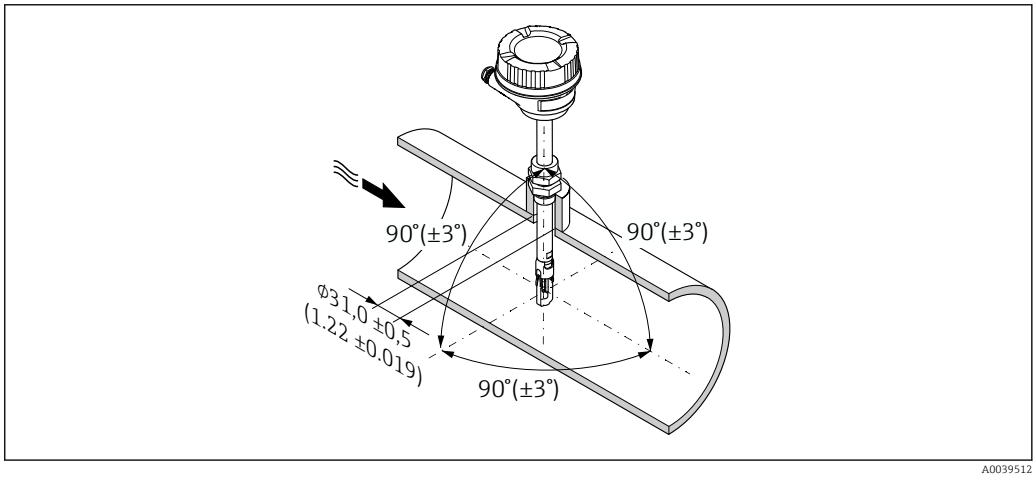
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D Ø 31.0 ± 0.5 mm (1.22 ± 0.019 in)

Aligning to the flow direction

The following criteria must be met for optimum flow measurement:

- The sensor is aligned at a 90° angle to the flow direction.
- The arrow engraved on the sensor shaft matches the positive flow direction.
- The scale on the sensor shaft is aligned with the pipe axis.



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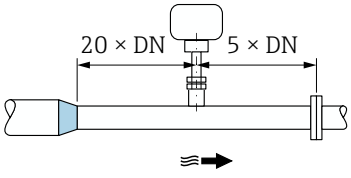
14 *Engineering unit: mm (in)*

Inlet and outlet runs

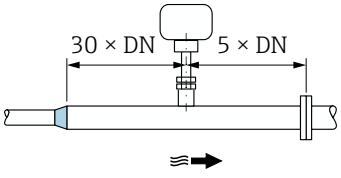
A fully developed flow profile is a requirement for optimal thermal flow measurement.

To achieve the best possible measuring performance, observe the following inlet and outlet runs at the very minimum.

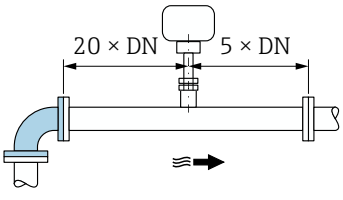
- In the case of bidirectional sensors, also observe the recommended inlet run in the opposite direction.
- If several flow disturbances are present, use flow conditioners.
- Use flow conditioners if it is not possible to observe the required inlet runs.
- In the case of control valves, the amount of disturbance depends on the valve type and opening degree. The recommended inlet run for control valves is 50 × DN.
- In the case of very light gases (helium, hydrogen), the recommended inlet run must be doubled.



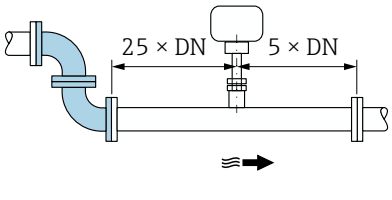
15 Reduction



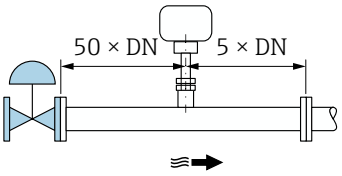
16 Expansion



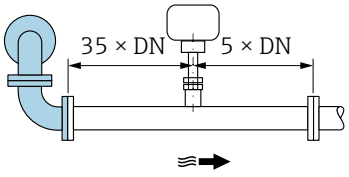
17 90° elbow



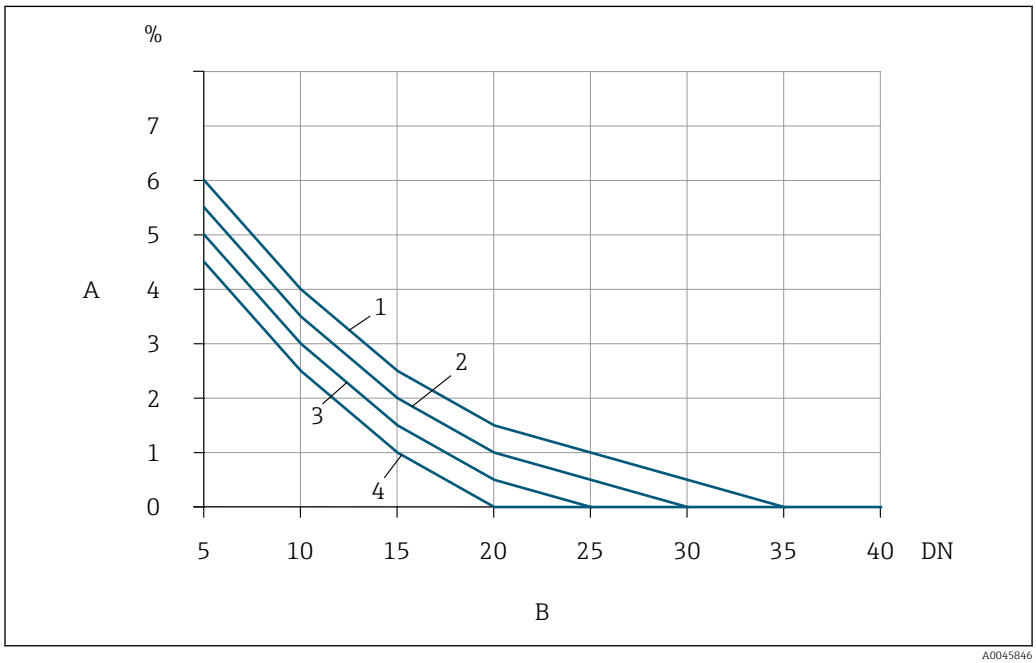
18 2 × 90° elbow



19 Control valve



20 2 × 90 ° elbow, 3-dimensional



21 The additional measured error to be expected without flow conditioners depending on the disturbance type and inlet run

A Additional measured error (%)
B Inlet run (DN)
1 2 × 90 ° elbow, 3-dimensional
2 Expansion
3 2 × 90° elbow
4 Reduction or 90° elbow

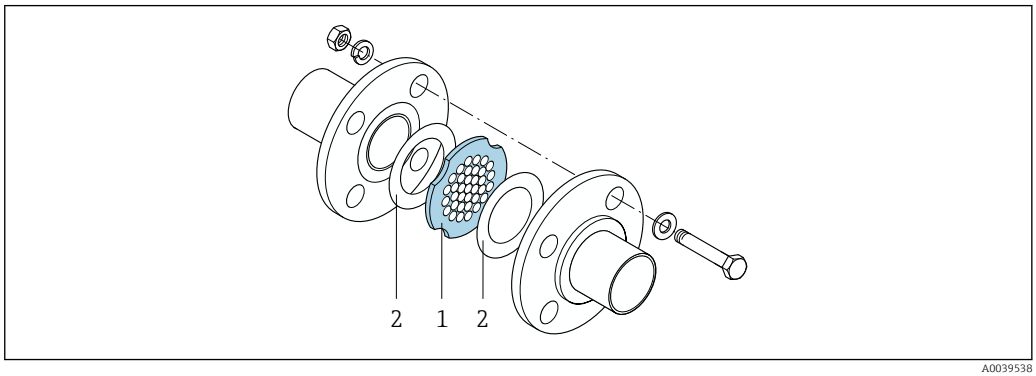
Flow conditioner

Use flow conditioners if it is not possible to observe the required inlet runs. Flow conditioners improve the flow profile and therefore reduce the necessary inlet runs.

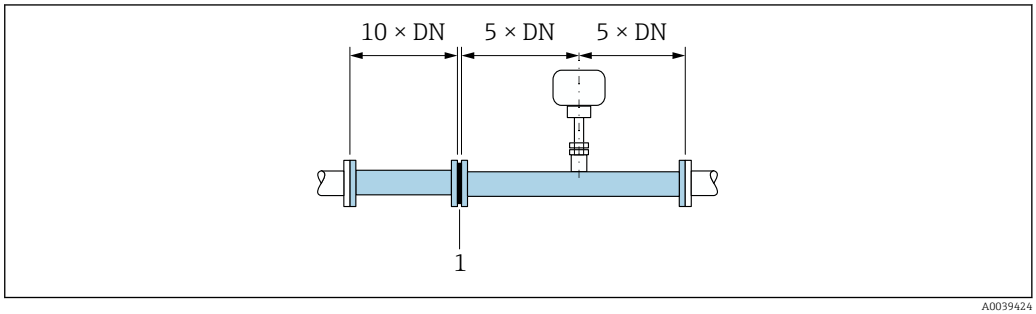
Mount the flow conditioner in flow direction in front of the measuring device.

Available in the following flange standards:
- ASME B16.5 Cl. 150/Cl. 300
- EN 1092-1 PN10/PN16/PN25/PN40
- JIS B2220 10K/20K

Available in the following line sizes:
- DN 80 (3")
- DN 100 (4")
- DN 150 (6")
- DN 200 (8")
- DN 250 (10")
- DN 300 (12")



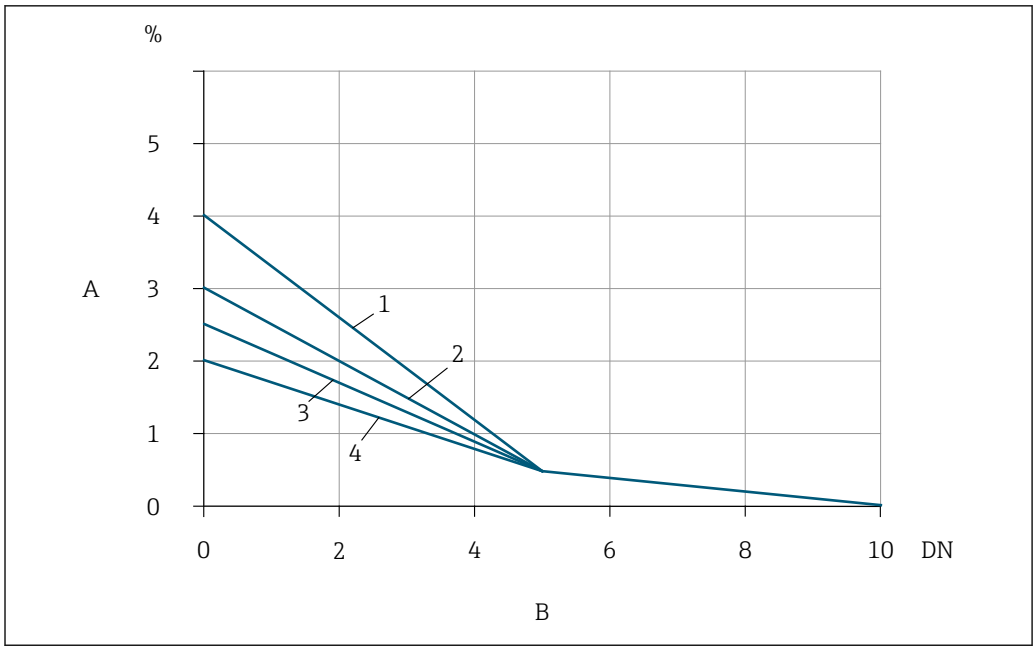
1 Flow conditioner
2 Seal



22 Recommended inlet and outlet runs when using a flow conditioner

1 Flow conditioner

In the case of bidirectional sensors, also observe the inlet run in the opposite direction.



23 The additional measured error to be expected with flow conditioners depending on the disturbance type and inlet run

A Additional measured error (%)
B Inlet runs upstream of the flow conditioner (DN)
1 2 × 90 ° elbow, 3-dimensional
2 Expansion
3 2 × 90° elbow
4 Reduction or 90° elbow

The pressure loss for flow conditioners is calculated as follows: Δp [mbar] = 0.0085 · ρ [kg/m^3] · v^2 [m/s]

Example of air

p = 10 bar abs.

t = 25 °C → ρ = 11.71 kg/m^3

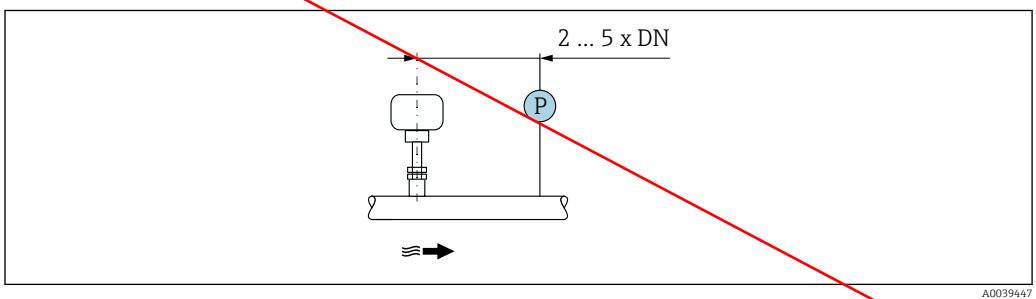
v = 10 m/s

$\Delta p = 0.0085 \cdot 11.71 \cdot 10^2 = 9.95$ mbar

ρ : density of the process medium
v: average flow velocity
abs. = absolute

Outlet runs with pressure measuring points

Install the pressure measuring point downstream of the measuring system. This prevents the pressure transmitter from potentially affecting the flow in the measuring point.



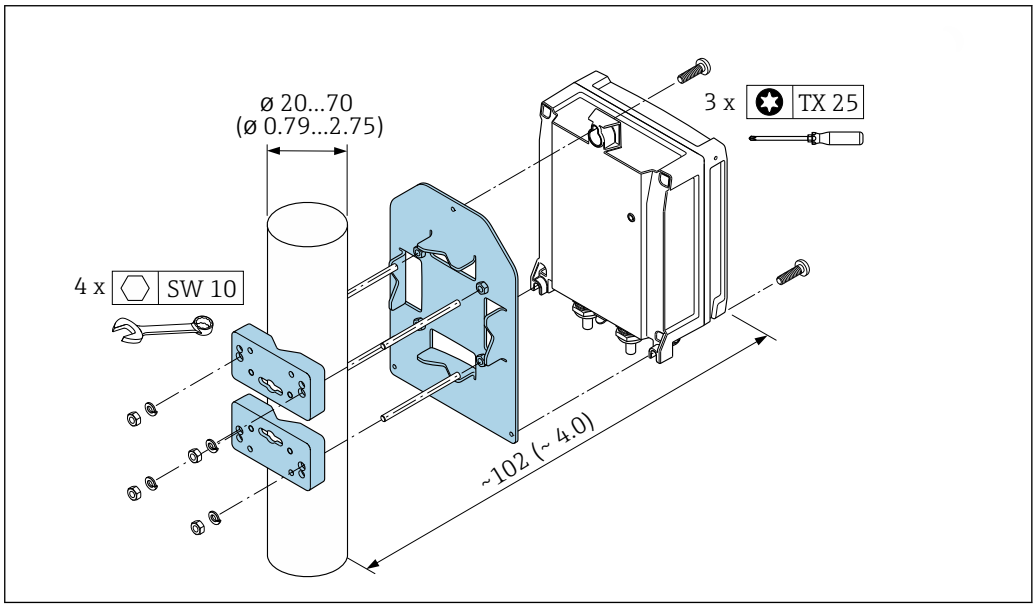
24 Installation of a pressure measuring point (P = pressure transmitter)

Mounting the transmitter housing

Proline 500 – digital transmitter

Pipe mounting

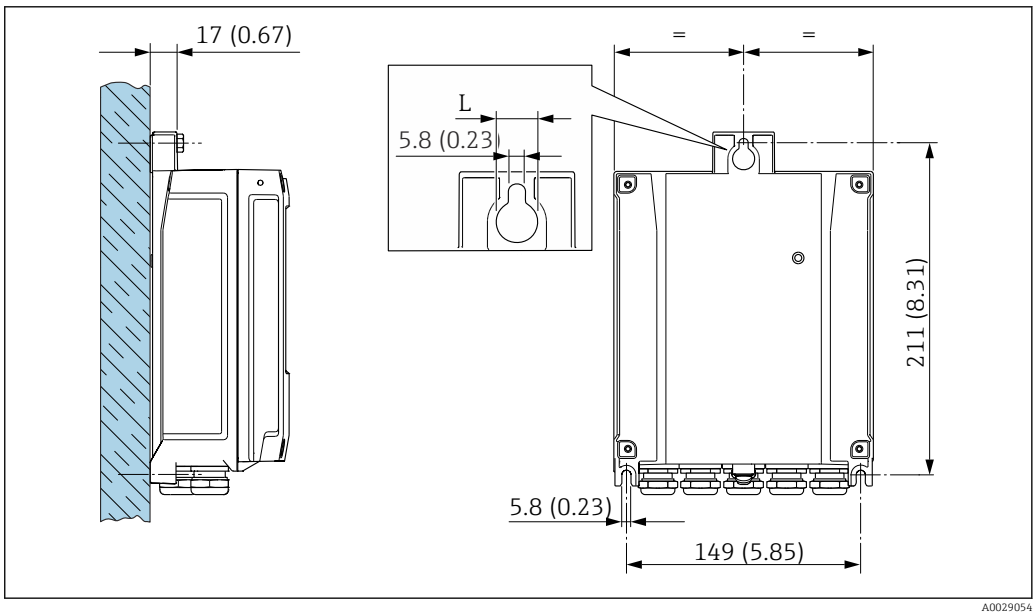
Required tools:
- Open-ended wrench AF 10
- Torx screwdriver TX 25



25 *Engineering unit mm (in)*

Wall mounting

Required tools:
Drill with drill bit Ø 6.0 mm



26 *Engineering unit mm (in)*

L Depends on order code for "Transmitter housing"

Order code for "Transmitter housing"
- Option **A**, aluminum, coated: L = 14 mm (0.55 in)
- Option **D**, polycarbonate: L = 13 mm (0.51 in)

Environment

Ambient temperature range

Measuring device	▪ −40 to +60 °C (−40 to +140 °F) ▪ ~~Order code for "Test, certificate", option JP:~~ −50 to +60 °C (−58 to +140 °F)
Readability of the local display	−20 to +60 °C (−4 to +140 °F) The readability of the display may be impaired at temperatures outside the temperature range.

NOTICE

Danger of overheating

- ▶ Ensure that the temperature at the lower end of the transmitter housing does not exceed 80 °C (176 °F).
- ▶ Ensure that sufficient convection takes place at the transmitter neck.
- ▶ When using in potentially explosive atmospheres, observe the information in the device-specific Ex documentation. For detailed information on the temperature tables, see the separate document entitled "Safety Instructions" (XA) for the device.
- ▶ Ensure that a sufficiently large area of the transmitter neck remains exposed. The uncovered part serves as a radiator and protects the electronics from overheating and excessive cooling.
- ▶ If operating outdoors:
  Avoid direct sunlight, particularly in warm climatic regions.

You can order a weather protection cover from Endress+Hauser→ 🖹 80.

Storage temperature

−50 to +80 °C (−58 to +176 °F), preferably at +20 °C (+68 °F)

Atmosphere

If a plastic transmitter housing is permanently exposed to certain steam and air mixtures, this can damage the housing.

In cases of doubt, please contact the Sales Center.

Degree of protection

Transmitter

- IP66/67, Type 4X enclosure, suitable for pollution degree 4
- When the housing is open: IP20, Type 1 enclosure, suitable for pollution degree 2
- Display module: IP20, Type 1 enclosure, suitable for pollution degree 2

Sensor

- IP66/67, Type 4X enclosure, suitable for pollution degree 4
- When the housing is open: IP20, Type 1 enclosure, suitable for pollution degree 2

Optional

~~Order code for "Sensor options", option CC "IP68, Type 6P, Cust. potted"~~

External WLAN antenna

IP67

Vibration- and shock-resistance

Vibration sinusoidal, in accordance with IEC 60068-2-6

Sensor
- 2 to 8.4 Hz, 3.5 mm peak
- 8.4 to 2 000 Hz, 1 g peak

Transmitter
- 2 to 8.4 Hz, 7.5 mm peak
- 8.4 to 2 000 Hz, 2 g peak

Vibration broad-band random, according to IEC 60068-2-64

Sensor
- 10 to 200 Hz, 0.003 g^2/Hz
- 200 to 2 000 Hz, 0.001 g^2/Hz
- Total: 1.54 g rms

Transmitter
- 10 to 200 Hz, 0.01 g^2/Hz
- 200 to 2 000 Hz, 0.003 g^2/Hz
- Total: 2.70 g rms

Shock half-sine, according to IEC 60068-2-27

- Sensor
  6 ms 30 g
- Transmitter
  6 ms 50 g

Rough handling shocks according to IEC 60068-2-31

Interior cleaning

Suitable for cleaning-in-place (CIP) and sterilization-in-place (SIP).

Manufacturer options for delivery of parts
- Oil- and grease-free wetted parts, no declaration. Order code for "Service", option HA.
- Oil- and grease-free wetted parts as per IEC/TR 60877-2.0 and BOC 50000810-4, with declaration. Order code for "Service", option HB. The plant operator must ensure that the measuring device meets the requirements of the operator's oxygen application.

Electromagnetic compatibility (EMC)

As per IEC/EN 61326 and NAMUR Recommendation 21 (NE 21)

Details are provided in the Declaration of Conformity.

This unit is not intended for use in residential environments and cannot guarantee adequate protection of the radio reception in such environments.

Process

Medium temperature range

Sensor
−40 to +180 °C (−40 to +356 °F)

Seals
- Sealing rings:
  - EPDM −40 to +140 °C (−40 to +284 °F)
  - FKM −40 to +180 °C (−40 to +356 °F)
- Ferrule:
  - PEEK −40 to +140 °C (−40 to +284 °F)
  - PVDF −20 to +110 °C (−4 to +230 °F)
  - 1.4404 −40 to +180 °C (−40 to +356 °F)

Ferrule in 1.4404: ferrule has a fixed position on the shaft. Restriction for repeat calibrations (observe minimum insertion depth → 39)

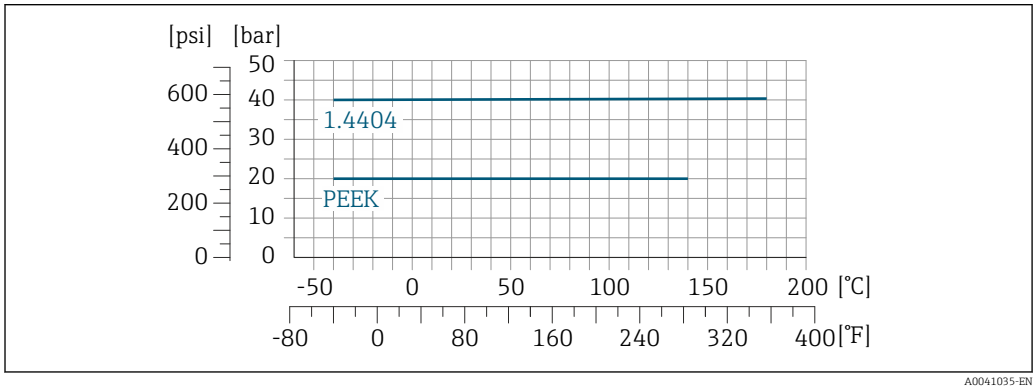
Medium pressure range

Minimum 0.5 bar absolute. Maximum permitted medium pressure → 48

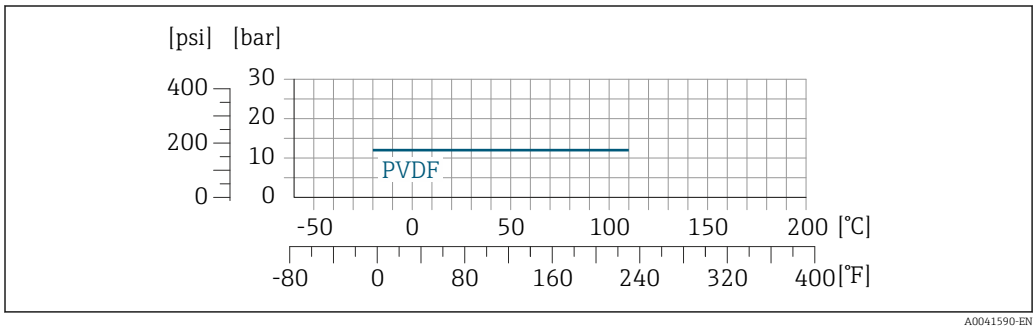
Pressure/temperature ratings

The following pressure/temperature diagrams apply to all pressure-bearing parts of the device and not just the process connection. The diagrams show the maximum permissible medium pressure depending on the specific medium temperature.

Ferrule



27 *With compression fitting material 1.4404/F316L/F316*



28 *With compression fitting material 1.4404/F316L/F316*

Flow limit

Measuring range → 12

The maximum flow depends on the gas type and the pipe nominal diameter used. The end of the measuring range is reached when the Mach number listed below is reached.

Mach number	Order code
0.2	▪ Order code for "Sensor version; sensor; insertion tube:", option SB "Bidirectional; stainless steel; stainless steel" ▪ Order code for "Sensor version; sensor; insertion tube:", option SC "Reverse flow detection; stainless steel; stainless steel"
0.4	▪ Order code for "Sensor version; sensor; insertion tube:", option SA "Unidirectional; stainless steel; stainless steel" ▪ Order code for "Sensor version; sensor; insertion tube:", option HA "Unidirectional; Alloy; stainless steel"

Use the Applicator to size the device.

Pressure loss

Use the Applicator for precise calculations.

Thermal insulation

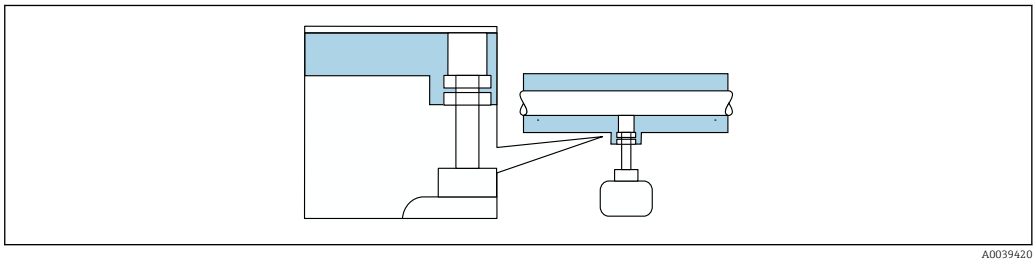
In the case of some fluids, it is important to keep the heat radiated from the sensor to the transmitter to a low level. A wide range of materials can be used for the required insulation.

If the gas is very wet or saturated with water (e.g. digester gas), the pipe and the sensor housing should be insulated, and heated where necessary, to prevent water droplets condensing on the sensing element.

NOTICE

Electronics overheating on account of thermal insulation!

- ▶ Recommended orientation: horizontal orientation, sensor connection housing pointing downwards.
- ▶ Do not insulate the sensor connection housing.
- ▶ Maximum permissible temperature at the lower end of the sensor connection housing: 80 °C (176 °F)
- ▶ Thermal insulation with not isolated extended neck: We recommend that you do not insulate the extended neck in order to ensure optimum dissipation of heat.



A0039420

29 Thermal insulation with not isolated extended neck

Heating

Some fluids require suitable measures to avoid loss of heat at the sensor.

Heating options

- Electrical heating, e.g. with electric band heaters
- Via pipes carrying hot water or steam

NOTICE

Electronics overheating on account of thermal insulation!

- ▶ Recommended orientation: horizontal orientation, sensor connection housing pointing downwards.
- ▶ Do not insulate the sensor connection housing.
- ▶ Maximum permissible temperature at the lower end of the sensor connection housing: 80 °C (176 °F)
- ▶ Thermal insulation with extended neck free: We recommend that you do not insulate the extended neck in order to ensure optimum dissipation of heat.

NOTICE

Danger of overheating when heating

- ▶ Ensure that the temperature at the lower end of the transmitter housing does not exceed 80 °C (176 °F).
- ▶ Ensure that sufficient convection takes place at the transmitter neck.
- ▶ When using in potentially explosive atmospheres, observe the information in the device-specific Ex documentation. For detailed information on the temperature tables, see the separate document entitled "Safety Instructions" (XA) for the device.
- ▶ Ensure that a sufficiently large area of the transmitter neck remains exposed. The uncovered part serves as a radiator and protects the electronics from overheating and excessive cooling.

Hot tap, process pressure

Only use the hot tap for mounting and removal at process pressure for non-toxic, innocuous gases.

Medium pressure version
- Max. process pressure: 20 bar (290 psi)
- Max. extraction pressure: 16 bar (230 psi)
- Max. extraction temperature: +50 °C (+122 °F)
- Min. insertion sensor length: 435mm (17")

Low pressure version
- Max. process pressure: 20 bar (290 psi)
- Max. extraction pressure: 4.5 bar (65 psi)
- Max. extraction temperature: +50 °C (+122 °F)
- Min. insertion sensor length: 335mm (13")

Cold tap, ambient pressure

Cold tap for mounting and removal at ambient pressure.

- Max. process pressure: 20 bar (290 psi)
- Max. extraction pressure: 1 bar (14.5 psi)
- Max. extraction temperature: +50 °C (+122 °F)
- Min. insertion sensor length: 335mm (13")

Mounting boss

To mount the device directly on the process pipe.

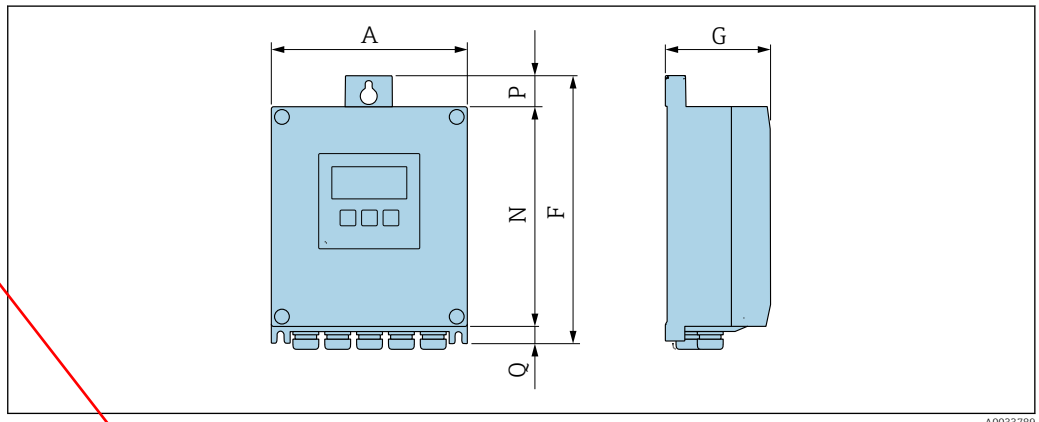
Max. process pressure: 40 bar (580 psi)

Mechanical construction

Dimensions in SI units

Housing of Proline 500 – digital transmitter

Non-hazardous area or hazardous area: Zone 2; Class I, Division 2



A0033789

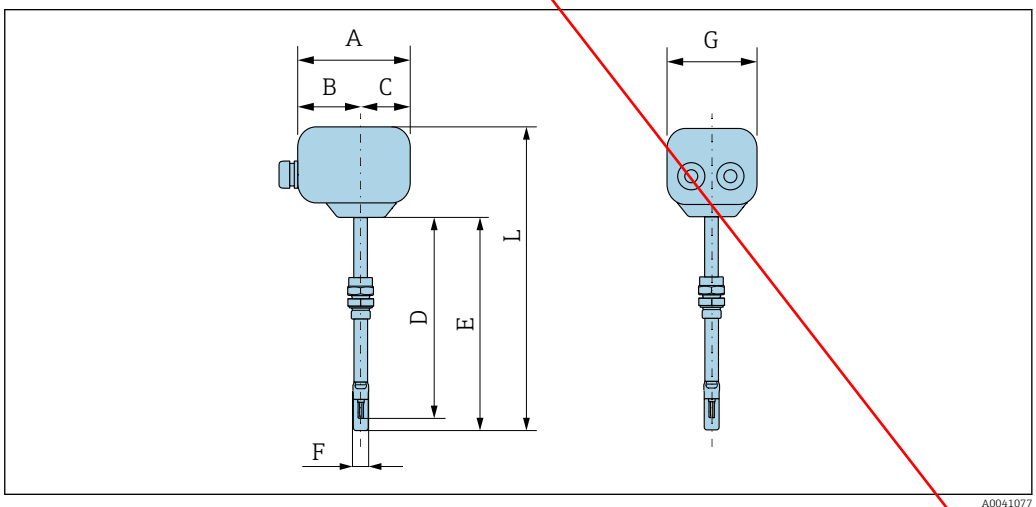
Order code for "Transmitter housing", option A "Aluminum, coated" and order code for "Integrated ISEM electronics", option A "Sensor"

A [mm]	F [mm]	G [mm]	N [mm]	P [mm]	Q [mm]
167	232	89	187	24	21

Order code for "Transmitter housing", option D "Polycarbonate" and order code for "Integrated ISEM electronics", option A "Sensor"

A [mm]	F [mm]	G [mm]	N [mm]	P [mm]	Q [mm]
177	234	89	197	17	22

Sensor connection housing



A0041077

Order code for "Sensor connection housing", option A "Aluminum, coated"

A [1] [mm]	B [1] [mm]	C [mm]	G [mm]
148	94	54	136

1) Depending on the cable gland used: values up to + 30 mm

Order code for "Sensor connection housing", option L "Cast, stainless"

A [1] [mm]	B [mm]	C [mm]	G [mm]
145	86	59	136

1) Depending on the cable gland used: values up to + 30 mm

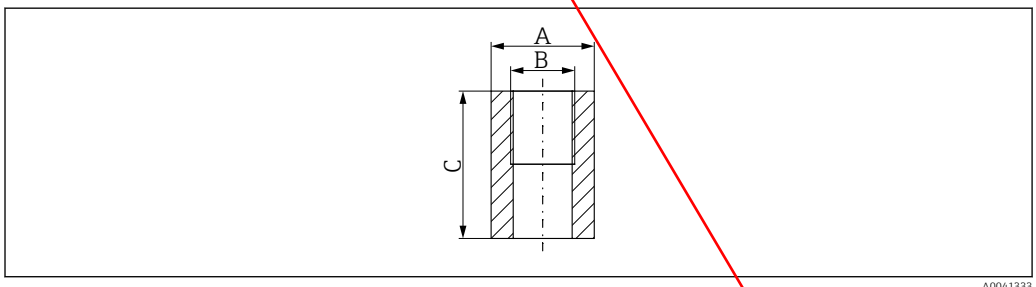
Order code for "Sensor connection housing", option A "Aluminum, coated"

Installed length [mm]	D [mm]	E [mm]	F [mm]	L [1] [mm]
235	281	298	22.4	408
335	381	398	22.4	508
435	481	498	22.4	608
608	652	669	22.4	779

1) With order code for "Sensor connection housing", option L "Cast, stainless" + 24 mm

Accessories

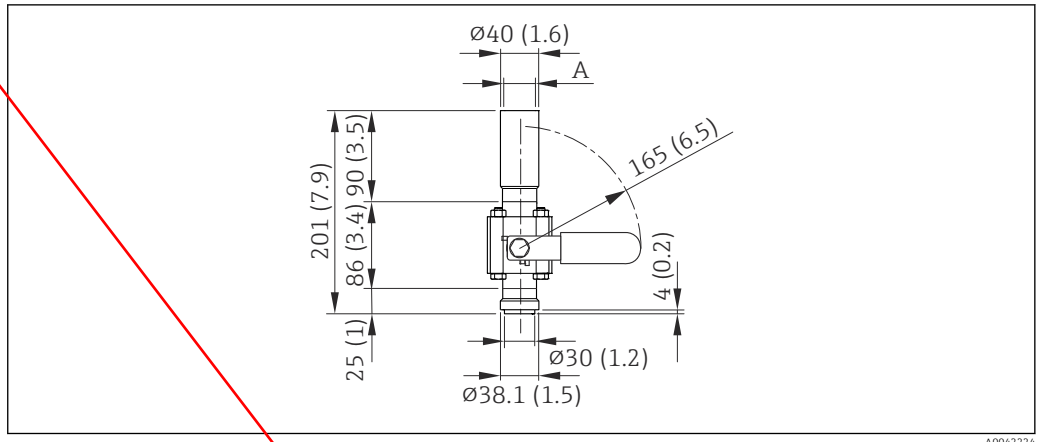
Welding socket



A *45 mm*
B *Order code for "Accessory enclosed", option "Welding socket"*
C *60 mm*

Order code for *"Accessory enclosed"*:
- Option PC *"Welding socket G 1"*
- Option PD *"Welding socket 1" NPT"*
- Option PE *"Welding socket G ¾"*
- Option PF *"Welding socket ¾" NPT"*

Cold tap, ambient pressure



30 Dimensions: mm (in)

A Order code for "Accessory enclosed", option "Welding socket"

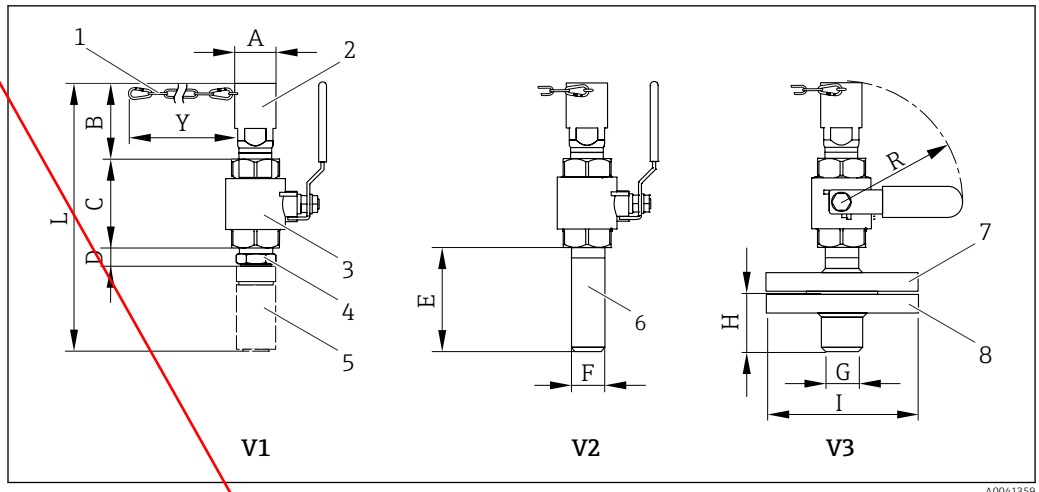
Order code for *"Accessory enclosed"*:
- Option PR *"Cold tap G 1", ambient pressure"*
- Option PS *"Cold tap 1" NPT, ambient pressure"*
- Option PT *"Cold tap G ¾", ambient pressure"*
- Option PU *"Cold tap ¾" NPT, ambient pressure"*

Cold/hot tap, process pressure

Low-pressure version

Available for order as:
- Order code for *"Accessory enclosed"*
  - Option PG *"Cold/hot tap G 1", low pressure = 4.5 bar/65 psig"*
  - Option PH *"Cold/hot tap 1" NPT, low pressure = 4.5 bar/65 psig"*
  - Option PK *"Cold/hot tap G ¾", low pressure = 4.5 bar/65 psig"*
  - Option PL *"Cold/hot tap ¾" NPT, low pressure = 4.5 bar/65 psig"*
  - The low-pressure version as "Accessory enclosed" comprises: V2 → 31, 54
- Can be ordered separately as "Accessories": DK6003 → 81
  Versions V1, V2 and V3 can be ordered via DK6003

- Can only be used with the following installed lengths:
  - Order code for "Installed length", option L2 "335mm (13")"
  - Order code for "Installed length", option L3 "435mm (17")"
  - Order code for "Installed length", option L4 "608mm (24")"
- Cannot be used with 1.4404 clamping ring. Maximum temperature is limited (140°C for PEEK and 110°C for PVDF)



31 *Versions available for order*

1 Safety chain for low-pressure version
2 Sensor connection
3 Ball valve
4 Retrofit adapter (for subsequent installation with existing welding socket (DK6MB))
5 Welding socket (DK6MB) only G1"/1" NPT
6 Process connection welding socket
7 Flange adapter
8 Process connection flange
V1 Version with retrofit adapter
V2 Version with welding socket
V3 Version with flange

A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	F [mm]	G [mm]	H [mm]	I [mm]	L [mm]	R [mm]	Y [1)] [mm]
41.4	~85	88	~30	95	33.4	33.4	54	108 to 125	~268	165	620

1) Safety chain (for p ≤ 4.5 bar) only in conjunction with low-pressure version

Weight [kg]		
V1	V2	V3
2.8	2.4	4.9

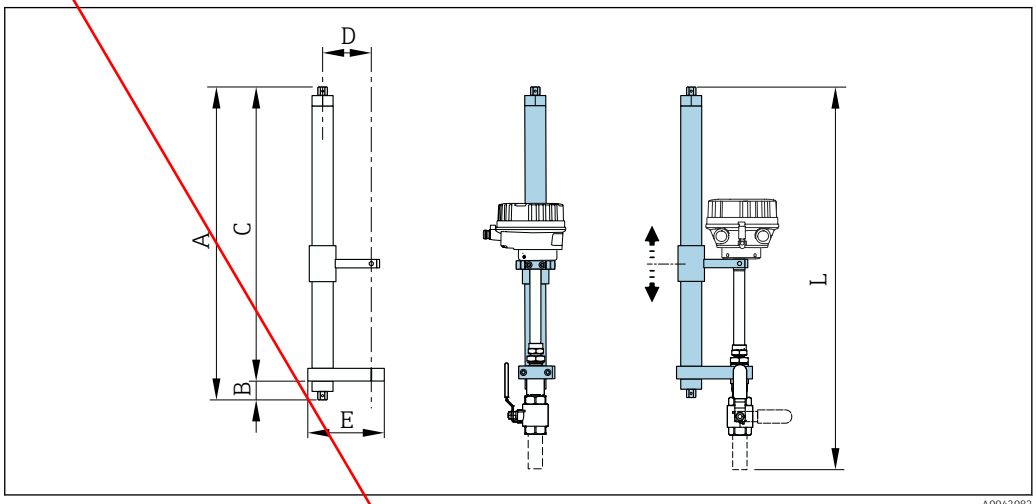
Medium-pressure version

Available for order as:
- Order code for *"Accessory enclosed"*
  - Option PI *"Cold/hot tap G 1", medium pressure = 16 bar/230 psig"*
  - Option PJ *"Cold/hot tap 1" NPT, medium pressure = 16 bar/230 psig"*
  - Option PM *"Cold/hot tap G ¾", medium pressure = 16 bar/230 psig"*
  - Option PN *"Cold/hot tap ¾" NPT, medium pressure = 16 bar/230 psig"*
  - The medium-pressure version comprises: V2 → 31, 54 and extractor assembly
- Can be ordered separately as "Accessories": DK6003 → 81
  Versions V1, V2 and V3 → 31, 54 can be ordered via DK6003

- Can only be used with the following installed lengths:
  - Order code for "Installed length", option L3 "435mm (17")"
  - Order code for "Installed length", option L4 "608mm (24")"
- Cannot be used with 1.4404 clamping ring. Maximum temperature is limited (140°C for PEEK and 110°C for PVDF)

Extractor assembly for medium-pressure version

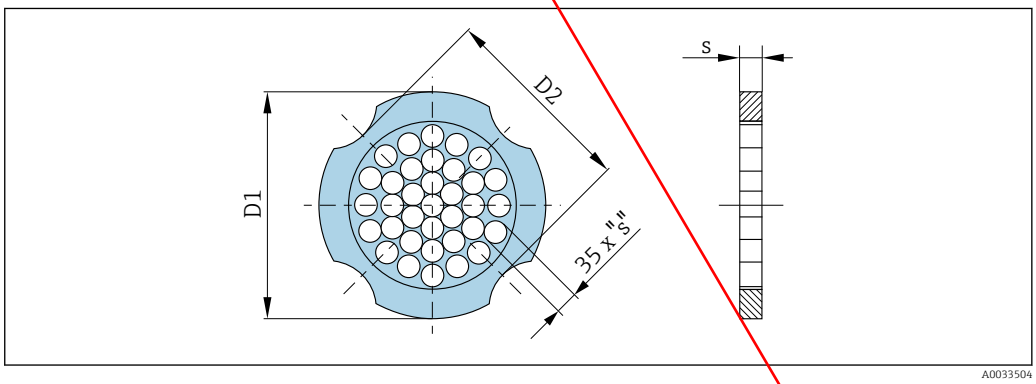
Order code for *"Accessory enclosed"*:
- Option PI *"Cold/hot tap G 1", medium pressure maximum 16 bar/230 psig"*
- Option PJ *"Cold/hot tap 1" NPT, medium pressure maximum 16 bar/230 psig"*
- Option PM *"Cold/hot tap G ¾", medium pressure maximum 16 bar/230 psig"*
- Option PN *"Cold/hot tap ¾" NPT, medium pressure maximum 16 bar/230 psig"*



32 *Extractor assembly*

L [mm]	A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	Weight [kg]
930	740	40	700	120	180	8.4

Flow conditioner



Used in combination with flanges according to DIN EN 1092-1: PN 10 1.4404 (316, 316L) Can be ordered separately as "Accessories": DK6004			
DN [mm]	**Centering diameter [mm]**	**D1 [1] / D2 [2]**	**s [mm]**
80	145.3	D2	10.1
100	165.3	D2	13.3
150	221.0	D2	20.0
200	274.0	D1	26.3

Used in combination with flanges according to DIN EN 1092-1: PN 10 1.4404 (316, 316L) Can be ordered separately as "Accessories": DK6004			
DN [mm]	**Centering diameter [mm]**	**D1 [1]/D2 [2]**	**s [mm]**
250	330.0	D2	33.0
300	380.0	D2	39.6

1) The flow conditioner is fitted at the outer diameter between the bolts.
2) The flow conditioner is fitted at the indentations between the bolts.

Used in combination with flanges according to DIN EN 1092-1: PN 16 1.4404 (316, 316L) Can be ordered separately as "Accessories": DK6004			
DN [mm]	**Centering diameter [mm]**	**D1 [1]/D2 [2]**	**s [mm]**
80	145.3	D2	10.1
100	165.3	D2	13.3
150	221.0	D2	20.0
200	274.0	D2	26.3
250	330.0	D2	33.0
300	380.0	D2	39.6

1) The flow conditioner is fitted at the outer diameter between the bolts.
2) The flow conditioner is fitted at the indentations between the bolts.

Used in combination with flanges according to DIN EN 1092-1: PN 25 1.4404 (316, 316L) Can be ordered separately as "Accessories": DK6004			
DN [mm]	**Centering diameter [mm]**	**D1 [1]/D2 [2]**	**s [mm]**
80	145.3	D2	10.1
100	171.3	D1	13.3
150	227.0	D2	20.0
200	280.0	D1	26.3
250	340.0	D1	33.0
300	404.0	D1	39.6

1) The flow conditioner is fitted at the outer diameter between the bolts.
2) The flow conditioner is fitted at the indentations between the bolts.

Used in combination with flanges according to DIN EN 1092-1: PN 40 1.4404 (316, 316L) Can be ordered separately as "Accessories": DK6004			
DN [mm]	**Centering diameter [mm]**	**D1 [1]/D2 [2]**	**s [mm]**
80	145.3	D2	10.1
100	171.3	D1	13.3
150	227.0	D2	20.0
200	294.0	D2	26.3

Used in combination with flanges according to DIN EN 1092-1: PN 40 1.4404 (316, 316L) Can be ordered separately as "Accessories": DK6004			
DN [mm]	**Centering diameter [mm]**	**D1 [1]/D2 [2]**	**s [mm]**
250	355.0	D2	33.0
300	420.0	D1	39.6

1) The flow conditioner is fitted at the outer diameter between the bolts.
2) The flow conditioner is fitted at the indentations between the bolts.

Used in combination with flanges according to ASME B16.5: Class 150 1.4404 (316, 316L) Can be ordered separately as "Accessories": DK6004			
DN [mm]	**Centering diameter [mm]**	**D1 [1]/D2 [2]**	**s [mm]**
80	138.4	D1	10.1
100	176.5	D2	13.3
150	223.5	D1	20.0
200	274.0	D2	26.3
250	340.0	D1	33.0
300	404.0	D1	39.6

1) The flow conditioner is fitted at the outer diameter between the bolts.
2) The flow conditioner is fitted at the indentations between the bolts.

Used in combination with flanges according to ASME B16.5: Class 300 1.4404 (316, 316L) Can be ordered separately as "Accessories": DK6004			
DN [mm]	**Centering diameter [mm]**	**D1 [1]/D2 [2]**	**s [mm]**
80	151.3	D1	10.1
100	182.6	D1	13.3
150	252.0	D1	20.0
200	309.0	D1	26.3
250	363.0	D1	33.0
300	402.0	D1	39.6

1) The flow conditioner is fitted at the outer diameter between the bolts.
2) The flow conditioner is fitted at the indentations between the bolts.

Used in combination with flanges according to JIS B2220: 10K 1.4404 (316, 316L) Can be ordered separately as "Accessories": DK6004			
DN [mm]	**Centering diameter [mm]**	**D1 [1]/D2 [2]**	**s [mm]**
80	136.3	D2	10.1
100	161.3	D2	13.3
150	221.0	D2	20.0
200	271.0	D2	26.3

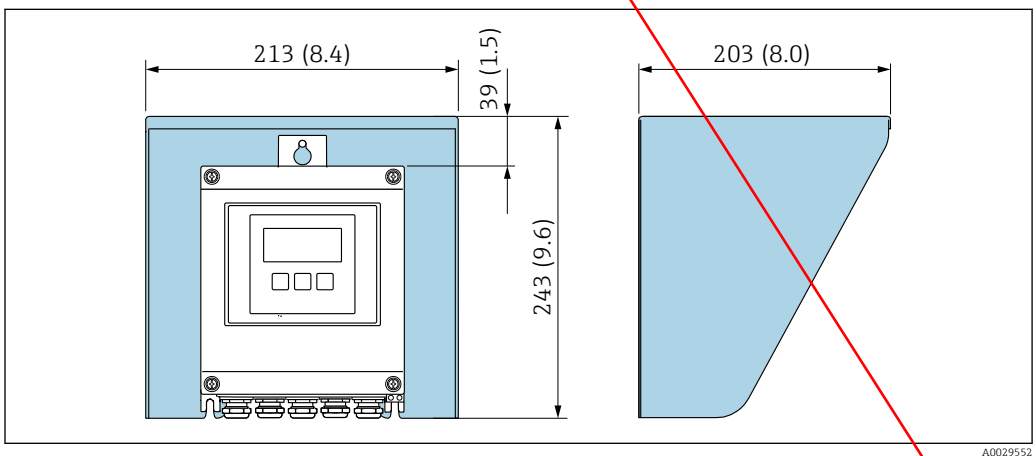
Used in combination with flanges according to JIS B2220: 10K 1.4404 (316, 316L) Can be ordered separately as "Accessories": DK6004			
DN [mm]	**Centering diameter [mm]**	**D1 [1]/D2 [2]**	**s [mm]**
250	330.0	D2	33.0
300	380.0	D2	39.6

1) The flow conditioner is fitted at the outer diameter between the bolts.
2) The flow conditioner is fitted at the indentations between the bolts.

Used in combination with flanges according to JIS B2220: 20K 1.4404 (316, 316L) Can be ordered separately as "Accessories": DK6004			
DN [mm]	**Centering diameter [mm]**	**D1 [1]/D2 [2]**	**s [mm]**
80	142.3	D1	10.1
100	167.3	D1	13.3
150	240.0	D1	20.0
200	284.0	D1	26.3
250	355.0	D2	33.0
300	404.0	D1	39.6

1) The flow conditioner is fitted at the outer diameter between the bolts.
2) The flow conditioner is fitted at the indentations between the bolts.

Weather protection cover

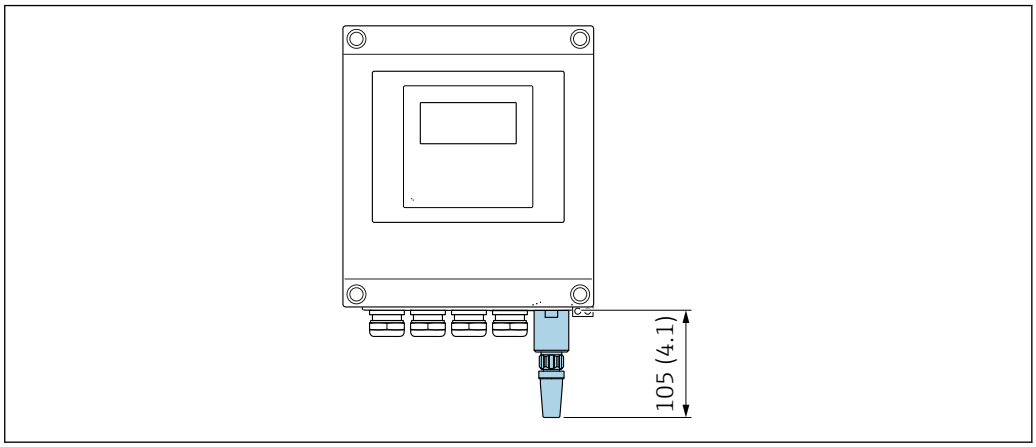


33 *Weather protection cover for Proline 500 – digital; engineering unit mm (in)*

External WLAN antenna

Proline 500 – digital

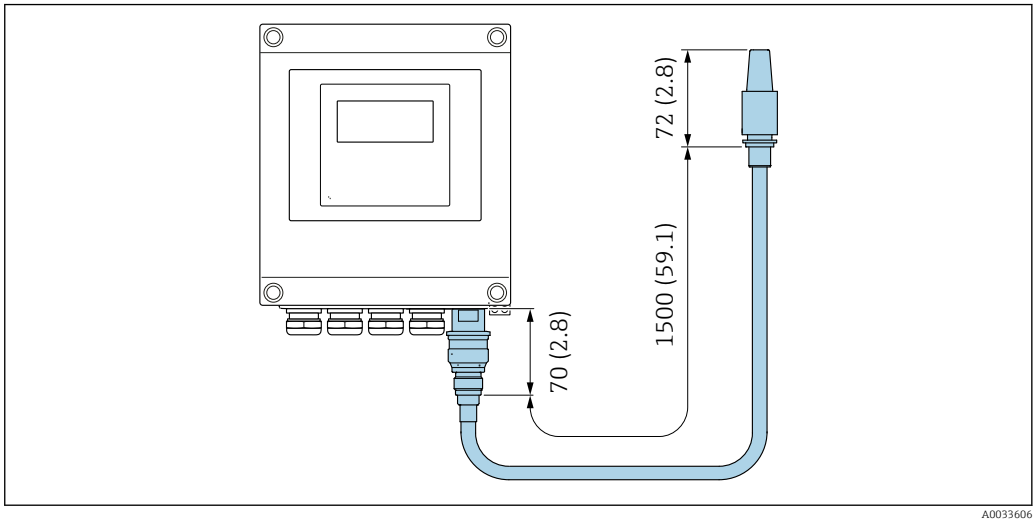
External WLAN antenna mounted on device



34 *Engineering unit mm (in)*

External WLAN antenna mounted with cable

The external WLAN antenna can be mounted separately from the transmitter if the transmission/ reception conditions at the transmitter mounting location are poor.

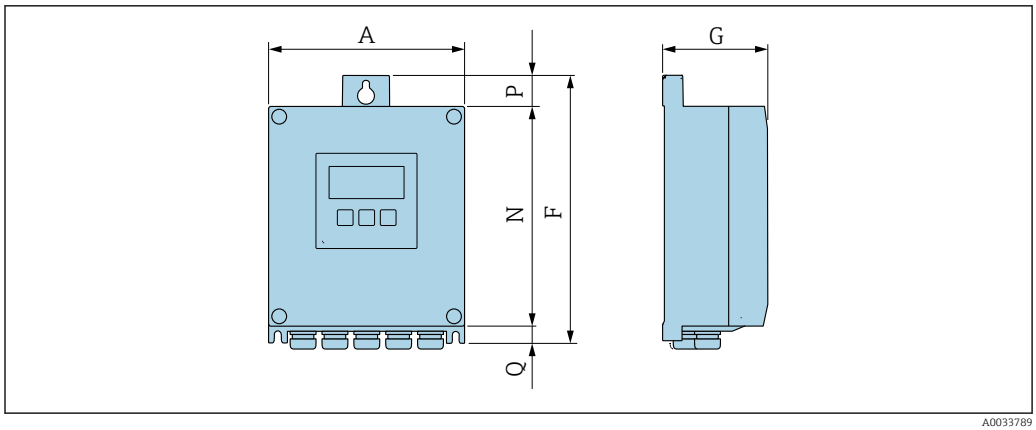


35 *Engineering unit mm (in)*

Dimensions in US units

Housing of Proline 500 – digital transmitter

Non-hazardous area or hazardous area: Zone 2; Class I, Division 2



A0033789

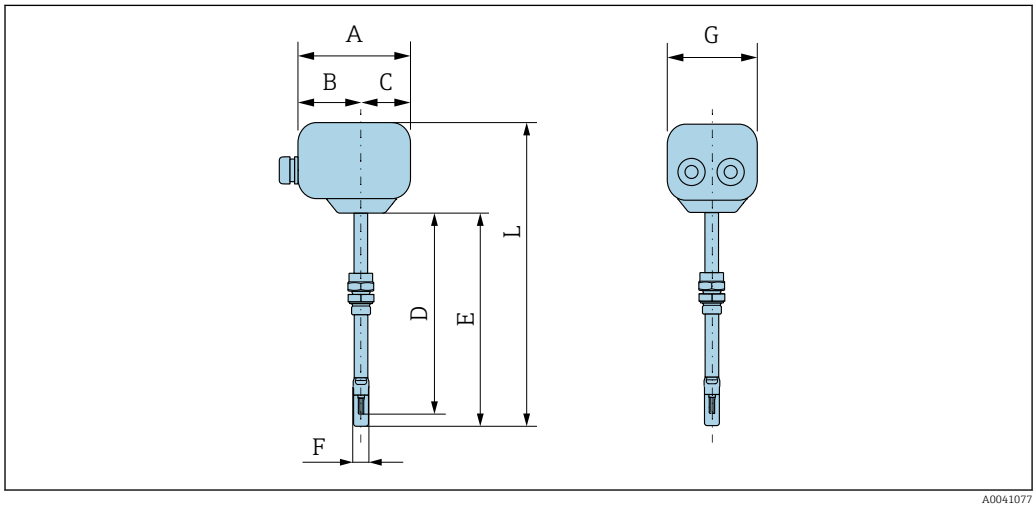
Order code for "Transmitter housing", option A "Aluminum, coated" and order code for "Integrated ISEM electronics", option A "Sensor"

A [in]	F [in]	G [in]	N [in]	P [in]	Q [in]
6.57	9.13	3.50	7.36	0.94	0.83

Order code for "Transmitter housing", option D "Polycarbonate" and order code for "Integrated ISEM electronics", option A "Sensor"

A [in]	F [in]	G [in]	N [in]	P [in]	Q [in]
6.97	9.21	3.50	7.76	0.67	0.87

Sensor connection housing



A0041077

Order code for "Sensor connection housing", option A "Aluminum, coated"

A [1] [in]	B [1] [in]	C [in]	G [in]
5.83	3.70	2.13	5.35

1) Depending on the cable gland used: values up to + 1.18 in

Order code for "Sensor connection housing", option L "Cast, stainless"

A [1] [in]	B [in]	C [in]	G [in]
5.71	3.39	2.32	5.35

1) Depending on the cable gland used: values up to + 1.18 in

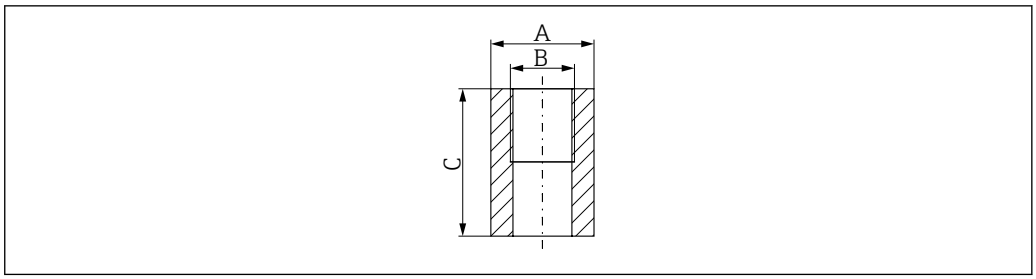
Order code for "Sensor connection housing", option A "Aluminum, coated"

Installed length [in]	D [in]	E [in]	F [in]	L [1] [in]
9	11.06	11.73	0.88	16.06
13	15	15.67	0.88	20
17	18.94	19.61	0.88	23.94
24	25.67	26.34	0.88	30.67

1) With order code for "Sensor connection housing", option L "Cast, stainless" + 0.94 in

Accessories

Welding socket

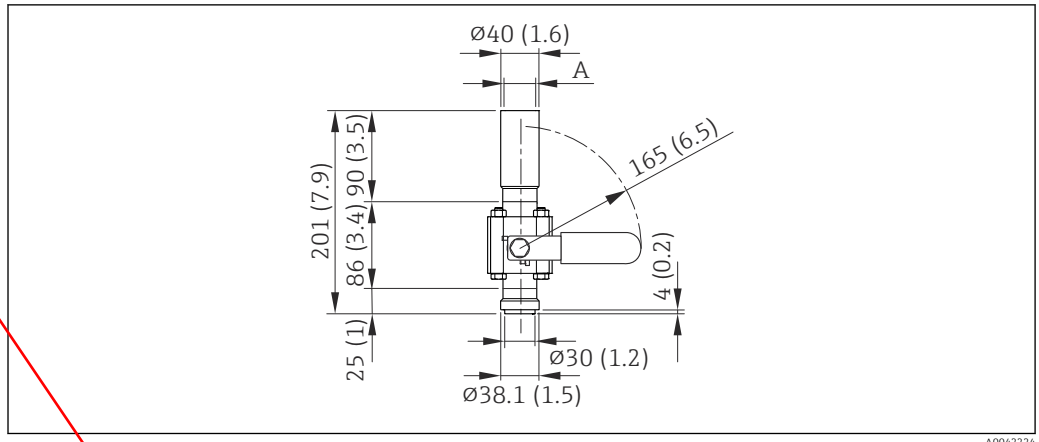


A0041333

A 1.77 in
B Order code for "Accessory enclosed", option "Welding socket"
C 2.36 in

Order code for *"Accessory enclosed"*:
- Option PC *"Welding socket G 1"*
- Option PD *"Welding socket 1" NPT"*
- Option PE *"Welding socket G ¾"*
- Option PF *"Welding socket ¾" NPT"*

Cold tap, ambient pressure



36 Dimensions: mm (in)

A Order code for "Accessory enclosed", option "Welding socket"

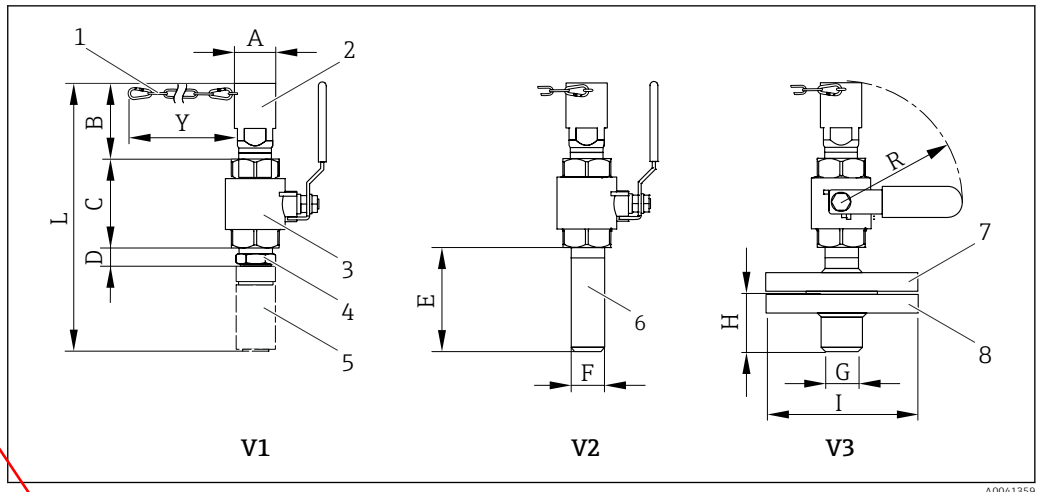
Order code for *"Accessory enclosed"*:
- Option PR *"Cold tap G 1", ambient pressure*
- Option PS *"Cold tap 1" NPT, ambient pressure*
- Option PT *"Cold tap G ¾", ambient pressure*
- Option PU *"Cold tap ¾" NPT, ambient pressure*

Cold/hot tap, process pressure

Low-pressure version

Available for order as:
- Order code for *"Accessory enclosed"*
  - Option PG *"Cold/hot tap G 1", low pressure = 4.5 bar/65 psig*
  - Option PH *"Cold/hot tap 1" NPT, low pressure = 4.5 bar/65 psig*
  - Option PK *"Cold/hot tap G ¾", low pressure = 4.5 bar/65 psig*
  - Option PL *"Cold/hot tap ¾" NPT, low pressure = 4.5 bar/65 psig*
  - The low-pressure version as "Accessory enclosed" comprises: V2 → 37, 63
- Can be ordered separately as "Accessories": DK6003 → 81
  Versions V1, V2 and V3 can be ordered via DK6003

- Can only be used with the following installed lengths:
  - Order code for "Installed length", option L2 "335mm (13")"
  - Order code for "Installed length", option L3 "435mm (17")"
  - Order code for "Installed length", option L4 "608mm (24")"
- Cannot be used with 1.4404 clamping ring. Maximum temperature is limited (284°F for PEEK and 230°F for PVDF)



37 *Versions available for order*

1 Safety chain for low-pressure version
2 Sensor connection
3 Ball valve
4 Retrofit adapter (for subsequent installation with existing welding socket (DK6MB))
5 Welding socket (DK6MB) only G1"/1" NPT
6 Process connection welding socket
7 Flange adapter
8 Process connection flange
V1 Version with retrofit adapter
V2 Version with welding socket
V3 Version with flange

A [in]	B [in]	C [in]	D [in]	E [in]	F [in]	G [in]	H [in]	I [in]	L [in]	R [in]	Y [1)] [in]
1.67	~3.35	3.46	~1.18	3.74	1.31	1.31	2.13	4.25 to 4.92	~10.6	6.50	24.4

1) Safety chain (for p ≤ 65 psi g) only in conjunction with low-pressure version

Weight [lbs]		
V1	V2	V3
6	5	11

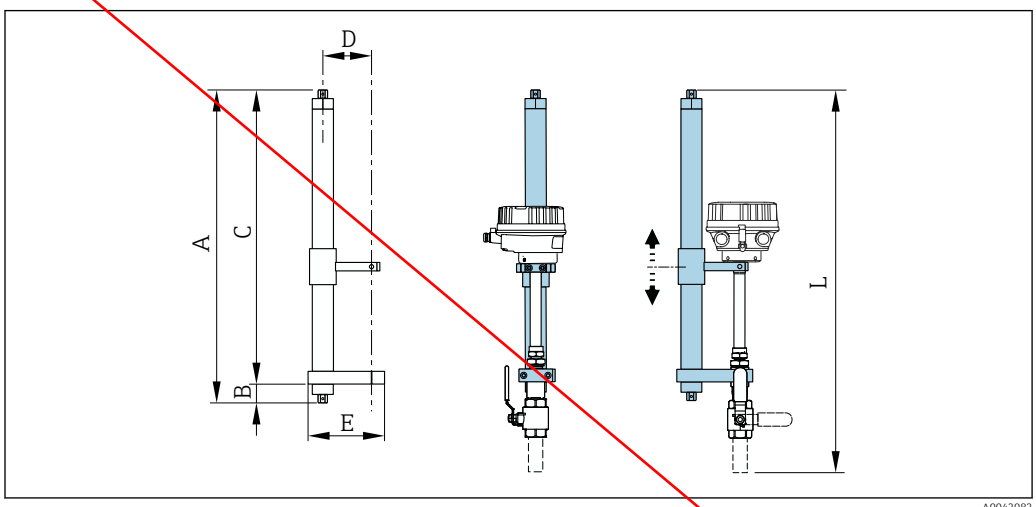
Medium-pressure version

Available for order as:
- Order code for *"Accessory enclosed"*
  - Option PI *"Cold/hot tap G 1", medium pressure = 16 bar/230 psig"*
  - Option PJ *"Cold/hot tap 1" NPT, medium pressure = 16 bar/230 psig"*
  - Option PM *"Cold/hot tap G ¾", medium pressure = 16 bar/230 psig"*
  - Option PN *"Cold/hot tap ¾" NPT, medium pressure = 16 bar/230 psig"*
  - The medium-pressure version comprises: V2 → 37, 63 and extractor assembly → 38, 64
- Can be ordered separately as "Accessories": DK6003 → 81
  Versions V1, V2 and V3 → 37, 63 can be ordered via DK6003

- Can only be used with the following installed lengths:
  - Order code for "Installed length", option L3 "435mm (17")"
  - Order code for "Installed length", option L4 "608mm (24")"
- Cannot be used with 1.4404 clamping ring. Maximum temperature is limited (140°C for PEEK and 110°C for PVDF)

Extractor assembly for medium-pressure version

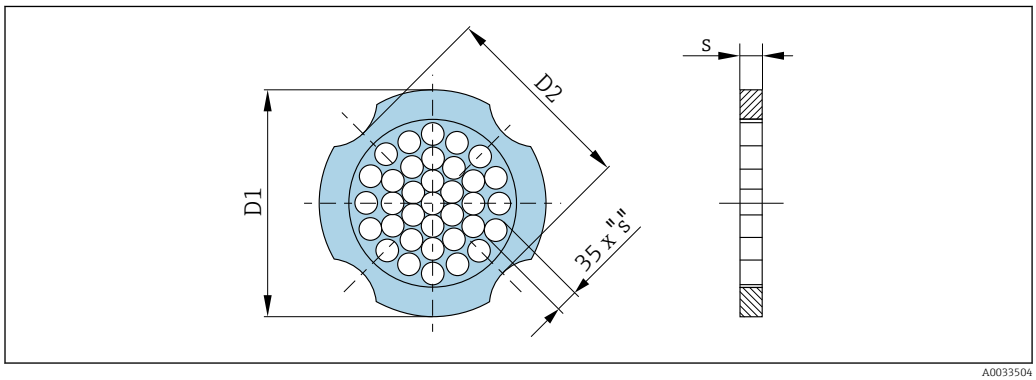
Order code for *"Accessory enclosed"*:
- Option PI *"Cold/hot tap G 1", medium pressure maximum 16 bar/230 psig"*
- Option PJ *"Cold/hot tap 1" NPT, medium pressure maximum 16 bar/230 psig"*
- Option PM *"Cold/hot tap G ¾", medium pressure maximum 16 bar/230 psig"*
- Option PN *"Cold/hot tap ¾" NPT, medium pressure maximum 16 bar/230 psig"*



38 *Extractor assembly*

L [in]	A [in]	B [in]	C [in]	D [in]	E [in]	Weight [lbs]
36.61	29.13	1.57	27.56	4.72	7.09	18.5

Flow conditioner



Used in combination with flanges according to ASME B16.5: Class 150 1.4404 (316, 316L) Can be ordered separately as "Accessories": DK6004			
DN [in]	**Centering diameter [in]**	**D1 [1]/D2 [2]**	**s [in]**
3	5.45	D1	0.40
4	6.95	D2	0.52
6	8.81	D1	0.79
8	10.80	D2	1.04

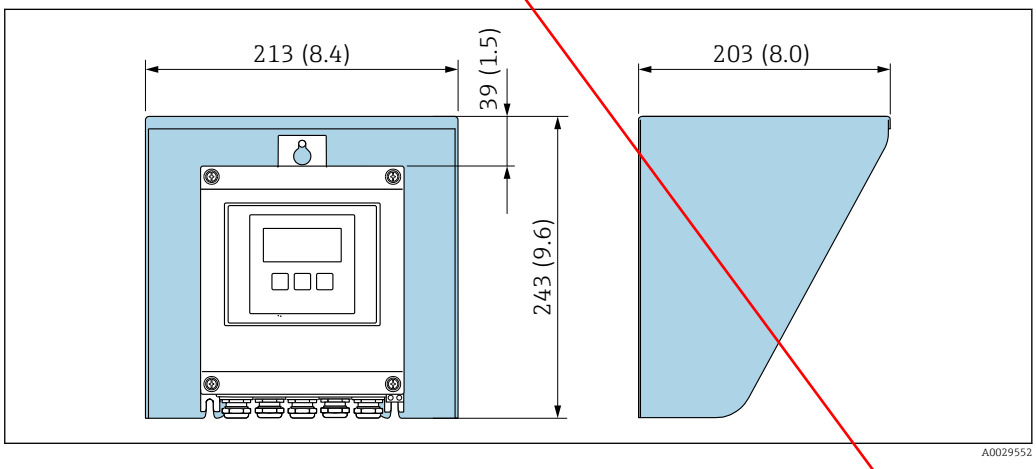
Used in combination with flanges according to ASME B16.5: Class 150 1.4404 (316, 316L) Can be ordered separately as "Accessories": DK6004			
DN [in]	**Centering diameter [in]**	**D1 [1]/D2 [2]**	**s [in]**
10	13.40	D1	1.30
12	15.90	D1	1.56

1) The flow conditioner is fitted at the outer diameter between the bolts.
2) The flow conditioner is fitted at the indentations between the bolts.

Used in combination with flanges according to ASME B16.5: Class 300 1.4404 (316, 316L) Can be ordered separately as "Accessories": DK6004			
DN [in]	**Centering diameter [in]**	**D1 [1]/D2 [2]**	**s [in]**
3	5.96	D1	0.40
4	7.19	D1	0.52
6	9.92	D1	0.79
8	12.20	D1	1.04
10	14.30	D1	1.30
12	15.80	D1	1.56

1) The flow conditioner is fitted at the outer diameter between the bolts.
2) The flow conditioner is fitted at the indentations between the bolts.

Weather protection cover

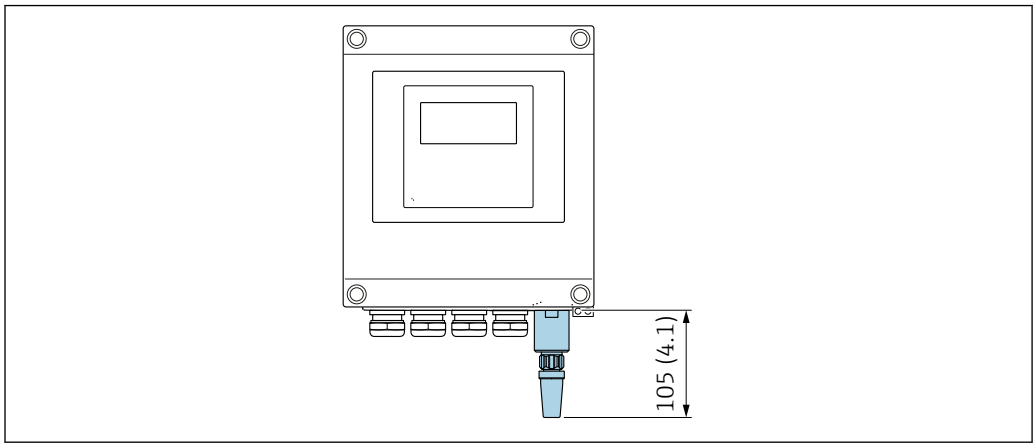


39 *Weather protection cover for Proline 500 – digital; engineering unit mm (in)*

External WLAN antenna

Proline 500 – digital

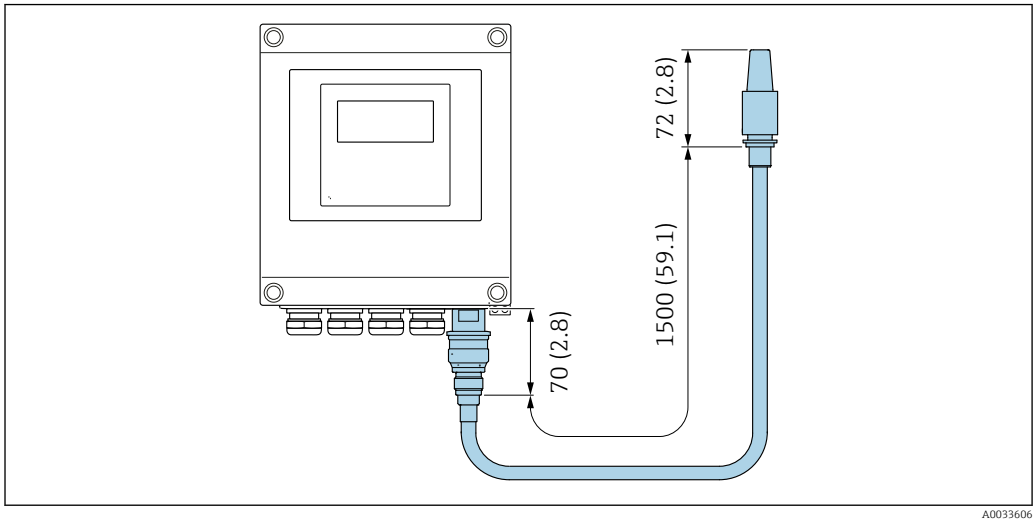
External WLAN antenna mounted on device



40 *Engineering unit mm (in)*

External WLAN antenna mounted with cable

The external WLAN antenna can be mounted separately from the transmitter if the transmission/ reception conditions at the transmitter mounting location are poor.



41 *Engineering unit mm (in)*

Materials

Transmitter housing

Housing of Proline 500 – digital transmitter

Order code for "Transmitter housing":
- Option **A** "Aluminum coated": aluminum, AlSi10Mg, coated
- Option **D** "Polycarbonate": polycarbonate

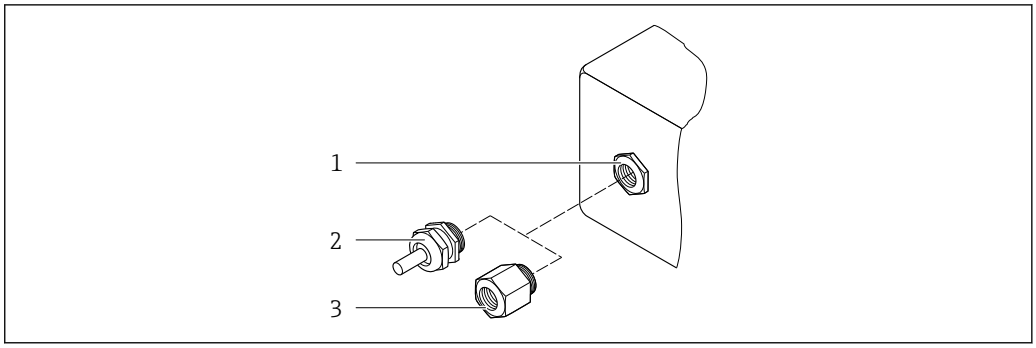
Window material

Order code for "Transmitter housing":
- Option **A** "Aluminum, coated": glass
- Option **D** "Polycarbonate": plastic

Sensor connection housing

Order code for "Sensor connection housing":
- Option **A** "Aluminum coated": aluminum, AlSi10Mg, coated
- Option **L** "Cast, stainless": 1.4409 (CF3M) similar to 316L

Cable entries/cable glands



42 *Possible cable entries/cable glands*

1 *Female thread M20 × 1.5*
2 *Cable gland M20 × 1.5*
3 *Adapter for cable entry with female thread G ½" or NPT ½"*

Cable entries and adapters	Material
Cable gland M20 × 1.5	Plastic
▪ Adapter for cable entry with female thread G ½" ▪ Adapter for cable entry with female thread NPT ½" Only available for certain device versions: ▪ Order code for "Transmitter housing": ▪ Option A "Aluminum, coated" ▪ Option D "Polycarbonate" ▪ Order code for "Sensor connection housing": Proline 500 – digital: Option A "Aluminum coated" Option B "Stainless"	Nickel-plated brass

Materials for insertion tube

Stainless steel, 1.4404 (316/316L)

Process connections, process coupling

Stainless steel, 1.4404 (316/316L)

Sensing element

Unidirectional
- Stainless steel, 1.4404 (316/316L)
- Alloy C22, 2.4602 (UNS N06022);

Bidirectional
Stainless steel, 1.4404 (316/316L)

Reverse flow detection
Stainless steel, 1.4404 (316/316L)

Ferrules

- PEEK
- PVDF
- 1.4404 (316/316L)

Flat ring seal

- EPDM
- FKM

For aggressive media (e.g. chlorine or ozone), we recommend special materials (Alloy for sensing element, PVDF or 1.4404 for ferrules and FKM for flat seal). For any requests, please contact the Endress+Hauser sales organization responsible for your area.

Sensor guard

Stainless steel, 1.4404 (316/316L)

Accessories

Protective cover

Stainless steel, 1.4404 (316L)

External WLAN antenna

- Antenna: ASA plastic (acrylonitrile styrene acrylate) and nickel-plated brass
- Adapter: Stainless steel and nickel-plated brass
- Cable: Polyethylene
- Plug: Nickel-plated brass
- Angle bracket: Stainless steel

Mounting boss (DK6MB)

Stainless steel, 1.4404 (316/316L)

Cold/hot tap, low pressure and medium pressure

Welding socket

Stainless steel 1.4404 (316L)

Ball valve

- Stainless cast steel CF3M or CF8M
- Seal: PTFE

Sensor connection

Stainless steel, 1.4404 (316/316L)

Cold tap, atmospheric pressure

- Stainless steel, 1.4404 (316/316L)
- Stainless cast steel CF3M or CF8M
- Seal: PTFE

Weight

Transmitter

- Proline 500 – digital polycarbonate: 1.4 kg (3.1 lbs)
- Proline 500 – digital aluminum: 2.4 kg (5.3 lbs)

Sensor

- Sensor with cast connection housing version, stainless: +3.7 kg (+8.2 lbs)
- Sensor with aluminum connection housing version:

Weight in SI units

Installed length [mm]	Weight [kg]
235	2.2
335	2.3
435	2.4
608	2.5

Weight in US units

Installed length [in]	Weight [lbs]
9	4.9
13	5.1

Installed length [in]	Weight [lbs]
17	5.3
24	5.5

Process connections

- G¾", ISO 228/1 compression fitting
- G1", ISO 228/1, compression fitting
- ¾" NPT, compression fitting
- 1" NPT, compression fitting

For information on the different materials used in the process connections → 67

Display and user interface

Operation concept

Operator-oriented menu structure for user-specific tasks
- Commissioning
- Operation
- Diagnostics
- Expert level

Fast and safe commissioning
- Guided menus ("Make-it-run" wizards) for applications
- Menu guidance with short explanations of the individual parameter functions
- Access to the device via Web server
- WLAN access to the device via mobile handheld terminal, tablet or smart phone

Reliable operation
- Operation in local language
- Uniform operating philosophy applied to device and operating tools
- If replacing electronic modules, transfer the device configuration via the integrated memory (HistoROM backup) which contains the process and measuring device data and the event logbook. No need to reconfigure.

Efficient diagnostics increase measurement availability
- Troubleshooting measures can be called up via the device and in the operating tools
- Diverse simulation options, logbook for events that occur and optional line recorder functions

Languages

Can be operated in the following languages:
- Via local operation
  English, German, French, Spanish, Italian, Dutch, Portuguese, Polish, Russian, Turkish, Chinese, Japanese, Korean, Vietnamese, Czech, Swedish
- Via Web browser
  English, German, French, Spanish, Italian, Dutch, Portuguese, Polish, Russian, Turkish, Chinese, Japanese, Vietnamese, Czech, Swedish
- Via "FieldCare", "DeviceCare" operating tool: English, German, French, Spanish, Italian, Chinese, Japanese

Local operation

Via display module

Equipment:
- Order code for "Display; operation", option F "4-line, illuminated, graphic display; touch control"
- Order code for "Display; operation", option G "4-line, illuminated, graphic display; touch control + WLAN"

Information about WLAN interface → 71

Display elements

- 4-line, illuminated, graphic display
- White background lighting; switches to red in event of device errors
- Format for displaying measured variables and status variables can be individually configured

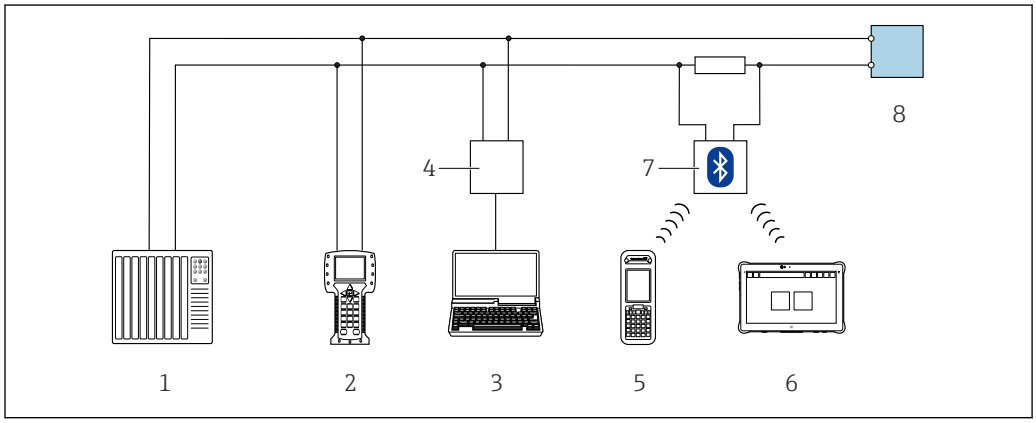
Operating elements

- External operation via touch control (3 optical keys) without opening the housing: ⊞, ⊟, Ⓔ
- Operating elements also accessible in the various zones of the hazardous area

Remote operation

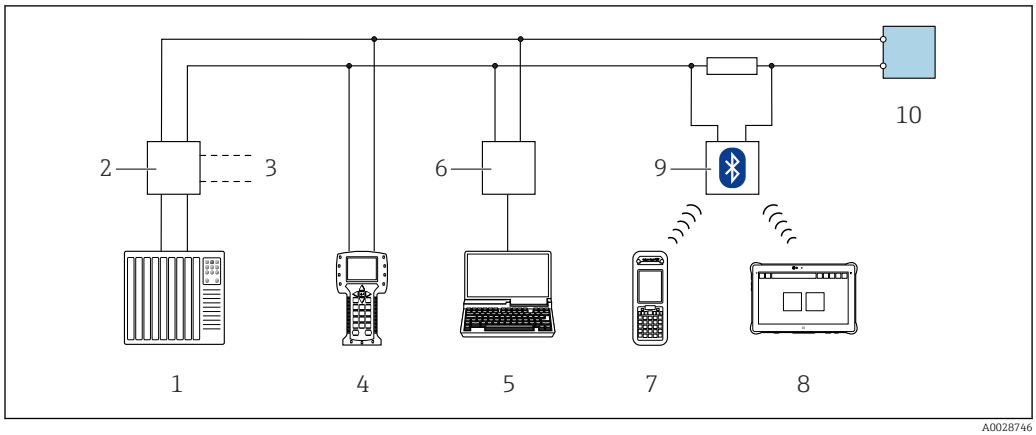
Via HART protocol

This communication interface is available in device versions with a HART output.



43 *Options for remote operation via HART protocol (active)*

1 *Control system (e.g. PLC)*
2 *Field Communicator 475*
3 *Computer with web browser (e.g. Microsoft Edge) to access the integrated device web server or computer with operating tool (e.g. FieldCare, DeviceCare, AMS Device Manager, SIMATIC PDM) with COM DTM "CDI Communication TCP/IP"*
4 *Commubox FXA195 (USB)*
5 *Field Xpert SFX350 or SFX370*
6 *Field Xpert SMT70*
7 *VIATOR Bluetooth modem with connecting cable*
8 *Transmitter*

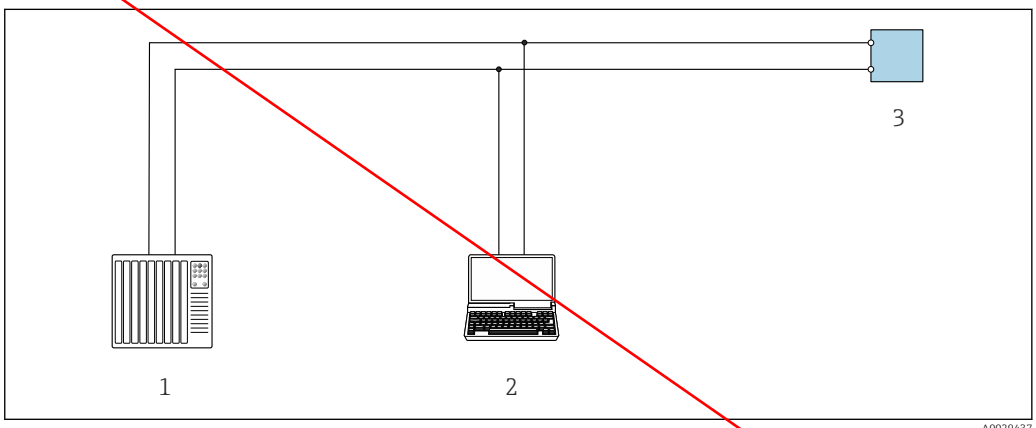


44 *Options for remote operation via HART protocol (passive)*

1 *Control system (e.g. PLC)*
2 *Transmitter power supply unit, e.g. RN221N (with communication resistor)*
3 *Connection for Commubox FXA195 and Field Communicator 475*
4 *Field Communicator 475*
5 *Computer with web browser (e.g. Microsoft Edge) to access the integrated device web server or computer with operating tool (e.g. FieldCare, DeviceCare, AMS Device Manager, SIMATIC PDM) with COM DTM "CDI Communication TCP/IP"*
6 *Commubox FXA195 (USB)*
7 *Field Xpert SFX350 or SFX370*
8 *Field Xpert SMT70*
9 *VIATOR Bluetooth modem with connecting cable*
10 *Transmitter*

Via Modbus RS485 protocol

This communication interface is available in device versions with a Modbus RS485 output.



45 *Options for remote operation via Modbus RS485 protocol (active)*

1 *Control system (e.g. PLC)*
2 *Computer with web browser (e.g. Microsoft Edge) to access the integrated device web server or with operating tool (e.g. FieldCare, DeviceCare) with COM DTM "CDI Communication TCP/IP" or Modbus DTM*
3 *Transmitter*

Service interface

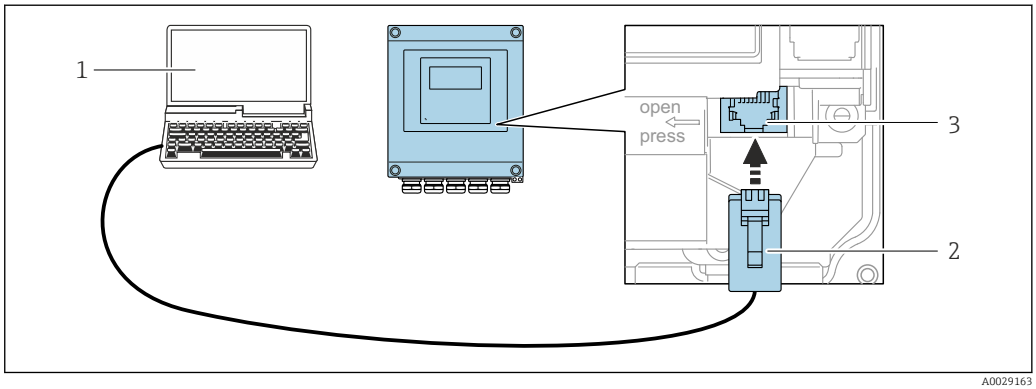
Via service interface (CDI-RJ45)

A point-to-point connection can be established to configure the device on site. With the housing open, the connection is established directly via the service interface (CDI-RJ45) of the device.

An adapter for the RJ45 to the M12 plug is optionally available for the non-hazardous area:
Order code for "Accessories", option **NB**: "Adapter RJ45 M12 (service interface)"

The adapter connects the service interface (CDI-RJ45) to an M12 plug mounted in the cable entry. The connection to the service interface can be established via an M12 plug without opening the device.

Proline 500 – digital transmitter



46 *Connection via service interface (CDI-RJ45)*

1 *Computer with web browser (e.g. Microsoft Internet Explorer, Microsoft Edge) to access the integrated web server or with an operating tool "FieldCare", "DeviceCare" with COM DTM "CDI Communication TCP/IP" or Modbus DTM*
2 *Standard Ethernet connecting cable with RJ45 plug*
3 *Service interface (CDI-RJ45) of the measuring device with access to the integrated web server*

Via WLAN interface

The optional WLAN interface is available on the following device version:
Order code for "Display; operation", option G "4-line, illuminated; touch control + WLAN"

Function	WLAN: IEEE 802.11 b/g (2.4 GHz) ▪ Access Point with DHCP server (factory setting) ▪ Network
Encryption	WPA2-PSK AES-128 (in accordance with IEEE 802.11i)
Configurable WLAN channels	1 to 11
Degree of protection	IP67
Available antennas	▪ Internal antenna ▪ External antenna (optional) In the event of poor transmission/reception conditions at the place of installation. Available as an accessory . Only 1 antenna is active at any one time!
Range	▪ Internal antenna: typically 10 m (32 ft) ▪ External antenna: typically 50 m (164 ft)
Materials (external antenna)	▪ Antenna: ASA plastic (acrylonitrile styrene acrylate) and nickel-plated brass ▪ Adapter: Stainless steel and nickel-plated brass ▪ Cable: Polyethylene ▪ Plug: Nickel-plated brass ▪ Angle bracket: Stainless steel

Supported operating tools

Different operating tools can be used for local or remote access to the measuring device. Depending on the operating tool used, access is possible with different operating units and via a variety of interfaces.

Supported operating tools	Operating unit	Interface	Additional information
Web browser	Notebook, PC or tablet with web browser	▪ CDI-RJ45 service interface ▪ WLAN interface	Special Documentation for device
DeviceCare SFE100	Notebook, PC or tablet with Microsoft Windows system	▪ CDI-RJ45 service interface ▪ WLAN interface ▪ Fieldbus protocol	→ 🖹 83
FieldCare SFE500	Notebook, PC or tablet with Microsoft Windows system	▪ CDI-RJ45 service interface ▪ WLAN interface ▪ Fieldbus protocol	→ 🖹 83
Field Xpert	SMT70/77/50	▪ All Fieldbus protocols ▪ WLAN interface ▪ Bluetooth ▪ CDI-RJ45 service interface	Operating Instructions BA01202S Device description files: Use update function of handheld terminal
SmartBlue app	Smart phone or tablet with iOs or Android	WLAN	→ 🖹 83

Other operating tools based on FDT technology with a device driver such as DTM/iDTM or DD/EDD can be used for device operation. These operating tools are available from the individual manufacturers. Integration into the following operating tools, among others, is supported:

- FactoryTalk AssetCentre (FTAC) from Rockwell Automation → www.rockwellautomation.com
- Process Device Manager (PDM) from Siemens → www.siemens.com
- Asset Management Solutions (AMS) from Emerson → www.emersonprocess.com
- FieldCommunicator 375/475 from Emerson → www.emersonprocess.com
- Field Device Manager (FDM) from Honeywell → www.process.honeywell.com
- FieldMate from Yokogawa → www.yokogawa.com
- PACTWare → www.pactware.com

The related device description files are available: www.endress.com → Download Area

Web server

With the integrated web server, the device can be operated and configured via a web browser service interface (CDI-RJ45) or WLAN interface. The structure of the operating menu is the same as for the local display. In addition to the measured values, status information on the device is displayed and can be used to monitor device health. Furthermore the device data can be managed and the network parameters can be configured.

A device that has a WLAN interface (can be ordered as an option) is required for the WLAN connection: order code for "Display; operation", option G "4-line, illuminated; touch control + WLAN". The device acts as an Access Point and enables communication by computer or a mobile handheld terminal.

Supported functions
Data exchange between the operating unit (such as a notebook, for example,) and measuring device:
- Upload the configuration from the measuring device (XML format, configuration backup)
- Save the configuration to the measuring device (XML format, restore configuration)
- Export event list (.csv file)
- Export parameter settings (.csv file or PDF file, document the measuring point configuration)
- Export the Heartbeat verification log (PDF file, only available with the **Heartbeat Verification** → 🖹 79 application package)
- Flash firmware version for device firmware upgrade, for example
- Download driver for system integration
- Visualize up to 1000 saved measured values (only available with the **Extended HistoROM** application package→ 🖹 79)

Special Documentation for web server

HistoROM data management

The measuring device features HistoROM data management. HistoROM data management comprises both the storage and import/export of key device and process data, making operation and servicing far more reliable, secure and efficient.

When the device is delivered, the factory settings of the configuration data are stored as a backup in the device memory. This memory can be overwritten with an updated data record, for example after commissioning.

Additional information on the data storage concept

There are different types of data storage units in which device data are stored and used by the device:

	HistoROM backup	T-DAT	S-DAT
Available data	▪ Event logbook, e.g. diagnostic events ▪ Parameter data record backup ▪ Device firmware package	▪ Measured value logging ("Extended HistoROM" order option) ▪ Current parameter data record (used by firmware at run time) ▪ Indicator (minimum/maximum values) ▪ Totalizer value	▪ Sensor data: e.g. nominal diameter ▪ Serial number ▪ Calibration data ▪ Device configuration (e.g. SW options, fixed I/O or multi I/O)
Storage location	Fixed on the user interface PC board in the connection compartment	Can be plugged into the user interface PC board in the connection compartment	In the sensor plug in the transmitter neck part

Data backup

Automatic
- The most important device data (sensor and transmitter) are automatically saved in the DAT modules
- If the transmitter or measuring device is replaced: once the T-DAT containing the previous device data has been exchanged, the new measuring device is ready for operation again immediately without any errors
- If the sensor is replaced: once the sensor has been replaced, new sensor data are transferred from the S-DAT in the measuring device and the measuring device is ready for operation again immediately without any errors
- If exchanging the electronics module (e.g. I/O electronics module): Once the electronics module has been replaced, the software of the module is compared against the current device firmware. The module software is upgraded or downgraded where necessary. The electronics module is available for use immediately afterwards and no compatibility problems occur.

Manual
Additional parameter data record (complete parameter settings) in the integrated device memory HistoROM backup for:
- Data backup function
  Backup and subsequent restoration of a device configuration in the device memory HistoROM backup
- Data comparison function
  Comparison of the current device configuration with the device configuration saved in the device memory HistoROM backup

Data transmission

Manual
Transfer of a device configuration to another device using the export function of the specific operating tool, e.g. with FieldCare, DeviceCare or Web server: to duplicate the configuration or to store in an archive (e.g. for backup purposes)

Event list

Automatic
- Chronological display of up to 20 event messages in the events list
- If the **Extended HistoROM** application package (order option) is enabled: up to 100 event messages are displayed in the events list along with a time stamp, plain text description and remedial measures
- The events list can be exported and displayed via a variety of interfaces and operating tools e.g. DeviceCare, FieldCare or Web server

Data logging

Manual
If the **Extended HistoROM** application package (order option) is enabled:
- Recording of 1 to 4 channels of up to 1 000 measured values (up to 250 measured values per channel)
- User configurable recording interval
- Export the measured value log via a variety of interfaces and operating tools e.g. FieldCare, DeviceCare or web server

Certificates and approvals

Current certificates and approvals for the product are available at www.endress.com on the relevant product page:

1. Select the product using the filters and search field.
2. Open the product page.
3. Select **Downloads**.

CE mark

The device meets the legal requirements of the applicable EU Directives. These are listed in the corresponding EU Declaration of Conformity along with the standards applied.

Endress+Hauser confirms successful testing of the device by affixing to it the CE mark.

UKCA marking

The device meets the legal requirements of the applicable UK regulations (Statutory Instruments). These are listed in the UKCA Declaration of Conformity along with the designated standards. By selecting the order option for UKCA marking, Endress+Hauser confirms a successful evaluation and testing of the device by affixing the UKCA mark.

Contact address Endress+Hauser UK:
Endress+Hauser Ltd.
Floats Road
Manchester M23 9NF
United Kingdom
www.uk.endress.com

RCM marking

The measuring system meets the EMC requirements of the "Australian Communications and Media Authority (ACMA)".

Ex approval

The measuring device is certified for use in hazardous areas and the relevant safety instructions are provided in the separate "Safety Instructions" (XA) document. Reference is made to this document on the nameplate.

The separate Ex documentation (XA) containing all the relevant explosion protection data is available from your Endress+Hauser sales center.

Proline 500 – digital

ATEX/IECEx

Currently, the following versions for use in hazardous areas are available:

Ex db

Transmitter		Sensor	
Category	**Type of protection**	**Category**	**Type of protection**
II(1)G	[Ex ia] IIC	II1/2G	Ex db ia IIC T4...T1 Ga/Gb
II(1)G	[Ex ia] IIC	II2G	Ex db ia IIC T4...T1 Gb
II3G	Ex ec nC [ia Ga] IIC T5...T1 Gc	II1/2G	Ex db ia IIC T4...T1 Ga/Gb
II3G	Ex ec nC [ia Ga] IIC T5...T1 Gc	II2G	Ex db ia IIC T4...T1 Gb

Ex tb

Transmitter		Sensor	
Category	**Type of protection**	**Category**	**Type of protection**
II(1)D	[Ex ia] IIIC	II2D	Ex tb IIIC T** °C Db

Non-Ex / Ex ec

Transmitter		Sensor	
Category	**Type of protection**	**Category**	**Type of protection**
Non - Ex	Non-Ex	II3G	Ex ec IIC T4...T1 Gc
II3G	Ex ec nC IIC T5...T1 Gc	II3G	Ex ec IIC T4...T1 Gc

$_{C}CSA_{US}$

Currently, the following versions for use in hazardous areas are available:

IS (Ex nA, Ex i)

Transmitter	Sensor
Class I Division 2 Groups A - D	Class I, II, III Division 1 Groups A-G

NI (Ex nA)

Transmitter	Sensor
Class I Division 2 Groups A - D	Class I Division 2 Groups A - D

Ex db

Transmitter	Sensor
Ex ec nC [ia Ga] IIC T5...T1 Gc	Ex db ia IIC T4...T1 Gb
Ex ec nC [ia Ga] IIC T5...T1 Gc	Ex db ia IIC T4...T1 Ga/Gb

Ex nA

Transmitter	Sensor
Class I, Zone 2 AEx/ Ex nA IIC T5...T4 Gc	Class I, Zone 2 AEx/ Ex nA IIC T5...T1 Gc

Ex tb

Transmitter	Sensor
Non - Ex	Zone 21, AEx/Ex ia tb IIIC T** °C Db

Functional safety

The measuring device can be used for flow monitoring systems (min., max., range) up to SIL 2 (single-channel architecture; order code for "Additional approval", option LA) and SIL 3 (multi-channel architecture with homogeneous redundancy) and is independently evaluated and certified in accordance with IEC 61508.

The following types of monitoring in safety equipment are possible:
Mass flow

Functional safety manual with information and restrictions for the SIL device → 📄 85

HART certification

HART interface

The measuring device is certified and registered by the FieldComm Group. The measuring system meets all the requirements of the following specifications:
- Certified according to HART 7
- The device can also be operated with certified devices of other manufacturers (interoperability)

Radio approval

The measuring device has radio approval.

For detailed information on the radio approval, see the Special Documentation → 📄 85

Additional certification	**CRN approval** Some device versions have CRN approval. A CRN-approved process connection with a CSA approval must be ordered for a CRN-approved device.
External standards and guidelines	▪ EN 60529 Degrees of protection provided by enclosure (IP code) ▪ EN 61010-1 Safety requirements for electrical equipment for measurement, control and laboratory use - general requirements ▪ IEC/EN 61326-2-3 Emission in accordance with Class A requirements. Electromagnetic compatibility (EMC requirements). ▪ NAMUR NE 21 Electromagnetic compatibility (EMC) of industrial process and laboratory control equipment ▪ NAMUR NE 32 Data retention in the event of a power failure in field and control instruments with microprocessors ▪ NAMUR NE 43 Standardization of the signal level for the breakdown information of digital transmitters with analog output signal. ▪ NAMUR NE 53 Software of field devices and signal-processing devices with digital electronics ▪ NAMUR NE 105 Specifications for integrating fieldbus devices in engineering tools for field devices ▪ NAMUR NE 107 Self-monitoring and diagnosis of field devices ▪ NAMUR NE 131 Requirements for field devices for standard applications ▪ ETSI EN 300 328 Guidelines for 2.4 GHz radio components. ▪ EN 301489 Electromagnetic compatibility and radio spectrum matters (ERM).
Classification of process sealing between electrical systems and (flammable or combustible) process fluids in accordance with ANSI/ISA 12.27.01	Endress+Hauser devices are designed in accordance with ANSI/ISA 12.27.01. allowing the user to waive the use and save the cost of installing external secondary process seals in the conduit as required by the process sealing sections of ANSI/NFPA 70 (NEC) and CSA 22.1 (CEC). These devices comply with the North American installation practice and provide a very safe and cost-saving installation for pressurized applications with hazardous fluids. Further information can be found in the control drawings of the relevant devices.

Ordering information

Detailed ordering information is available as follows:

- In the Product Configurator on the Endress+Hauser website: www.endress.com -> Click "Corporate" -> Select your country -> Click "Products" -> Select the product using the filters and search field -> Open product page -> The "Configure" button to the right of the product image opens the Product Configurator.
- From your Endress+Hauser Sales Center:www.addresses.endress.com

Product Configurator - the tool for individual product configuration

- Up-to-the-minute configuration data
- Depending on the device: Direct input of measuring point-specific information such as measuring range or operating language
- Automatic verification of exclusion criteria
- Automatic creation of the order code and its breakdown in PDF or Excel output format
- Ability to order directly in the Endress+Hauser Online Shop

Application packages

Many different application packages are available to enhance the functionality of the device. Such packages might be needed to address safety aspects or specific application requirements.

The application packages can be ordered with the device or subsequently from Endress+Hauser. Detailed information on the order code in question is available from your local Endress+Hauser sales center or on the product page of the Endress+Hauser website: www.endress.com.

Detailed information on the application packages:
Special Documentation → 85

Diagnostic functionality

Order code for "Application package", option EA "Extended HistoROM"

Comprises extended functions concerning the event log and the activation of the measured value memory.

Event log:
Memory volume is extended from 20 message entries (standard version) to up to 100 entries.

Data logging (line recorder):
- Memory capacity for up to 1000 measured values is activated.
- 250 measured values can be output via each of the 4 memory channels. The recording interval can be defined and configured by the user.
- Measured value logs can be accessed via the local display or operating tool e.g. FieldCare, DeviceCare or Web server.

For detailed information, see the Operating Instructions for the device.

Heartbeat Technology

Order code for "Application package", option EB "Heartbeat Verification + Monitoring"

Heartbeat Verification
Meets the requirement for traceable verification to DIN ISO 9001:2008 Chapter 7.6 a) "Control of monitoring and measuring equipment".
- Functional testing in the installed state without interrupting the process.
- Traceable verification results on request, including a report.
- Simple testing process via local operation or other operating interfaces.
- Clear measuring point assessment (pass/fail) with high test coverage within the framework of manufacturer specifications.
- Extension of calibration intervals according to operator's risk assessment.

Heartbeat Monitoring
Continuously supplies data, which are characteristic of the measuring principle, to an external condition monitoring system for the purpose of preventive maintenance or process analysis. These data enable the operator to:
- Draw conclusions - using these data and other information - about the impact on the measuring performance over time.
- Schedule servicing in time.
- Monitor the process or product quality , e.g. process stability.

Special Documentation SD02712D

Second gas group

Package	Description
Second gas group	This application package enables the configuration of two different standard gases/gas mixtures in the device and allows the user to switch from one gas group to another using the status input or (if available) via bus communication.

Accessories

Various accessories, which can be ordered with the device or subsequently from Endress+Hauser, are available for the device. Detailed information on the order code in question is available from your local Endress+Hauser sales center or on the product page of the Endress+Hauser website: www.endress.com.

Device-specific accessories

For the transmitter

Accessories	Description
Transmitter Proline 500 – digital	Transmitter for replacement or storage. Use the order code to define the following specifications: ▪ Approvals ▪ Output ▪ Input ▪ Display/operation ▪ Housing ▪ Software Proline 500 – digital transmitter: Order number: 6X5BXX-*********A Proline 500 transmitter for replacement: It is essential to specify the serial number of the current transmitter when ordering. On the basis of the serial number, the device-specific data (e.g. calibration factors) of the replaced device can be used for the new transmitter. Proline 500 – digital transmitter: Installation Instructions EA01287D
External WLAN antenna	External WLAN antenna with 1.5 m (59.1 in) connecting cable and two angle brackets. Order code for "Accessory enclosed", option P8 "Wireless antenna wide area". ▪ The external WLAN antenna is not suitable for use in hygienic applications. ▪ Additional information regarding the WLAN interface → 🖹 71. Order number: 71351317 Installation Instructions EA01238D
Pipe mounting set	Pipe mounting set for transmitter. Proline 500 – digital transmitter Order number: 71346427 Installation Instructions EA01195D
Weather protection cover Transmitter Proline 500 – digital	Is used to protect the measuring device from the effects of the weather: e.g. rainwater, excess heating from direct sunlight. Proline 500 – digital transmitter Order number: 71343504 Installation Instructions EA01191D

Display guard Proline 500 – digital	Is used to protect the display against impact or scoring, for example from sand in desert areas. Order number: 71228792 Installation Instructions EA01093D
Connecting cable Proline 500 – digital Sensor – Transmitter	The connecting cable can be ordered directly with the measuring device (order code for "Cable, sensor connection) or as an accessory (order number). The following cable lengths are available: order code for "Cable, sensor connection" ▪ Option B: 20 m (65 ft) ▪ Option E: User-configurable up to 50 mmax. ▪ Option F: User-configurable up to 165 ftmax. Maximum possible cable length for a Proline 500 – digital connecting cable: 300 m (1 000 ft)

For the sensor

Accessories	Description
Mounting boss	**Order code for "Accessory enclosed"** ▪ Option PC "Mounting boss, G1" ▪ Option PD "Mounting boss, 1" NPT" ▪ Option PE "Mounting boss, G¾" ▪ Option PF "Mounting boss, ¾" NPT" Can be ordered separately: order code DK6MB
Cold tap (ambient pressure)	**Order code for "Accessory enclosed"** ▪ Option PR "Cold tap G1", ambient pressure" ▪ Option PS "Cold tap 1" NPT, ambient pressure" ▪ Option PT "Cold tap G¾", ambient pressure" ▪ Option PU "Cold tap ¾" NPT, ambient pressure" Can be ordered separately: order code DK6ML
Hot tap (low pressure)	**Order code for "Accessory enclosed"** ▪ Option PG "Hot tap G1", low pressure max. 4.5 bar/65 psig" ▪ Option PH "Hot tap 1" NPT, low pressure max. 4.5 bar/65 psig" ▪ Option PK "Hot tap G¾", low pressure max. 4.5 bar/65 psig" ▪ Option PL "Hot tap ¾" NPT, low pressure max. 4.5 bar/65 psig" Mounting set contains mounting boss (process connection), sensor connection with safety chain and ball valve. To insert or remove the sensor at process pressures up to max. 4.5 barg (65 psi). If the accessory is ordered separately, individual combinations can be selected. Order code DK6003

Hot tap (medium pressure)	**Order code for "Accessory enclosed"** ▪ Option PI "Hot tap G1", medium pressure max. 16 bar/230 psig" ▪ Option PJ "Hot tap 1" NPT, medium pressure max. 16 bar/230 psig" ▪ Option PM "Hot tap G¾", medium pressure max. 16 bar/230 psig" ▪ Option PN "Hot tap ¾" NPT, medium pressure max. 16 bar/230 psig" Mounting set contains mounting boss (process connection), sensor connection, ball valve and extractor assembly. To insert or remove the sensor at process pressures up to max. 16 barg (230 psi). If the accessory is ordered separately, individual combinations can be selected. Order code DK6003
Flow conditioner	Can be ordered separately: order code DK6004 **Available for the following pipe diameters:** ▪ DN 80 (3") ▪ DN 100 (4") ▪ DN 150 (6") ▪ DN 200 (8") ▪ DN 250 (10") ▪ DN 300 (12") **Available for the following process connections:** ▪ PN10, EN1092-1 ▪ PN16, EN1092-1 ▪ PN25, EN1092-1 ▪ PN40, EN1092-1 ▪ Cl.150, ASME B16.5 ▪ Cl.300, ASME B16.5 ▪ 10K, JIS B2220 ▪ 20K, JIS B2220 Screws and seals are not included in the delivery.

Communication-specific accessories

Accessories	Description
Commubox FXA195 HART	For intrinsically safe HART communication with FieldCare via the USB port. Technical Information TI00404F
HART Loop Converter HMX50	Is used to evaluate and convert dynamic HART process variables to analog current signals or limit values. ▪ Technical Information TI00429F ▪ Operating Instructions BA00371F
Fieldgate FXA42	Transmission of the measured values of connected 4 to 20 mA analog measuring devices, as well as digital measuring devices ▪ Technical Information TI01297S ▪ Operating Instructions BA01778S ▪ Product page: www.endress.com/fxa42
Field Xpert SMT50	The Field Xpert SMT70 tablet PC for device configuration enables mobile plant asset management in non-hazardous areas. It is suitable for commissioning and maintenance staff to manage field instruments with a digital communication interface and to record progress. This tablet PC is designed as an all-in-one solution with a preinstalled driver library and is an easy-to-use, touch-sensitive tool which can be used to manage field instruments throughout their entire life cycle. ▪ Technical Information TI01342S ▪ Operating Instructions BA01709S ▪ Product page: www.endress.com/smt50

Field Xpert SMT70	The Field Xpert SMT70 tablet PC for device configuration enables mobile plant asset management in hazardous and non-hazardous areas. It is suitable for commissioning and maintenance staff to manage field instruments with a digital communication interface and to record progress. This tablet PC is designed as an all-in-one solution with a preinstalled driver library and is an easy-to-use, touch-sensitive tool which can be used to manage field instruments throughout their entire life cycle. ▪ Technical Information TI01342S ▪ Operating Instructions BA01709S ▪ Product page: www.endress.com/smt70
Field Xpert SMT77	The Field Xpert SMT77 tablet PC for device configuration enables mobile plant asset management in areas categorized as Ex Zone 1. ▪ Technical Information TI01418S ▪ Operating Instructions BA01923S ▪ Product page: www.endress.com/smt77

Service-specific accessories

Accessories	Description
Applicator	Software for selecting and sizing Endress+Hauser measuring devices: ▪ Choice of measuring devices for industrial requirements ▪ Calculation of all the necessary data for identifying the optimum flowmeter: e.g. nominal diameter, pressure loss, flow velocity and accuracy. ▪ Graphic illustration of the calculation results ▪ Determination of the partial order code, administration, documentation and access to all project-related data and parameters over the entire life cycle of a project. Applicator is available: ▪ Via the Internet: https://portal.endress.com/webapp/applicator ▪ As a downloadable DVD for local PC installation.
W@M	W@M Life Cycle Management Improved productivity with information at your fingertips. Data relevant to a plant and its components is generated from the first stages of planning and during the asset's complete life cycle. W@M Life Cycle Management is an open and flexible information platform with online and on-site tools. Instant access for your staff to current, in-depth data shortens your plant's engineering time, speeds up procurement processes and increases plant uptime. Combined with the right services, W@M Life Cycle Management boosts productivity in every phase. For more information, see: www.endress.com/lifecyclemanagement
FieldCare	FDT-based plant asset management tool from Endress+Hauser. It can configure all smart field units in your system and helps you manage them. By using the status information, it is also a simple but effective way of checking their status and condition. Operating Instructions BA00027S and BA00059S
DeviceCare	Tool to connect and configure Endress+Hauser field devices. Innovation brochure IN01047S

System components

Accessories	Description
Memograph M graphic data manager	The Memograph M graphic data manager provides information on all the relevant measured variables. Measured values are recorded correctly, limit values are monitored and measuring points analyzed. The data are stored in the 256 MB internal memory and also on a SD card or USB stick. ▪ Technical Information TI00133R ▪ Operating Instructions BA00247R
Ceraphant PTC31B	The pressure transmitter for measuring the absolute and gauge pressure in gases, steam, liquids and dusts. It can be used to read in the operating pressure value. ▪ Technical Information TI01130P ▪ Operating Instructions BA01270P

Accessories	Description
Cerabar PMC21	The pressure transmitter for measuring the absolute and gauge pressure in gases, steam, liquids and dusts. It can be used to read in the operating pressure value. ▪ Technical Information TI01133P ▪ Operating Instructions BA01271P
Cerabar S PMC71	The pressure transmitter for measuring the absolute and gauge pressure of gases, steam and liquids. It can be used to read in the operating pressure value. ▪ Technical Information TI00383P ▪ Operating Instructions BA00271P

Documentation

For an overview of the scope of the associated Technical Documentation, refer to the following:
- *Device Viewer* (www.endress.com/deviceviewer): Enter the serial number from the nameplate
- *Endress+Hauser Operations app*: Enter serial number from nameplate or scan matrix code on nameplate.

Standard documentation

Supplementary information on the semi-standard options is available in the relevant Special Documentation in the TSP database.

Brief Operating Instructions

Brief Operating Instructions for the sensor

Measuring device	Documentation code
Proline t-mass I	KA01443D

Brief Operating Instructions for the transmitter

	Documentation code	
Measuring device	HART	Modbus RS485
Proline 500 – digital	KA01446D	KA01447D

Operating Instructions

Measuring device	Documentation code	
	HART	Modbus RS485
t-mass I 500	BA01997D	BA01999D

Description of Device Parameters

	Documentation code	
Measuring device	HART	Modbus RS485
t-mass 500	GP01145D	GP01146D

Supplementary device-dependent documentation

Safety instructions

Safety instructions for electrical equipment for hazardous areas.

Contents	Documentation code
ATEX/IECEx Ex d/Ex de	XA01970D
ATEX/IECEx Ex ec	XA01971D
cCSAus XP	XA01974D
cCSAus Ex d/ Ex de	XA01972D
cCSAus Ex nA	XA01973D

Remote display and operating module DKX001

Contents	Documentation code
ATEX/IECEx Ex i	XA01494D
ATEX/IECEx Ex ec	XA01498D
cCSAus IS	XA01499D

Contents	Documentation code
cCSAus Ex nA	XA01513D
INMETRO Ex i	XA01500D
INMETRO Ex ec	XA01501D
NEPSI Ex i	XA01502D
NEPSI Ex nA	XA01503D

Functional safety manual

Contents	Documentation code
Proline t-mass 500	SD02484D

Special documentation

Contents	Documentation code	
	HART	Modbus RS485
Functional Safety Manual	SD02484D	–
Heartbeat Technology	SD02479D	SD02480D
Web server	SD02487D	SD02488D

Installation Instructions

Contents	Comment
Installation instructions for spare part sets and accessories	Documentation code: specified for each individual accessory .

Registered trademarks

HART®
Registered trademark of the FieldComm Group, Austin, Texas, USA

Modbus®
Registered trademark of SCHNEIDER AUTOMATION, INC.



www.addresses.endress.com

Endress+Hauser

People for Process Automation

INS-05

MEMBRANE TANK FLOW SWITCHES

For Earth, For Life
Kubota

Submittal Transmittal

Membrane tank float switches

Project Name	TAYLOR BAY BEACH CLUB WWTF UPGRADE
Project Site	8220 178TH AVENUE, LONGBRANCH, WA 98351
Engineer	Gray & Osborne, Inc 1130 RAINIER AVENUE SOUTH, SUITE 300
Submit to	Gray & Osborne, Inc
Prepared by	Shingo Kubo | Lead Project Manager KUBOTA Water and Environment U.S.A. Corporation 19910 N Creek Pkwy, Suite 100 Bothell, WA 98011
KMU Project #	KMU-OPID85
Issued Date	August 24, 2025
Package #	OPID85- INS-05-B-Membrane tank float switches
Item	Tag # 02 LS 03 02 LS 04 02 LS 05 02 LS 06

Clarifications;

1. Section1 contains Kubota scope list. The subjected item for this submittal is marked in red.

2. Section2 contains the manufacture submittal and datasheet for review.

Response to 60% review comment;

1) General – Make Corrections Noted

a. Note that BABA certifications from manufacturers should be included in the final

Kubota Response: Manufacture Email confirmation is included at the last page of section 2. Please note that the certificate is subjected to be updated after the manufacturer receives the order.

b. Note that manufacturer services should be included in the final submittal.

Kubota Response: Manufacturer field service is not applicable to this product.

For Earth, For Life
Kubota

SECTION 1

KUBOTA Water and Environment U.S.A. Corporation
19910 N Creek Pkwy, Suite 100 Bothell, WA 98011| Phone: 425 898 2858 | Fax: 425-898-2853

No	Equipment Location	Tag	Category	Function	Name	Type	Chosen Size/Capacity	Unit	Material	Manufacturer	Model/ Specification	Motor HP	Voltage	FLA	QTY
	MBR Equipment	**x**													
1	MBR	02 MBR 01 02 MBR 02 02 MBR 03 02 MBR 04	SMU	Membrane Filtration	MBR SMU	Flat Plate			304SS	KUBOTA	FS150				4
2	MBR	n/a	SMU	SMU Maintenance	MBR SMU Lifting Tool	Lifting Tool			CS, SS	KUBOTA	TG150				1
3	MBR	n/a	SMU	SMU Maintenance	MBR SMU Lifting Chain	Lifting Tool			304SS	KUBOTA	CS30M				4
4	MBR	02 MOV 03 02 MOV 04	Auto Valve	Diffuser Cleaning	MBR Diffuser Cleaning Valve	ON/OFF Plug	3	inch	CI/CI	Auma/Pratt	SQ12.2-AC01.2/S601 w/extention stem	1/12	120 VAC	2.9	2
5	MBR	n/a	Other Valve	Isolation Valve	SMU Air Isolation Valve(inlet)	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S30				4
6	MBR	n/a	Other Valve	Isolation Valve	SMU Air Isolation Valve(outlet)	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S30				4
7	MBR	BV281 BV282 BV283 BV284	Other Valve	Isolation Valve	SMU PRMT Isolation Valve	Manual Butterfly	2	inch	DI, EPDM, Nylon Coat	Bray	S30				4
8	MBR	n/a	Other Valve	Manual Valves	Isolation Valves for CIP injection	Manual Ball	1	inch	PVC	ASAHI	Type21 True Union				4
9	MBR	02 LS 03 02 LS 04 02 LS 05 02 LS 06	Gauge, Switch	Level Measurement	MBR Level Switch	Float			PP, PU	Conery	2902-B8S1 w/ counter weight and brackets		Loop power		4
10	MBR	n/a	Fabrication	Fabrication	MBR SMU Guide & Stabilizer + Seismic Bracing				304SS	TBD					4
11	MBR	n/a	Fabrication	Fabrication	MBR SMU Fasteners				304SS	TBD					40
12	MBR	n/a	Fabrication	Fabrication	MBR In-Basin Pipe&Supports (Permeate Drop Pipe)				PVC	TBD					4
13	MBR	n/a	Fabrication	Fabrication	MBR In-Basin Pipe&Supports (Air Drop Pipe)				304SS	TBD					8
	Permeate (PRMT) Control Equipment	**x**													
14	PRMT	01 PMP 01 01 PMP 02 01 PMP 03	Permeate Pump	Permeate Extraction	PRMT Pump	Rotary Lobe	45	gpm		Boerger	AN 70 w/ piggyback mount	5	460 VAC	6.6	3
15	PRMT	PI169 PI170 PI171	Gauge, Switch	Pressure Gauge	PRMT Pump Pressuge Gauge(Inlet)		-15 - +15	psig	SS	Ashcroft or equivalent	1279 w/ grycelin filled				3
16	PRMT	PI172 PI173 PI174	Gauge, Switch	Pressure Gauge	PRMT Pump Pressuge Gauge (Inlet)		-15 - +15	psig	SS	Ashcroft or equivalent	1279 w/ grycelin filled				3
17	PRMT	01 PTR 01 01 PTR 02	Pressure Sensor	TMP Measurement	PRMT Pump Pressure Transmitter	Diaphragm	-15 - +15	psi	SS	Endress & Hauser	Cerabar PMCB51		Loop power		2
18	PRMT	01 MFM 01 01 MFM 02	Flow Sensor	Flow Measurement	PRMT Flow Meter	Electromagnetic	3	inch	PU	Endress & Hauser	Promag W 400		24VDC		2
19	MBR	n/a	Other Valve	Isolation Valve	MBR PRMT Pump isolation valve	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S30				8
20	MBR	CV261 CV261 CV261	Other Valve	Check valve	MBR PRMT Pump discharge check valve	Manual ball	3	inch	PVC, EPDM	ASAHI	True Union Ball Check				3
21	PRMT	01 TM 01	Other Instrument	Turbidity Measurement	PRMT Turbidity Meter	Laser	0-5	NTU		HACH	TU5300sc				1
22	PRMT	01 TM 01	Other Instrument	Turbidity Measurement	PRMT Turbidity Transmitter					HACH	SC4500		24VDC		1
23	PRMT	n/a	Other Instrument	Turbidity Measurement	Turbidity Meter Maintenance Kit					HACH					1
	Return Activated Sludge (RAS) Control	**x**													
24	MBR	Relocated from MBR 02 SLS02 02 SLS03	Other Instrument	Level Measurement	MBR Level Sensor	Hydrostatic	15	ft	SS	Endress & Hauser	Waterpilot FMX21 w/ brackets		Loop power		2
	MBR Blower	**x**													
25	MBR BLW	01 MSB 01 01 MSB 02 01 MSB 03	Blower	Blower	MBR Blower	Positive Displacement	114	scfm	CI	Aerzen	GM 4S DN 80	5	460 VAC	6.6	3

No	Equipment Location	Tag	Category	Function	Name	Type	Chosen Size/Capacity	Unit	Material	Manufacturer	Model/ Specification	Motor HP	Voltage	FLA	QTY
26	MBR BLW	n/a	Option	Noise Suppression	MBR Blower Sound Enclosure	With Blower									3
27	MBR BLW	n/a	Option	Blower Temperature	MBR Blower Temperature Gauge	With Blower									3
28	MBR BLW	n/a	Option	Blower Pressure	MBR Blower Pressure Gauge	With Blower									3
29	MBR BLW	n/a	Option	Blower Temperature	MBR Blower Temperature Switch	With Blower									3
30	MBR BLW	01 AFM 01 01 AFM 02	Flow Sensor	Air Flow Measurement	MBR Blower Flow Meter	Thermal Mass	3	inch	PU	Endress & Hauser	t-mass I 300, w/ flow conditioner plate		24VDC		2
31	MBR BLW	n/a	Other Valve	Manual Valves	Air Scour Blower Isolation Valves	Manual Butterfly	3	inch	DI, FKM, SS Disk	Bray	S30				4
	Clean-In-Place Equipment	**x**													
32	SMU CIP	n/a	Chemical Injection	Chemical Injection	SMU CIP System PVC pipes		1	inch	PVC	KUBOTA	Loose ship parts shown on xxx				1
33	SMU CIP	n/a	Flow Sensor	Flow Measurement	CIP solution Flow Meter	Electromagnetic	1	inch	PU				24 VDC		1
34	SMU CIP	n/a	Flow Sensor	Flow Measurement	CIP shelf chenical Flow Meter	Electromagnetic	3/8	inch	PU	Keyence	FD-Q10C		24VDC		1
35	SMU CIP	n/a	Auto Valve	Flow Control	CIP Flow Control Valve	ON/OFF Ball	1	inch	DI	ASAHI	S19-120VAC--1"-C20/S20		120VAC	0.18	1
36	SMU CIP	n/a	Other Valve	Manual Valves	Isolation Valves on CIP Station	Manual Ball	1, 0.5	inch	PVC	ASAHI	Type21 True Union				1
37	SMU CIP	n/a	Other Valve	Manual Valves	Pressure reducing valve	Pressure Reducing	1.5	inch	CI	Zurn	ZW209				1
	System Control Equipment	**x**													
38	CONTROL	n/a	Control Panel	Control Panel	Control Panel	OIT, PLC					NEMA 4/12, 72" x 72" x 18" floor mount enclosure (estimated size) , Allen Bradley 1756-L81E PLC (BABA-Version), FactoryTalk View SE		120VAC	TBD	1
39	D. SERVICE	n/a	D. Service	Direct Service	Direct Service						Design support, start-up, field service, remote service				1

SECTION 2



B8

MERCURY

- Pear Shaped Bulb
- Newest Mechanical Design
- Now in Standard Bulb
- Available for 48 hour shipment in all cable lengths

Designed for accurate liquid level control in nearly any application, including potable water, industrial, sewage and wastewater environments. The durable outer shell and foam filled interior provide for leak-proof operation and tremendous impact resistance.

Operating Options

NORMALLY OPEN (N/O) - GREEN BULB... FOR PUMP DOWN APPLICATIONS
The mechanical switch activates (contacts close) as the float rises 1.00fl or 5 degrees above horizontal.

NORMALLY CLOSED (N/C) - GREEN/RED BULB... FOR PUMP UP APPLICATIONS
The mechanical switch de-activates (contacts open) as the float rises 1.00fl or 5 degrees above horizontal.

SINGLE POLE, DOUBLE THROW (SPDT) - GREEN/BLUE BULB... NORMALLY OPEN OR NORMALLY CLOSED
A variation on the standard normally open or normally closed float switch, this float may be wired at installation to perform either operation but not both.

Specifications - Float & Cable

B8 Bulb Style Is 3.50fl X 5.00fl
Durable Polypropylene Shell
Solid Polyurethane Foam Filling
Mechanically Activated Micro-Switch
Non - Mercury Design
Operating Temperature Of 32-170 F
Chlorinated Polyethylene Cable
SJOOW-300 Volt - 18/2 Cable
SJOOW-300 Volt - 18/3 Cable For Spdt Design

Specifications - Electrical

Rated For 10 Amps @ 120 VAC
Rated For 3 Amps @ 240 VAC
Not For Use With 460 Volt Applications

c UL us LISTED

Gold Contacts (GC) **$20 net adder.** Must be added for Intrinsically Safe Applications.

Mounting Options

C1 - Zinc Plated, Cast-Iron Cord Weight (1.22 Lbs)
C3 - SS Clamp For Pipe Mount
C4 - Releasable Poly Tie Strap
C7 - Float Collar For 1.00fl Pipe Mount


C1


C3


C4


C7

FLOAT SWITCH PART NUMBER & PRICE WORKSHEET

Instructions:

A. Fill in the shaded blanks in the boxes below to determine exact part number (please note that many abbreviations are usedŠrefer to catalog for complete descriptions)
B. Reference the cost amounts below each letter/number designation to build the exact price
C. Using the multiplier table (below & left), determine the quantity discount for net price
D. Stainless floats & vertical floats have their own charts

FLOAT SWITCH ORIENTATION	BULB TYPE	SWITCH TYPE	PIGGYBACK PLUG	CORD ASSEMBLY	PACKAGING	CABLE LENGTH (IN 5' INCREMENTS)
REQUIRED	**REQUIRED**	**REQUIRED**	(OPTIONAL)	(OPTIONAL)	(OPTIONAL)	**REQUIRED**
	- **B**	- **S**	- **P**	- **C**	- **K**	- **15' STANDARD**
$62.00 - **2900** NORMALLY OPEN	$6.85 **1** STD BULB - MERC	$0.00 - **1** NARROW ANGLE	$11.50 - **1** 120V PLUG	$10.75 - **1** CORD WEIGHT	$4.00 - **1** IND BOXED	($2.00) - **- 5'** ANY TYPE FLOAT
$62.00 - **2901** NORMALLY CLOSED	$6.85 **2** MINI BULB - MERC	$20.25 - **2** NA - SPDT	$16.00 - **2** 240V PLUG	$6.35 - **2** CLAMP - POLY	$325 - **2** IND BAGGED	- **15'** STANDARD
$62.00 - **2902** SPDT	$3.00 **3** MECHANICAL BULB	$10.80 - **3** NA - 600V	(PLUGS USABLE	$8.10 - **3** CLAMP - STNLS		$8.60 - **+ 5'** S1, S4, S14, 20 AMP
	$22.00 **4** INT WTD BULB MERCURY FOAM FILLED	$15.00 - **4** WIDE ANGLE	ON WIDE ANGLE FLOATS ONLY)	$8.10 - **31** CLAMP - SM STNLS		$13.20 - **+ 5'** S2, S5
		$24.65 - **5** WA - SPDT		$6.35 - **4** RLS TIE STRAP		$13.65 - **+ 5'** S3, S6
	$18.35 **6** INT WTD BULB MECHANICAL FOAM FILLED	$33.25 - **6** WA-2HP MECH		$8.15 - **7** FLOAT COLLAR		
	$3.00 **8** STANDARD BULB MECHANICAL FOAM FILLED					

MECHANICAL FLOAT
Add Gold Contact (GC) for Intrinsically Safe Applications
$15.00 Net Adder

STAINLESS STEEL FLOAT SWITCHES

SWITCH TYPE	CABLE LENGTH (IN 10' INCREMENTS)	FLOAT SWITCH ORIENTATION	SWITCH TYPE
	REQUIRED	**REQUIRED**	(OPTIONAL)
SF -	**20' STANDARD** -	-	(NA STANDARD)
$240.00	$33.00 - **+ 10'**	**NO** NORMALLY OPEN **NC** NORMALLY CLOSED	**NA** NARROW ANGLE $17.0 0 **WA** WIDE ANGLE

Restocking Fee

Conery Mfg Inc charges a standard 15% restocking fee on approved returned goods.

Minimum Order Fee

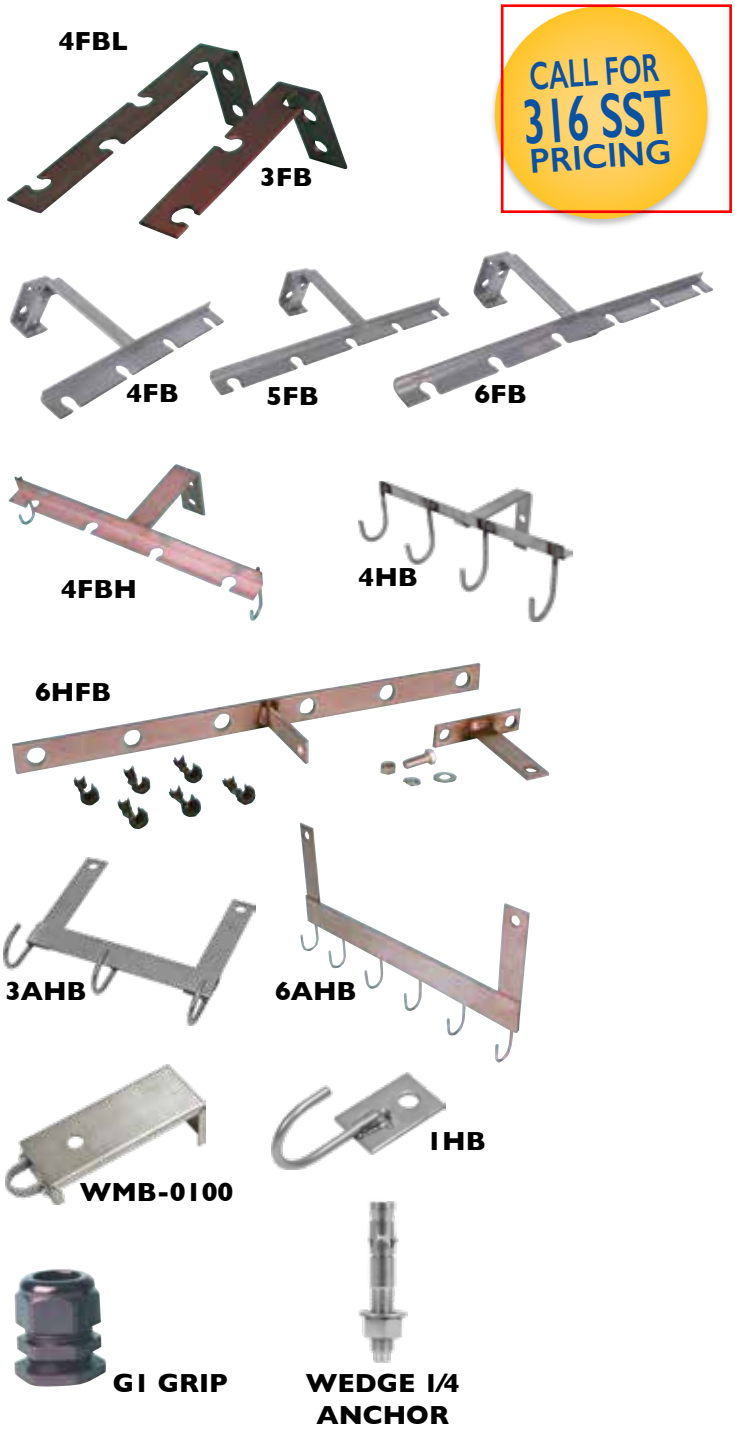
Conery Mfg Inc reserves the right to include up to a $5.00 minimum order fee for orders that are less than $30.00 before shipping charges.

Shipping Information

Conery Mfg Inc ships all orders via FedEx Ground unless specified to be expedited or shipped by freight with a carrier of our choice. Expediting fees may apply.

Warranty - For full warranty information visit www.coneryMFG.com/warranty.

Brackets are designed to keep multiple float switches organized within the basin. All brackets are made of Type 304 stainless st and come with black cord bushings to securely attach float cables. As an option, liquid tight cord grips are also available for the sa purpose. Additional hook type style brackets are also available. Additionally, the T-shaped bracket styles are supplied with a mount piece so that the bracket itself may be easily removed from the basin with the floats still attached.



L-TYPE BRACKETS

	List Price
3FB	$ 62.50
4FBL	72.50

T-TYPE BRACKETS

4FB	78.00
5FB	92.50
6FB	94.00

T-TYPE BRACKETS W/SIDE HOOKS

4FBH	85.00
5FBH	104.00
6FBH	108.00
4HB	82.00
6HB	94.50

H-TYPE BRACKETS

4HFB	108.00
6HFB	124.00

U-TYPE BRACKET

3AHB	88.00
4AHB	107.00
6AHB	119.00
4SFB	78.00
5SFB	93.00
6SFB	98.00

SPECIALTY TYPE BRACKETS

WMB-100	78.00
1HB - 75 lb. max	35.00
1HBXL - over 75 lb.	54.00

OPTIONAL CORD GRIPS

G1	6.00

Note: To add cord grips to your float bracket order, simply specify G1 after the part number. You will receive the number of cord grips that fit each respective float bracket.

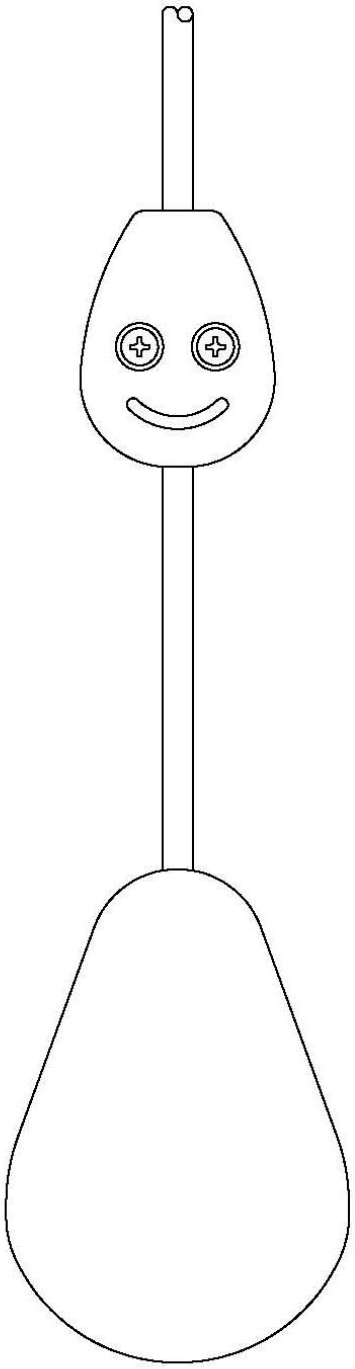
WEDGE ANCHORS

Wedge Anchor - 1/4" x 2 1/4", 304 SST - Use with Float Brackets	3.65

Please Call for Custom Brackets

NON-MERCURY FLOAT SWITCH - CONTROL DUTY

2900 MECHANICAL SERIES - NARROW ANGLE FLOAT SWITCH



GENERAL

DESIGNED FOR ACCURATE LIQUID LEVEL CONTROL IN MANY APPLICATIONS INCLUDING POTABLE WATER OR SEWAGE ENVIRONMENTS. THE FLOAT SWITCH CAN BE UTILIZED TO SIGNIFY SPECIFIC WATER LEVELS OR FOR DIRECT ALARM ACTUATION.

SWITCH VARIATIONS

NORMALLY OPEN (N/O) - GREEN SHELL

THE CONTACTS ARE OPEN (OR OFF) IN THE HANGING POSITION. AS THE FLOAT RISES 1" (5°) ABOVE HORIZONTAL, THE CONTACTS BECOME CLOSED AND ACTUATE (TURN ON) THE SWITCH. THIS FLOAT IS GENERALLY USED IN PUMP DOWN APPLICATIONS.

NORMALLY CLOSED (N/C) - GREEN/RED SHELL

THE CONTACTS ARE CLOSED (OR ON) IN THE HANGING POSITION. AS THE FLOAT RISES 1" (5°) ABOVE HORIZONTAL, THE CONTACTS BECOME OPEN AND ACTUATE (TURN OFF) THE SWITCH. THIS FLOAT IS GENERALLY USED IN PUMP UP APPLICATIONS.

SINGLE POLE, DOUBLE THROW (SPDT) - GREEN/BLUE SHELL

A VARIATION OF THE PREVIOUSLY LISTED SWITCHES. THIS FLOAT SWITCH CAN BE WIRED TO OPERATE AS EITHER (BUT NOT BOTH) A NORMALLY OPEN OR NORMALLY CLOSED SWITCH BASED ON THE USER'S NEED.

SWITCH SPECIFICATIONS

2900 SERIES MECHANICAL FLOAT SWITCHES ARE DESIGNED TO OPERATE UNDER THE FOLLOWING PARAMETERS.

MINIMUM OPERATING TEMPERATURE	-	32 DEGREES F.
MAXIMUM OPERATING TEMPERATURE	-	170 DEGREES F.
ELECTRICAL RATING	-	10 AMP-120 VAC, 5 AMP-240 VAC
ACTUATION POINT	-	1" ABOVE / BELOW HORIZONTAL.

POWER CORD SPECIFICATIONS

CONDUCTOR CORD - PHYSICAL	-	CHLORINATED POLY ETHYLENE.
ELECTRICAL FOR N/O OR N/C SWITCH	-	18 AWG 2, TYPE SJOOW - 300 V.
ELECTRICAL FOR SPDT SWITCH	-	18 AWG 3, TYPE SJOOW - 300 V.

FLOAT SPECIFICATIONS

DURABLE POLYPROPYLENE MATERIAL CONSTRUCTION.
SOLID POLYURETHANE FOAM INTERIOR.
LEAK PROOF, SHOCK PROOF, AND IMPACT RESISTANT.
RESISTANT TO SEWAGE AND WASTEWATER APPLICATIONS.

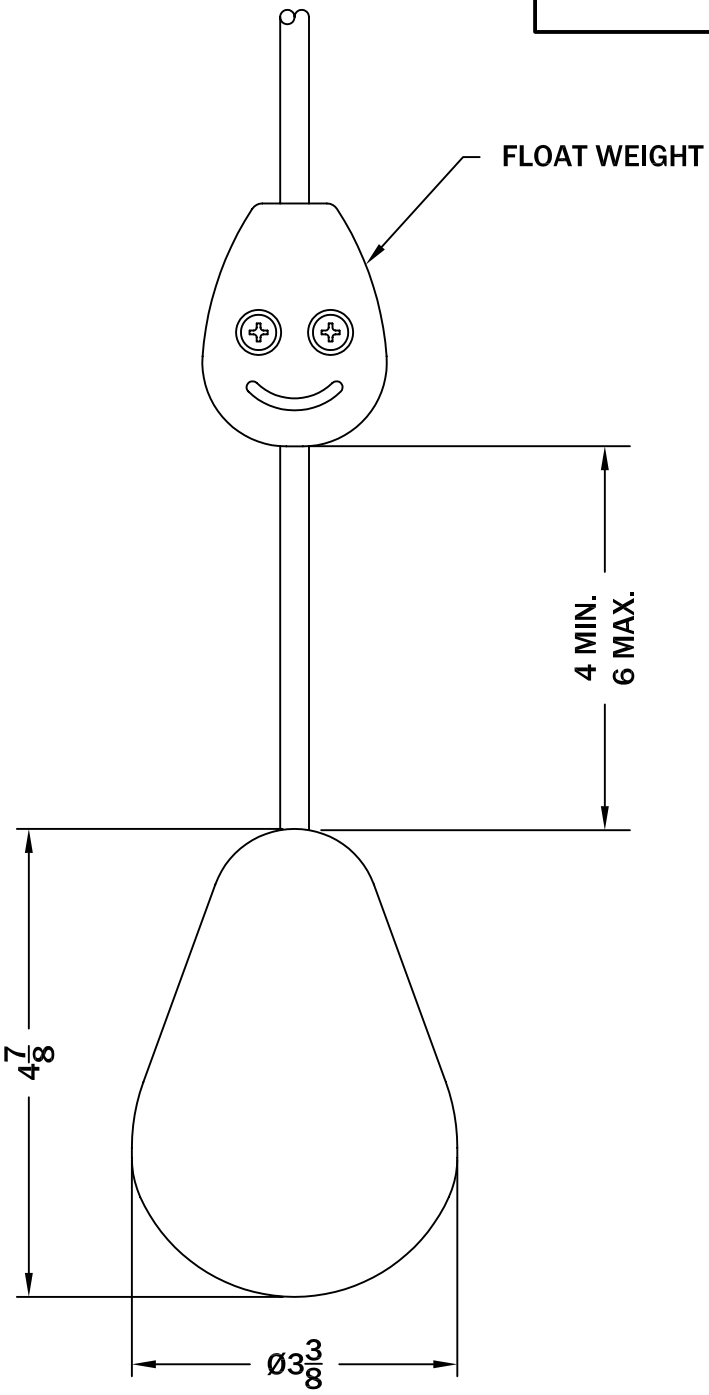
CORD WEIGHT

ZINC PLATED CAST IRON - 1.22 LBS.
SPLIT WEIGHT DESIGN ALLOWS FOR EASY ADJUSTMENT.
DESIGN ALLOWS FOR SECURE AND PERMANENT ATTACHMENT TO CORD.

c UL us LISTED
Ind. Cont. Eq.
47UF

CONERY MFG INC 1380 ENTERPRISE PKWY ASHLAND, OH 44805
info@conerymfg.com PH (419) 289-1444 FAX (419) 281-0366

2900 SERIES B8



ALL INFORMATION CONTAINED IN THIS DRAWING IS CONFIDENTIAL AND PROPRIETARY TO CONERY MFG, INC.

CONERY MFG INC

CHANGES		TOLERANCES	DRAWN BY	DATE
F		DECIMALS .XXX = ±.005 .XX = ±.010 FRACTIONAL X/X = ±.1/64 ANGLES X° = ±1/2°	D. MIDDLETON	07/30/09
E			MATERIAL SPECIFICATION:	
D				
C				
B				
A				

SPECIFICATION SHEET
MECHANICAL FLOAT

SCALE: HALF

2900 SERIES B8
NON–MERCURY

NOTE: ALL ELECTRICAL DIAGRAMS SHOWN ARE EXAMPLES ONLY, CONSULT WITH LOCAL ELECTRICAL AUTHORITIES AND CODES. DO NOT USE THESE PRODUCTS IN GASOLINE, VOLATILES, OTHER COMBUSTIBLES.

2900 SERIES B8

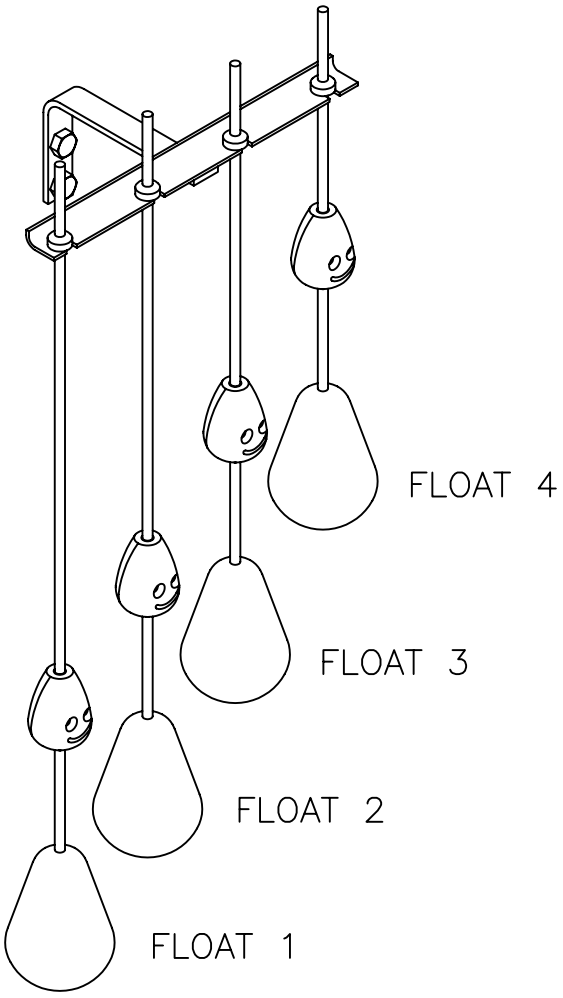
FOR PUMP DOWN USE
(NORMALLY OPEN FLOATS)

FOR PUMP UP USE
(NORMALLY CLOSED FLOATS)

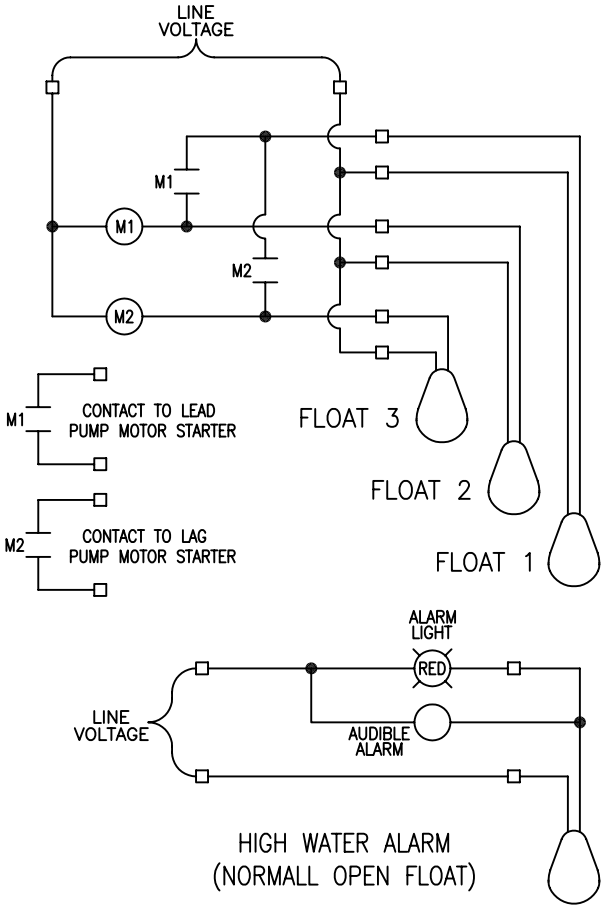
FOR SPDT FLOATS
GREEN – N/O
WHITE – COMMON
BLACK – N/C

c UL us LISTED

TYPICAL MOUNTING



TYPICAL 2 PUMP USES



ALL INFORMATION CONTAINED IN THIS DRAWING IS CONFIDENTIAL AND PROPRIETARY TO CONERY MFG, INC.

CONERY MFG INC

CHANGES	TOLERANCES	DRAWN BY	DATE
F	DECIMALS	D. MIDDLETON	07/30/09
E	.XXX = ±.005		
D	.XX = ±.010	MATERIAL SPECIFICATION:	
C	FRACTIONAL		
B	X/X = ±.1/64		
A	ANGLES		
	X° = ±1/2°		

SPECIFICATION SHEET
MECHANICAL FLOAT

SCALE: NONE

2900 SERIES B8
NON–MERCURY

For Earth, For Life
Kubota

Kubo, Shingo <shingo.kubo@kubota.com>

Conery BABA Certificate | 2902-B8-S1 Float switches

Lugo, Juan <juan.lugo@kubota.com> Thu, Aug 7, 2025 at 1:16 PM
To: mbekeleski@conerymfg.com
Cc: Shingo Kubo <shingo.kubo@kubota.com>, KMU Procurement <kmu_g.procurement@kubota.com>

Hey Mike,

Excellent, thank you for confirming! This would be for Taylor Bay, WA. If you can get us the certificate that would be great.

On Thu, Aug 7, 2025 at 9:53 AM <mbekeleski@conerymfg.com> wrote:

> Yes those would be BABA compliant. If you want me to issue a certificate I need to know the Project Name and I can send you a letter. We make those floats in house here in Ohio.

From: Lugo, Juan <juan.lugo@kubota.com>
Sent: Thursday, August 7, 2025 12:35 PM
To: Mike Bekeleski <mbekeleski@conerymfg.com>; sales@conerymfg.com; Heidi Plas <hplas@conerymfg.com>
Cc: Shingo Kubo <shingo.kubo@kubota.com>; KMU Procurement <kmu_g.procurement@kubota.com>
Subject: Conery BABA Certificate | 2902-B8-S1 Float switches

DUE: Response by end of day today requested. - Certificate due by 8/12 LATEST

Hey Mike & Conery team,

Could you please confirm if the below Conery float switch is BABA compliant? If so, can you please get us the BABA certificate? I have also added some more guidelines for our request.

2902-B8-S1 Float switches

1. Attached is the PDF of the item(s) with the highlighted specifications we are looking for. Can you confirm if they are BABA compliant? The model number is highlighted on the PDF.
2. If they are BABA compliant, can you please get the BABA certificate from them?
3. If they are not BABA compliant, can you please propose any alternatives that can provide something equivalent to the PDF and are BABA compliant?

DUE: Response by end of day today requested. - Certificate due by 8/12 LATEST

Thank you in advance,

--

--

Juan Lugo | Procurement Specialist

KUBOTA Water and Environment U.S.A. Corporation

19910 N Creek Pkwy, Suite 100 Bothell, WA 98011

Phone: +1-206-532-1919

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Juan Lugo | Procurement Specialist
KUBOTA Water and Environment U.S.A. Corporation

INS-06

RAS PUMP STATION LEVEL TRANSMITTERS

For Earth, For Life
Kubota

Submittal Transmittal

RAS Pump Station Level Transmitters

Project Name	TAYLOR BAY BEACH CLUB WWTF UPGRADE
Project Site	8220 178TH AVENUE, LONGBRANCH, WA 98351
Engineer	Gray & Osborne, Inc 1130 RAINIER AVENUE SOUTH, SUITE 300
Submit to	Gray & Osborne, Inc
Prepared by	Shingo Kubo | Lead Project Manager KUBOTA Water and Environment U.S.A. Corporation 19910 N Creek Pkwy, Suite 100 Bothell, WA 98011
KMU Project #	KMU-OPID85
Issued Date	August 24, 2025
Package #	OPID85- INS-06-B-RAS Pump Station Level Transmitters
Item	Tag # Relocated from MBR 02 SLS02 02 SLS03

Clarifications;

1. Section1 contains Kubota scope list. The subjected item for this submittal is marked in red.

2. Section2 contains the manufacture submittal and datasheet for review.

Response to 60% review comment;

1) General – Make Corrections Noted

a. Note that BABA certifications from manufacturers should be included in the final

Kubota Response: Endress Hauser instruments do not comply with BABA requirement as shown in ATTACHMENT B.

ATTACHMENT B

SCOPE OF SUPPLY COMPONENTS THAT DO NOT COMPLY WITH BABA REQUIREMENTS

Part Identification (Name)	Equipment Description and Type	Manufacturer	Number of Units	Total Lump Sum Equipment Cost for Line Item
Kubota SMU Equipment	FS150 SMU Units + Associated Lifting Tool	Kubota	4 SMUs 1 Lifting Tool + Chains	$80,400.00
SMU Basin Associated Endress + Hauser Instrumentation	1. Air Pressure Transmitters 2. Blower Flow Meters 3. Permeate Flow Meter 4. Pump Pressure Transmitter 5. Level Transmitter	Endress + Hauser	Type 1 - QTY 3 Type 2 - QTY 2 Type 3 - QTY 1 Type 4 - QTY 2 Type 5 - QTY 2	$33,896.00
SMU Basin Hach Instrumentation	1. Air Pressure Transmitters 2. Blower Flow Meters 3. Permeate Flow Meters	Hach	Type 1 - QTY 1 Type 2 - QTY 1 Type 3 - QTY 1	$12,633.00
Kubota Standard CIP System	Kubota CIP system based around Mazzei injector, rotometer and flow control valve	Various	1 System of Supply	$18,500.00
PVC Isolation Valves + Check Valves	3 inch PVC Ball Valves 3 inch PVC Check Valves	Asahi	11 Ball Valves 3 Check Vavles	$11,072.00

b. Note that manufacturer services should be included in the final submittal.

Kubota Response: Manufacturer service is included per the specifications. For the items that Kubota is certified to provide service, Kubota will provide it.

18) INS-06-A-RAS Pump Station Level Transmitters – No Exceptions Taken / Make Corrections Noted / Amend & Resubmit

a. The model number listed is acceptable. Please edit the PDF to indicated only those items, models, or series of equipment that are being supplied and cross out all extraneous material per 01300.

Kubota Response: See section 2 for the equipment datasheet with cross out.

b. The chosen sensor appears to have an external diameter of 22 mm (from submittal pg. 8). The sensor should be the 42 mm external diameter option per 13424 2.2

Kubota Response: The sensor has been updated to 42mm type.

For Earth, For Life
Kubota

SECTION 1

KUBOTA Water and Environment U.S.A. Corporation
19910 N Creek Pkwy, Suite 100 Bothell, WA 98011| Phone: 425 898 2858 | Fax: 425-898-2853

No	Equipment Location	Tag	Category	Function	Name	Type	Chosen Size/Capacity	Unit	Material	Manufacturer	Model/ Specification	Motor HP	Voltage	FLA	QTY
	MBR Equipment	**x**													
1	MBR	02 MBR 01 02 MBR 02 02 MBR 03 02 MBR 04	SMU	Membrane Filtration	MBR SMU	Flat Plate			304SS	KUBOTA	FS150				4
2	MBR	n/a	SMU	SMU Maintenance	MBR SMU Lifting Tool	Lifting Tool			CS, SS	KUBOTA	TG150				1
3	MBR	n/a	SMU	SMU Maintenance	MBR SMU Lifting Chain	Lifting Tool			304SS	KUBOTA	CS30M				4
4	MBR	02 MOV 03 02 MOV 04	Auto Valve	Diffuser Cleaning	MBR Diffuser Cleaning Valve	ON/OFF Plug	3	inch	CI/CI	Auma/Pratt	SQ12.2-AC01.2/S601 w/extention stem	1/12	120 VAC	2.9	2
5	MBR	n/a	Other Valve	Isolation Valve	SMU Air Isolation Valve(inlet)	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S30				4
6	MBR	n/a	Other Valve	Isolation Valve	SMU Air Isolation Valve(outlet)	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S30				4
7	MBR	BV281 BV282 BV283 BV284	Other Valve	Isolation Valve	SMU PRMT Isolation Valve	Manual Butterfly	2	inch	DI, EPDM, Nylon Coat	Bray	S30				4
8	MBR	n/a	Other Valve	Manual Valves	Isolation Valves for CIP injection	Manual Ball	1	inch	PVC	ASAHI	Type21 True Union				4
9	MBR	02 LS 03 02 LS 04 02 LS 05 02 LS 06	Gauge, Switch	Level Measurement	MBR Level Switch	Float			PP, PU	Conery	2902-B8S1 w/ counter weight and brackets		Loop power		4
10	MBR	n/a	Fabrication	Fabrication	MBR SMU Guide & Stabilizer + Seismic Bracing				304SS	TBD					4
11	MBR	n/a	Fabrication	Fabrication	MBR SMU Fasteners				304SS	TBD					40
12	MBR	n/a	Fabrication	Fabrication	MBR In-Basin Pipe&Supports (Permeate Drop Pipe)				PVC	TBD					4
13	MBR	n/a	Fabrication	Fabrication	MBR In-Basin Pipe&Supports (Air Drop Pipe)				304SS	TBD					8
	Permeate (PRMT) Control Equipment	**x**													
14	PRMT	01 PMP 01 01 PMP 02 01 PMP 03	Permeate Pump	Permeate Extraction	PRMT Pump	Rotary Lobe	45	gpm		Boerger	AN 70 w/ piggyback mount	5	460 VAC	6.6	3
15	PRMT	PI169 PI170 PI171	Gauge, Switch	Pressure Gauge	PRMT Pump Pressuge Gauge(Inlet)		-15 - +15	psig	SS	Ashcroft or equivalent	1279 w/ grycelin filled				3
16	PRMT	PI172 PI173 PI174	Gauge, Switch	Pressure Gauge	PRMT Pump Pressuge Gauge (Inlet)		-15 - +15	psig	SS	Ashcroft or equivalent	1279 w/ grycelin filled				3
17	PRMT	01 PTR 01 01 PTR 02	Pressure Sensor	TMP Measurement	PRMT Pump Pressure Transmitter	Diaphragm	-15 - +15	psi	SS	Endress & Hauser	Cerabar PMCB51		Loop power		2
18	PRMT	01 MFM 01 01 MFM 02	Flow Sensor	Flow Measurement	PRMT Flow Meter	Electromagnetic	3	inch	PU	Endress & Hauser	Promag W 400		24VDC		2
19	MBR	n/a	Other Valve	Isolation Valve	MBR PRMT Pump isolation valve	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S30				8
20	MBR	CV261 CV261 CV261	Other Valve	Check valve	MBR PRMT Pump discharge check valve	Manual ball	3	inch	PVC, EPDM	ASAHI	True Union Ball Check				3
21	PRMT	01 TM 01	Other Instrument	Turbidity Measurement	PRMT Turbidity Meter	Laser	0-5	NTU		HACH	TU5300sc				1
22	PRMT	01 TM 01	Other Instrument	Turbidity Measurement	PRMT Turbidity Transmitter					HACH	SC4500		24VDC		1
23	PRMT	n/a	Other Instrument	Turbidity Measurement	Turbidity Meter Maintenance Kit					HACH					1
	Return Activated Sludge (RAS) Control	**x**													
24	MBR	Relocated from MBR 02 SLS02 02 SLS03	Other Instrument	Level Measurement	MBR Level Sensor	Hydrostatic	15	ft	SS	Endress & Hauser	Waterpilot FMX21 w/ brackets		Loop power		2
	MBR Blower	**x**													
25	MBR BLW	01 MSB 01 01 MSB 02 01 MSB 03	Blower	Blower	MBR Blower	Positive Displacement	114	scfm	CI	Aerzen	GM 4S DN 80	5	460 VAC	6.6	3

No	Equipment Location	Tag	Category	Function	Name	Type	Chosen Size/Capacity	Unit	Material	Manufacturer	Model/ Specification	Motor HP	Voltage	FLA	QTY
26	MBR BLW	n/a	Option	Noise Suppression	MBR Blower Sound Enclosure	With Blower									3
27	MBR BLW	n/a	Option	Blower Temperature	MBR Blower Temperature Gauge	With Blower									3
28	MBR BLW	n/a	Option	Blower Pressure	MBR Blower Pressure Gauge	With Blower									3
29	MBR BLW	n/a	Option	Blower Temperature	MBR Blower Temperature Switch	With Blower									3
30	MBR BLW	01 AFM 01 01 AFM 02	Flow Sensor	Air Flow Measurement	MBR Blower Flow Meter	Thermal Mass	3	inch	PU	Endress & Hauser	t-mass I 300, w/ flow conditioner plate		24VDC		2
31	MBR BLW	n/a	Other Valve	Manual Valves	Air Scour Blower Isolation Valves	Manual Butterfly	3	inch	DI, FKM, SS Disk	Bray	S30				4
	Clean-In-Place Equipment	**x**													
32	SMU CIP	n/a	Chemical Injection	Chemical Injection	SMU CIP System PVC pipes		1	inch	PVC	KUBOTA	Loose ship parts shown on xxx				1
33	SMU CIP	n/a	Flow Sensor	Flow Measurement	CIP solution Flow Meter	Electromagnetic	1	inch	PU				24 VDC		1
34	SMU CIP	n/a	Flow Sensor	Flow Measurement	CIP shelf chenical Flow Meter	Electromagnetic	3/8	inch	PU	Keyence	FD-Q10C		24VDC		1
35	SMU CIP	n/a	Auto Valve	Flow Control	CIP Flow Control Valve	ON/OFF Ball	1	inch	DI	ASAHI	S19-120VAC--1"-C20/S20		120VAC	0.18	1
36	SMU CIP	n/a	Other Valve	Manual Valves	Isolation Valves on CIP Station	Manual Ball	1, 0.5	inch	PVC	ASAHI	Type21 True Union				1
37	SMU CIP	n/a	Other Valve	Manual Valves	Pressure reducing valve	Pressure Reducing	1.5	inch	CI	Zurn	ZW209				1
	System Control Equipment	**x**													
38	CONTROL	n/a	Control Panel	Control Panel	Control Panel	OIT, PLC					NEMA 4/12, 72" x 72" x 18" floor mount enclosure (estimated size) , Allen Bradley 1756-L81E PLC (BABA-Version), FactoryTalk View SE		120VAC	TBD	1
39	D. SERVICE	n/a	D. Service	Direct Service	Direct Service						Design support, start-up, field service, remote service				1

SECTION 2

TI00431P/00/EN/18.22-00
71593286
2022-09-12

Technical Information
Waterpilot FMX21

Hydrostatic level measurement



Compact transmitter for level measurement

Application

The Waterpilot FMX21 is a pressure sensor for hydrostatic level measurement.

Endress+Hauser offers three different versions of the device:
- FMX21 with a stainless steel housing, external diameter of 22 mm (0.87 in): This version is excellently suited to drinking water applications and for use in bore holes and wells with small diameters
- FMX21 with a stainless steel housing, external diameter of 42 mm (1.65 in): Heavy-duty version and easy to clean thanks to flush-mounted process isolating diaphragm, ideally suited to wastewater and wastewater treatment plants
- FMX21 with plastic insulation, external diameter of 29 mm (1.14 in): Robust version for use in salt water and excellently suited to applications on ships (e.g. ballast water tanks)

Your benefits

- High resistance to overload
- High-precision, robust ceramic measuring cell with long-term stability
- Climate proofed sensor thanks to completely potted electronics and 2-filter pressure compensation system
- Simultaneous measurement of level and temperature with optionally integrated Pt100 temperature sensor
- Accuracy
  - Standard reference accuracy ±0.2 %
  - PLATINUM version ±0.1 %
- Automatic density compensation to increase accuracy
- Usage in drinking water: KTW, NSF, ACS
- Approvals: ATEX, FM, CSA
- Marine approvals: GL, ABS, BV, DNV
- Extensive range of accessories provides complete measuring point solutions

Endress+Hauser
People for Process Automation

Configuration summary

Mat. no.	Description Order code	Quantity	Unit
71082058	Waterpilot FMX21 FMX21-CE221GDE11A+F1POPRR5	1	ST

010	Approval:	CE	CSA C/US IS Cl.I Div.1 Gr.A-D, Ex ia, zone 1
020	Output:	2	4-20mA HART
045	Probe Tube:	2	316L, d=42mm/1.66in, flush mount
070	Sensor Range:	1G	600mbar/60kPa/9psi gauge, 6mH2O/20ftH2O/240inH2O
080	Reference Accuracy:	D	Platinum
090	Calibration; Unit:	E	Sensor range; inH2O/ftH2O
100	Probe Connection:	11	20m cable, shortable, PE
190	Seal:	A	FKM
550	>Calibration:	F1	Factory calibration certificate, 5-point
620	>>Accessory Enclosed:	PO	Suspension clamp, 316L
		PR	Cable-mounting-screw NPT1-1/2, 304
		R5	Remote display RIA15, Ex, field housing plastic

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TEFLON® 55
HART® 55
FieldCare® 55
DeviceCare® 55
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About this document

Document function

The document contains all the technical data on the device and provides an overview of the accessories and other products that can be ordered for the device.

Symbols

Safety symbols

DANGER

This symbol alerts you to a dangerous situation. Failure to avoid this situation will result in serious or fatal injury.

WARNING

This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in serious or fatal injury.

CAUTION

This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minor or medium injury.

NOTICE

This symbol contains information on procedures and other facts which do not result in personal injury.

Electrical symbols

Direct current

Alternating current

Direct and alternating current

Ground connection
Grounded clamp, which is grounded via a grounding system.

Protective earth (PE)
Ground terminals, which must be grounded prior to establishing any other connections. The ground terminals are located on the inside and outside of the device.

Equipotential connection
A connection that has to be connected to the plant grounding system: This may be a potential equalization line or a star grounding system depending on national or company codes of practice.

Symbols for certain types of information

Permitted
Procedures, processes or actions that are permitted

Preferred
Procedures, processes or actions that are preferred

Forbidden
Procedures, processes or actions that are forbidden

Tip
Indicates additional information

Reference to documentation

Reference to page

Reference to graphic

1., 2., 3.
Series of steps

Result of a step

Help in the event of a problem

Visual inspection

Symbols in graphics

1, 2, 3, ...
Item numbers

1., 2., 3.
Series of steps

A, B, C, ...
Views

A-A, B-B, C-C etc.
Sections

Documentation

The following types of documentation are available in the Download Area of the Endress+Hauser website (www.endress.com/downloads):

For an overview of the scope of the associated Technical Documentation, refer to the following:
- *W@M Device Viewer* (www.endress.com/deviceviewer): Enter the serial number from the nameplate
- *Endress+Hauser Operations App*: Enter the serial number from the nameplate or scan the matrix code on the nameplate

Operating Instructions (BA)

Your reference guide
These Operating Instructions contain all the information that is required in various phases of the life cycle of the device: from product identification, incoming acceptance and storage, to mounting, connection, operation and commissioning through to troubleshooting, maintenance and disposal.

Brief Operating Instructions (KA)

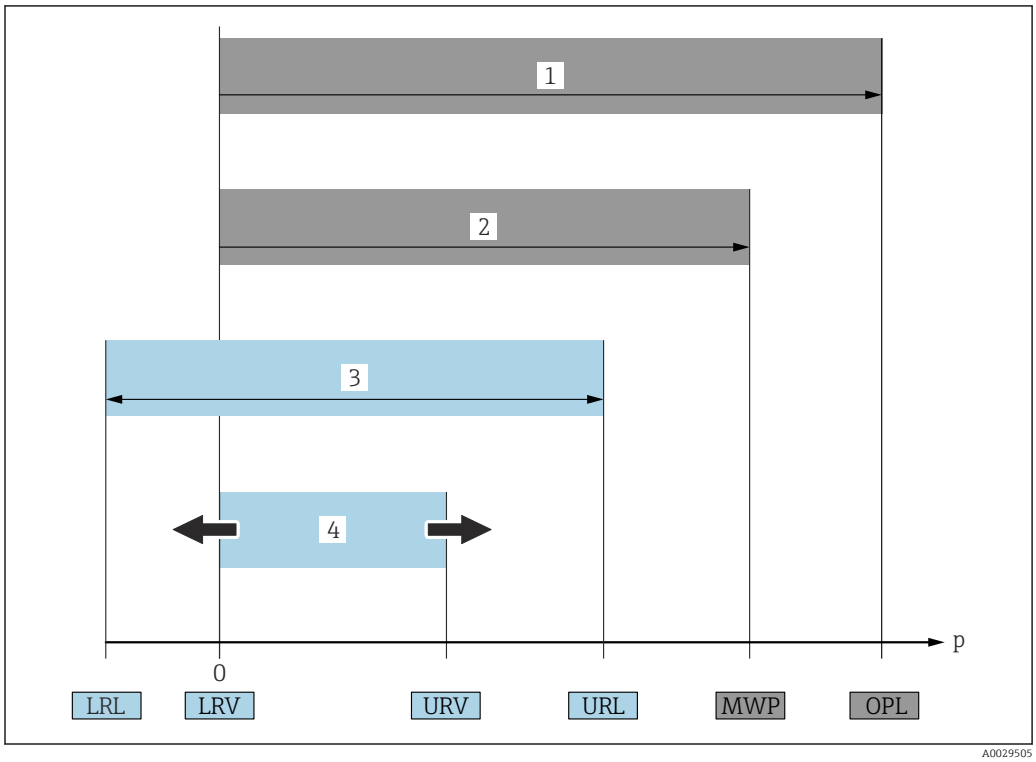
Guide that takes you quickly to the 1st measured value
The Brief Operating Instructions contain all the essential information from incoming acceptance to initial commissioning.

Safety Instructions (XA)

Depending on the approval, the following Safety Instructions (XA) are supplied with the device. They are an integral part of the Operating Instructions.

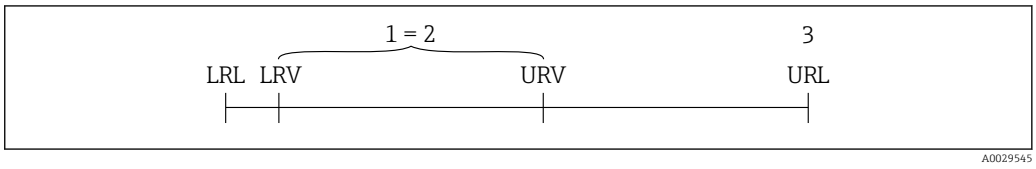
The nameplate indicates the Safety Instructions (XA) that are relevant to the device.

Terms and abbreviations



- **OPL (1)**
  The OPL (Over Pressure Limit) for the measuring device depends on the lowest-rated element, with regard to pressure, of the selected components i.e. the process connection has to be taken into consideration in addition to the measuring cell. Also observe pressure-temperature dependency.
  The OPL may only be applied for a limited period of time.
- **MWP (2)**
  The MWP (Maximum Working Pressure) for the sensors depends on the lowest-rated element, with regard to pressure, of the selected components, i.e. the process connection has to be taken into consideration in addition to the measuring cell. Also observe pressure-temperature dependency.
  The MWP may be applied at the device for an unlimited period.
  The MWP can also be found on the nameplate.
- **Maximum sensor measuring range (3)**
  Span between LRL and URL. This sensor measuring range is equivalent to the maximum calibratable/adjustable span.
- **Calibrated/adjusted span (4)**
  Span between LRV and URV. Factory setting: 0 to URL
  Other calibrated spans can be ordered as customized spans.
- **p**: Pressure
- **LRL**: Lower range limit
- **URL**: Upper range limit
- **LRV**: Lower range value
- **URV**: Upper range value
- **TD (Turn down)**: Example - see the following section
- **PE**: Polyethylene
- **FEP**: Fluorinated ethylene propylene
- **PUR**: Polyurethane

Turn down calculation



1 Calibrated/adjusted span
2 Zero point-based span (4 to 20 mA Analog: customer-specific span can only be set at the factory when ordered)
3 URL sensor

Example

- Sensor:10 bar (150 psi)
- Upper range value (URL) = 10 bar (150 psi)
- Calibrated/adjusted span: 0 to 5 bar (0 to 75 psi)
- Lower range value (LRV) = 0 bar (0 psi)
- Upper range value (URV) = 5 bar (75 psi)

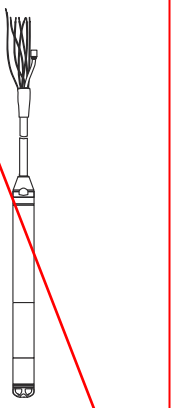
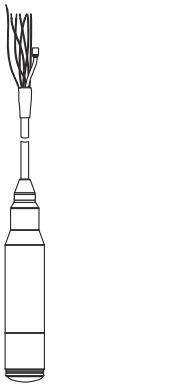
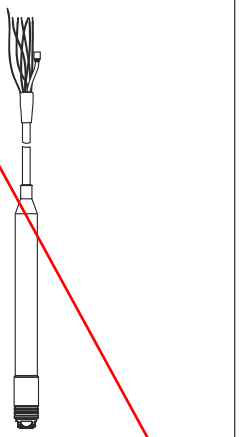
Turn down (TD):

$$TD = \frac{URL}{|URV - LRV|}$$

$$TD = \frac{10\ \text{bar (150 psi)}}{|5\ \text{bar (75 psi)} - 0\ \text{bar (0 psi)}|} = 2$$

In this example, the TD is 2:1.
This span is based on the zero point.

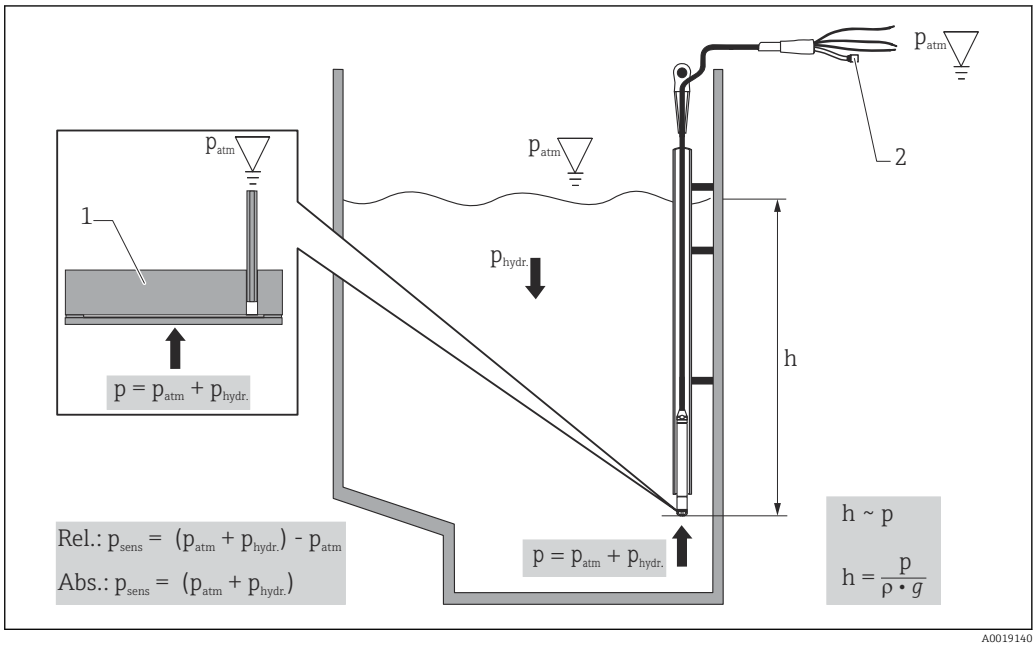
Function and system design

External diameter	22 mm (0.87 in)	42 mm (1.65 in)	Max. 29 mm (1.14 in)
	 A0018640	 A0018641	 A0018642
Field of application	Hydrostatic level measurement in deep wells e.g. drinking water	Hydrostatic level measurement in wastewater	Hydrostatic level measurement in saltwater
	NOTICE **The Waterpilot is not suitable for use in biogas plants since the gases can diffuse through the elastomers (seals, cable).** ▶ For applications involving biogas, Endress+Hauser offers the Deltapilot level measuring device.		
Process connection	▪ Suspension clamp ▪ Cable mounting screw with G 1½" A or NPT 1½" thread		
Extension cable	PE, PUR, FEP → 🖹 45		
Seals	▪ FKM Viton ▪ EPDM [1]	FKM Viton	▪ FKM Viton ▪ EPDM [1]
Measuring ranges	▪ Gauge pressure: 0 to 0.1 bar (0 to 1.5 psi) to 0 to 20 bar (0 to 300 psi) ▪ Absolute pressure: 0 to 2 bar (0 to 30 psi) to 0 to 20 bar (0 to 300 psi)		▪ Gauge pressure: 0 to 0.1 bar (0 to 1.5 psi) to 0 to 4 bar (0 to 60 psi) ▪ Absolute pressure: 0 to 2 bar (0 to 30 psi) to 0 to 4 bar (0 to 60 psi)
	▪ Customer-specific measuring ranges; factory-calibrated. ▪ The following output units can be configured: %, mbar, bar, kPa, MPa, mmH_2O, mH_2O, inH_2O, ftH_2O, psi and numerous level units.		
Overload	To 40 bar (600 psi)		To 25 bar (375 psi)
Process temperature range	−10 to +70 °C (+14 to +158 °F)		0 to +50 °C (+32 to +122 °F)
Reference accuracy	▪ ±0.2 % of set span ▪ Optional: ±0.1 % of set span (PLATINUM version)		
Supply voltage	10.5 to 35 V_{DC}, Ex: 10.5 to 30 V_{DC}		
Output	▪ 4 to 20 mA Analog ▪ 4 to 20 mA HART (can be inverted) with superimposed digital communication protocol HART 6.0, 2-wire		
Options	Drinking water approval	–	
	▪ Wide range of approvals, including ATEX, FM, CSA ▪ Numerous accessories ▪ Integrated Pt100 temperature sensor and TMT71 temperature head transmitter (4 to 20 mA) ▪ Integrated Pt100 temperature sensor and TMT72 temperature head transmitter (4 to 20 mA) ▪ Marine approval		
Specialties	▪ High-precision, robust ceramic measuring cell with long-term stability ▪ Automatic density compensation ▪ Customer-specific cable marking		

1) Recommended for drinking water applications, not suitable for use in hazardous areas.

Measuring principle The ceramic measuring cell is a dry measuring cell i.e. the pressure acts directly on the robust, ceramic process isolating diaphragm of the Waterpilot FMX21. Changes in air pressure are guided

via a pressure compensation tube through the extension cable to the rear of the ceramic process isolating diaphragm and are compensated for. A pressure-dependent change in capacitance, caused by the movement of the process isolating diaphragm, is measured at the electrodes of the ceramic carrier. The electronics unit then converts this to a signal that is proportional to the pressure and linear to the level.



A0019140

1 *Ceramic measuring cell*
2 *Pressure compensation tube*
h *Height level*
p *Total pressure = atmospheric pressure + hydrostatic pressure*
ρ *Density of the medium*
g *Acceleration due to gravity*
$P_{hydr.}$ *Hydrostatic pressure*
P_{atm} *Atmospheric pressure*
P_{sens} *Pressure displayed on the sensor*

Temperature measurement

With optional Pt100 resistance thermometer [1)]

For simultaneous measurement of level and temperature, Endress+Hauser offers the device with an optional 4-wire Pt100 resistance thermometer → 51. The Pt100 is categorized as Accuracy Class B as per DIN EN 60751.

With optional Pt100 and TMT71 temperature head transmitter

To convert the temperature signal to an analog, scalable 4 to 20 mA output signal, Endress+Hauser also offers the TMT71 temperature head transmitter.

Ordering information: → 49; "Accessories" → 51. Technical Information TI01393T.

With optional Pt100 and TMT72 temperature head transmitter [1)]

Endress+Hauser also offers the TMT72 temperature head transmitter with HART protocol for converting the temperature signal to an analog, scalable 4 to 20 mA output signal superimposed with HART 6.0. See also: "Density compensation with Pt100 temperature sensor" → 12

Ordering information: → 49; "Accessories" → 51. Technical Information TI01392T.

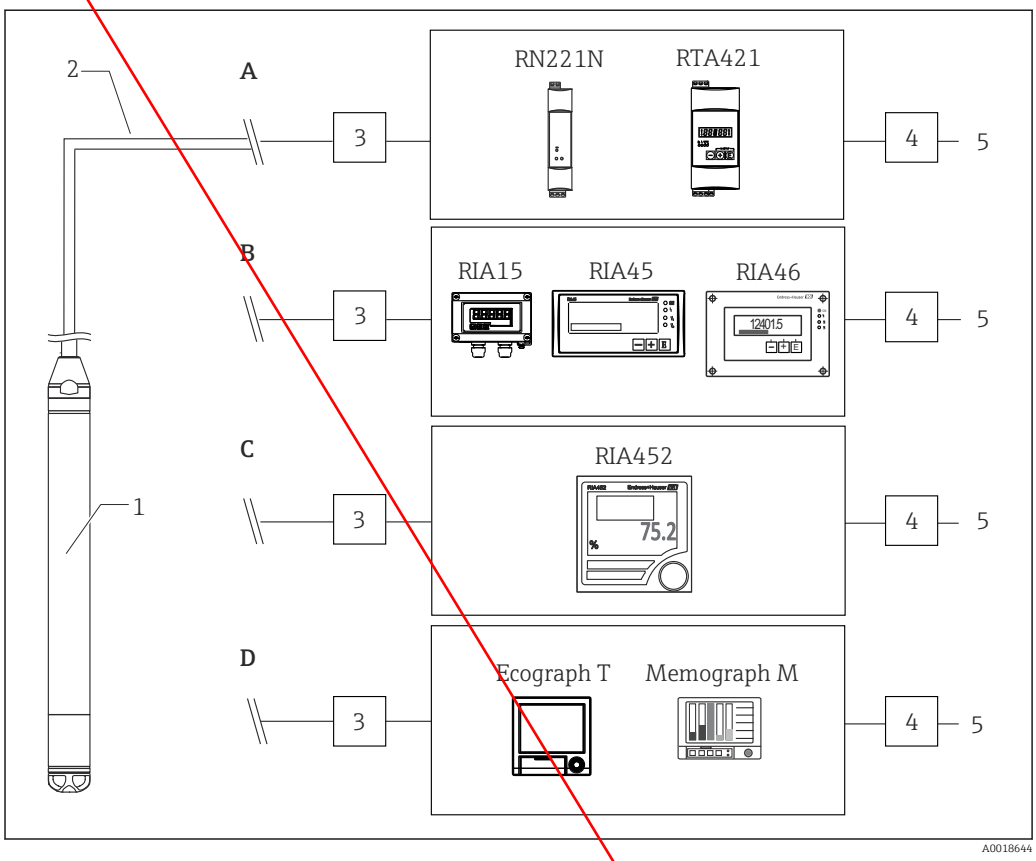
1) Not for use in hazardous areas.

Measuring system

Application examples

As standard, the complete measuring system consists of a device and a transmitter power supply unit with a supply voltage of 10.5 to 30 V_{DC} (hazardous area) or 10.5 to 35 V_{DC} (non-hazardous area).

Possible measuring point solutions with a transmitter and evaluation units from Endress+Hauser:



1 Device
2 4 to 20 mA or 4 to 20 mA HART
3+4 Overvoltage protection, e.g. HAW from Endress+Hauser (not for use in hazardous areas) HAW562; for DIN rail: HAW562/intrinsically safe HAW562Z. Selection in accordance with supply voltage.
5 Power supply

A: Easy and cost-effective measuring point solution: power supplied to the device in hazardous and non-hazardous areas via the RN221N active barrier. Power supply and additional control of two appliances, such as pumps, via the RTA421 limit value switch with local display.

B: The RIA45 evaluation unit (for panel mounting) or the RIA46 evaluation unit (for field installation) offers power supply, local display and two switch outputs. If the RIA15 is used, the basic settings for the HART device can be made via the display module.

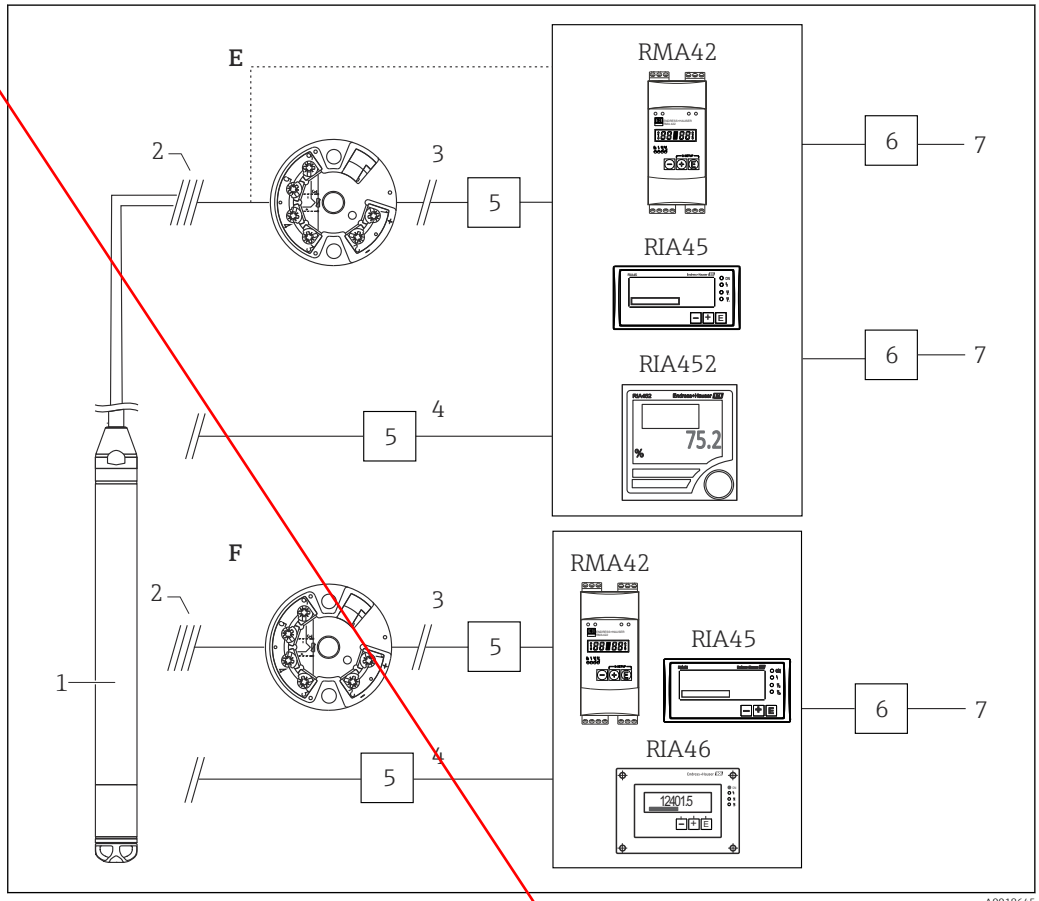
C: If several pumps are used, the pump service life can be prolonged by alternate switching. With alternating pump control, the pump which was out of service for the longest period of time is switched on. The RIA452 evaluation unit (for panel mounting) offers this option in addition to numerous other functions.

D: State-of-the-art recording technology with graphic display recorders from Endress+Hauser, such as Ecograph T, Memograph M for documentation, monitoring, visualization and archiving purposes.

Application examples with the Pt100

As standard, the complete measuring system consists of a device and a transmitter power supply unit with a supply voltage of 10.5 to 30 V_{DC} (hazardous area) or 10.5 to 35 V_{DC} (non-hazardous area).

Possible measuring point solutions with a transmitter and evaluation units from Endress+Hauser:

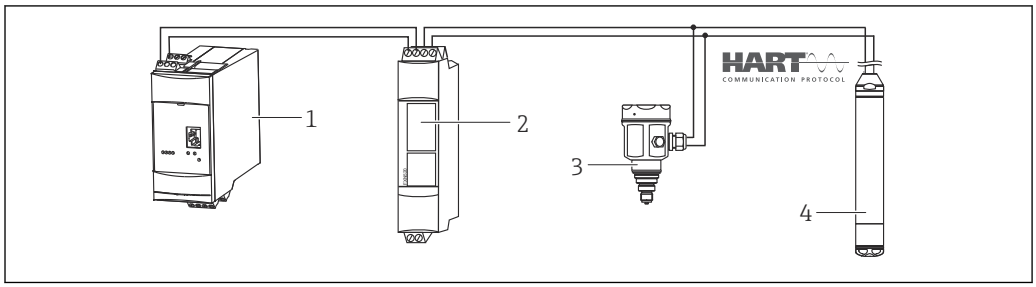


1 *Device*
2 *Connection for integrated Pt100 in the FMX21*
3 *Temperature for 4 to 20 mA or 4 to 20 mA HART*
4 *Level for 4 to 20 mA or 4 to 20 mA HART*
5 *Overvoltage protection, e.g. HAW from Endress+Hauser (not for use in hazardous areas) on the sensor side for field installation: HAW569; for DIN rail: HAW562/intrinsically safe HAW562Z. Selection in accordance with supply voltage.*
6 *Overvoltage protection, e.g. HAW from Endress+Hauser (not for use in hazardous areas) on the supply side for DIN rail: HAW561 (115/230 V) and HAW561K (24/48 V AC/DC). Selection in accordance with supply voltage.*
7 *Power supply*

E: If you wish to measure, display and evaluate the temperature as well as the level, e.g. to monitor the temperature in fresh water for the purpose of detecting temperature limits for germ formation, the options available to you include the following: The optionally available TMT72 temperature head transmitter can convert the Pt100 signal to a 4 to 20 mA signal or a 4 to 20 mA HART signal and transfer it to any commonly used evaluation unit. The RMA42, RIA45 and RIA452 evaluation units also offer a direct input for the Pt100 signal.

F: If you wish to record and evaluate the level and temperature measured value with one device, use the RMA42, RIA45 and RIA46 evaluation units with two inputs. It is even possible to mathematically link the input signals with this unit. These evaluation units are HART-compatible.

Level measurement with absolute pressure probe and external pressure signal



1 *Fieldgate FXA520*
2 *Multidrop Connector FXN520*
3 *Cerabar*
4 *Waterpilot 4 to 20 mA HART*

It is advisable to use an absolute pressure probe for applications in which condensation can occur. For level measurement using an absolute pressure probe, the measured value is affected by fluctuations in the ambient pressure. To correct the resulting measured error, you can connect an external absolute pressure sensor (e.g. Cerabar) to the HART signal line, switch the Waterpilot to burst mode and operate the Cerabar in the "Electr. Delta P" mode. The external absolute pressure sensor then calculates the difference between the two pressure signals and can thus determine the level precisely. Only one level measured value can be corrected in this way.

If using intrinsically safe devices, the regulations for interconnecting intrinsically safe circuits as stipulated in IEC60079-14 (proof of intrinsic safety) must be observed.

Density compensation with the Pt100 temperature sensor

The device can correct measured errors that result from fluctuations in the density of the water caused by temperature. Users can choose from the following options:

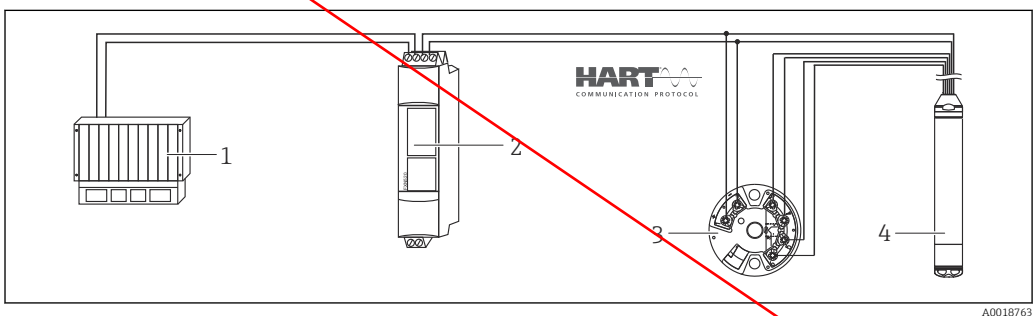
Use the internally measured sensor temperature of the device

The internally measured sensor temperature is calculated in the device for density compensation. The level signal is thus corrected according to the density characteristic line of water.

Use the optional internal temperature sensor for density compensation in a suitable HART master (e.g. PLC)

The device is available with an optional Pt100 temperature sensor. To convert the Pt100 signal to a 4 to 20 mA HART signal, Endress+Hauser also offers the TMT72 temperature head transmitter.

The temperature and pressure signals are queried by a HART master (e.g. PLC), where a corrected level value can be generated using a stored linearization table or density function (of a chosen medium).

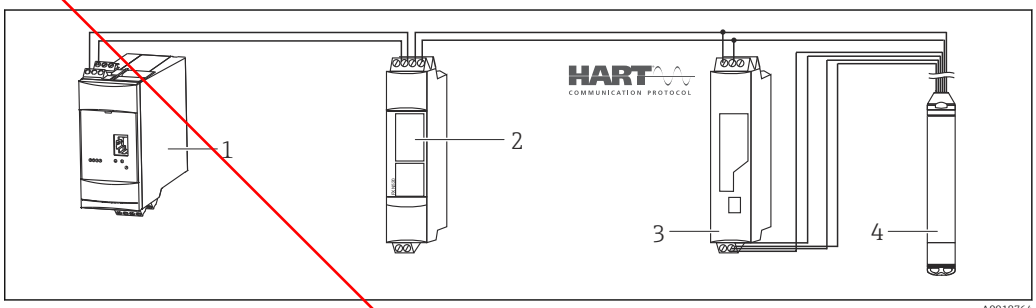


1 *HART master, e.g. PLC (programmable logic controller)*
2 *FXN520 Multidrop Connector*
3 *TMT72 temperature head transmitter*
4 *Waterpilot FMX21 4 to 20 mA HART*

Use an external temperature signal which is transmitted to the device via the HART burst mode

The device is available with an optional Pt100 temperature sensor. With this option, the signal of the Pt100 is evaluated with a HART-compliant temperature transmitter (min. HART 5.0) that supports the BURST mode. The temperature signal can be transmitted to the device in this way. The device uses this signal for density correction of the level signal.

The TMT72 temperature head transmitter is not suitable for this configuration.



1 Fieldgate FXA520
2 Multidrop Connector FXN520
3 HART-compatible temperature transmitter with burst function (e.g. TMT82)
4 Waterpilot FMX21 4 to 20 mA HART

Without additional compensation due to the anomaly of water, errors of up to 4 % may occur at a temperature of +70 °C (+158 °F), for example. With density compensation, this error is less than 0.5 % in the entire temperature range from 0 to +70 °C (+32 to +158 °F).

More information can be found in the Technical Information:

- TI01010T: TMT82 temperature transmitter (4 to 20 mA HART)
- TI00369F: Fieldgate FXA520
- TI00400F: Multidrop Connector FXN520

Communication protocol

- 4 to 20 mA analog
- 4 to 20 mA HART

System integration

The device can be given a tag name.

Input

Measured variable

FMX21 + Pt100 (optional)

- Hydrostatic pressure of a liquid
- Pt100: Temperature

TMT71 temperature head transmitter (optional)

Temperature

TMT72 temperature head transmitter (optional)

Temperature

Measuring range

- Customer-specific measuring ranges or calibration that has been preset in the factory
- Temperature measurement of −10 to +70 °C (+14 to +158 °F) with Pt100 (optional)

Gauge pressure

Sensor measuring range	Lowest calibratable span [1]	Vacuum resistance	Option [2]
0.1 bar (1.5 psi)	0.01 bar (0.15 psi)	0.3 bar $_{abs}$ (4.5 psi $_{abs}$)	1C
0.2 bar (3.0 psi)	0.02 bar (0.3 psi)	0.3 bar $_{abs}$ (4.5 psi $_{abs}$)	1D
0.4 bar (6.0 psi)	0.04 bar (1.0 psi)	0 bar $_{abs}$ (0 psi $_{abs}$)	1F
0.6 bar (9.0 psi)	0.06 bar (1.0 psi)	0 bar $_{abs}$ (0 psi $_{abs}$)	1G
1.0 bar (15.0 psi)	0.1 bar (1.5 psi)	0 bar $_{abs}$ (0 psi $_{abs}$)	1H
2.0 bar (30.0 psi)	0.2 bar (3.0 psi)	0 bar $_{abs}$ (0 psi $_{abs}$)	1K
4.0 bar (60.0 psi)	0.4 bar (6.0 psi)	0 bar $_{abs}$ (0 psi $_{abs}$)	1M
10.0 bar (150 psi) [3]	1.0 bar (15.0 psi)	0 bar $_{abs}$ (0 psi $_{abs}$)	1P
20.0 bar (300 psi) [3]	2.0 bar (30.0 psi)	0 bar $_{abs}$ (0 psi $_{abs}$)	1Q

1) Largest turn down that can be configured at the factory: 10:1, higher turn down can be configured on request or in the device (for FMX21 4 to 20 mA HART).
2) Product Configurator order code for "070"
3) These measuring ranges are not available for the probe version with plastic insulation, outer diameter of 29 mm (1.14 in).

Absolute pressure

Sensor measuring range	Lowest calibratable span [1]	Vacuum resistance	Option [2]
2.0 bar (30.0 psi)	0.2 bar (3.0 psi)	0 bar $_{abs}$ (0 psi $_{abs}$)	2K
4.0 bar (60.0 psi)	0.4 bar (6.0 psi)	0 bar $_{abs}$ (0 psi $_{abs}$)	2M
10.0 bar (150 psi) [3]	1.0 bar (15.0 psi)	0 bar $_{abs}$ (0 psi $_{abs}$)	2P
20.0 bar (300 psi) [3]	2.0 bar (30.0 psi)	0 bar $_{abs}$ (0 psi $_{abs}$)	2Q

1) Largest turn down that can be configured at the factory: 10:1, higher turn down can be configured on request or in the device (for FMX21 4 to 20 mA HART).
2) Product Configurator order code for "070"
3) These measuring ranges are not available for the probe version with plastic insulation, outer diameter of 29 mm (1.14 in).

Input signal

FMX21 + Pt100 (optional)

- Change in capacitance
- Pt100: Change in resistance

TMT71 temperature head transmitter (optional)

Pt100 resistance signal, 4 wire

TMT72 temperature head transmitter (optional)

Pt100 resistance signal, 4 wire

Output

Output signal

Device + Pt100 (optional)

- 4 to 20 mA Analog, 2-wire for hydrostatic pressure measured value.
- 4 to 20 mA HART with superimposed digital communication protocol HART 6.0, 2-wire for hydrostatic pressure measured value.
  Options:
  - Max. alarm (factory setting 22 mA): can be set from 21 to 23 mA
  - Hold measured value: last measured value is held
  - Min. alarm: 3.6 mA
- Pt100: temperature-dependent resistance value

TMT71 temperature head transmitter (optional)

4 to 20 mA analog for temperature measured value, 2-wire

TMT72 temperature head transmitter (optional)

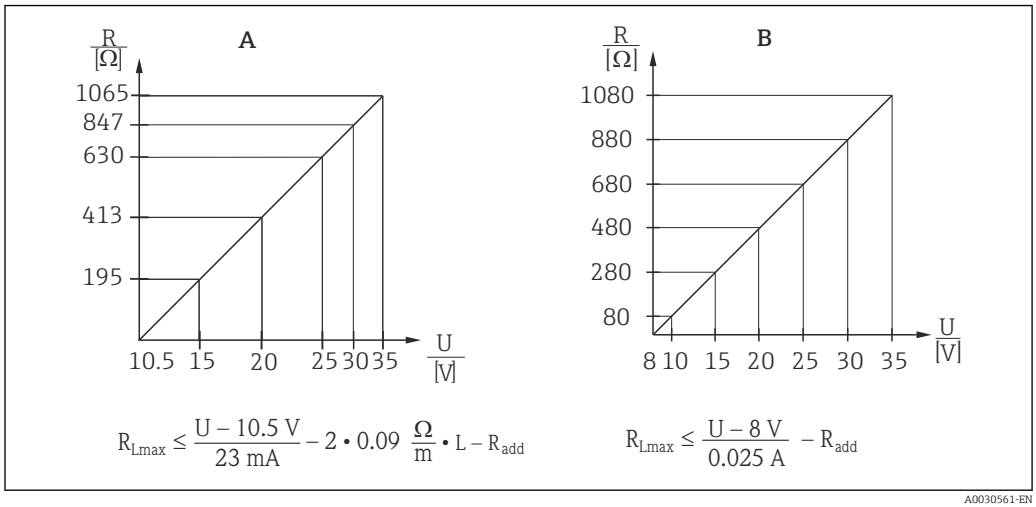
4 to 20 mA HART with superimposed digital communication protocol HART 5.0 for temperature measured value, 2-wire

Signal range

3.8 to 20.5 mA

Maximum load

The maximum load resistance depends on the supply voltage (U) and must be determined individually for each current loop, see formula and diagrams for the device and temperature head transmitter. The total resistance resulting from the resistances of the connected devices, the connecting cable and, where applicable, the resistance of the extension cable may not exceed the load resistance value.



A0030561-EN

A Load diagram for device 4 to 20 mA analog for an approximate calculation of the load resistance. Additional resistances, such as the resistance of the extension cable, have to be subtracted from the value calculated as shown in the equation.

B Load diagram for TMT71 temperature head transmitter for estimating the load resistance. Additional resistances must be subtracted from the value calculated as shown in the equation

R_{Lmax} *Max. load resistance [Ω]*

R_{add} *Additional resistances such as resistance of evaluating device and/or display unit, cable resistance [Ω]*

U Supply voltage [V]

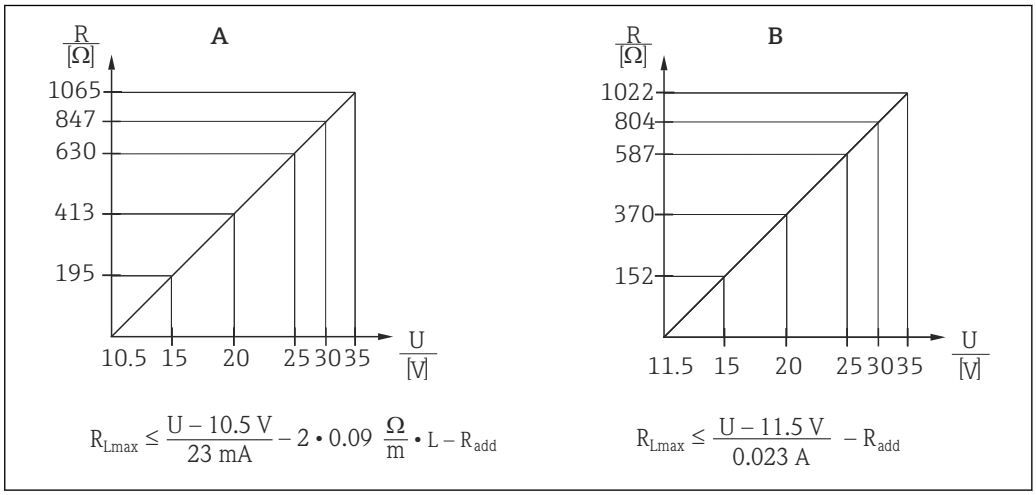
L Basic length of extension cable [m] (cable resistance per wire ≤0.09 Ω/m

When using the measuring device in hazardous areas, installation must comply with the corresponding national standards and regulations and the Safety Instructions or Installation or Control Drawings (XA).

Maximum load

The maximum load resistance depends on the supply voltage (U) and must be determined individually for each current loop, see formula and diagrams for the device and temperature head transmitter. The total resistance resulting from the resistances of the connected devices, the

connecting cable and, where applicable, the resistance of the extension cable may not exceed the load resistance value.



A Load diagram for device 4 to 20 mA HART for an approximate calculation of the load resistance. Additional resistances, such as the resistance of the extension cable, have to be subtracted from the value calculated as shown in the equation.

B Load diagram for TMT72 temperature head transmitter for estimating the load resistance. Additional resistances must be subtracted from the value calculated as shown in the equation

R_{Lmax} Max. load resistance [Ω]

R_{add} Additional resistances such as resistance of evaluating device and/or display unit, cable resistance [Ω]

U Supply voltage [V]

L Basic length of extension cable [m] (cable resistance per wire ≤0.09 Ω/m

- When using the measuring device in hazardous areas, installation must comply with the corresponding national standards and regulations and the Safety Instructions or Installation or Control Drawings (XA).
- When operating via a handheld terminal or via a PC with an operating program, a minimum communication resistance of 250 Ω must be taken into account.

Damping

- Via HART handheld terminal or PC with operating program: continuously 0 to 999 s
- Factory setting: 2 s

Protocol-specific data

- Manufacturer ID: 17 (11 hex)
- Device type ID: 25 (19 hex)
- Device revision: 01 (01 hex) - SW version 01.00.zz
- HART specification: 6
- DD revision: 01
- Device description files (DTM, DD):
  - www.endress.com
  - www.fieldcommgroup.org
- HART load: min. 250 Ω
- HART device variables. The dynamic variables SV, TV and QV may be assigned to any device variable:
  - Standard process values for SV, TV (second and third device variable) are dependent on the measuring mode: pressure, level
  - Standard process value for QV (fourth device variable) is the sensor temperature: temperature
  - Measured values for PV (first device variable) are dependent on the measuring mode: pressure, level, tank content
- Supported functions:
  - Burst mode
  - Additional transmitter status
  - Device locking
  - Alternative measuring modes
  - Catch variable
  - Long tag

Power supply

⚠ WARNING

Electrical safety is compromised by an incorrect connection!

- When using the measuring device in a hazardous area, the relevant national standards and guidelines as well as the Safety Instructions (XAs) or installation or control drawings (ZDs) must be adhered to. All data relating to explosion protection can be found in separate documentation which is available on request. This documentation is supplied with the devices as standard → 🖹 55

Supply voltage

Device ~~+ Pt100 (optional)~~

- 10.5 to 35 V (non-hazardous area)
- 10.5 to 30 V (hazardous area)

~~TMT71 temperature head transmitter (optional)~~

8 to 35 V_{DC}

TMT72 temperature head transmitter (optional)

11.5 to 35 V_{DC}

Power consumption

Device ~~+ Pt100 (optional)~~

- ≤ 0.805 W at 35 V_{DC} (non-hazardous area)
- ≤ 0.690 W at 30 V_{DC} (hazardous area)

~~TMT71 temperature head transmitter (optional)~~

≤ 0.875 W at 35 V_{DC}

TMT72 temperature head transmitter (optional)

≤ 0.805 W at 35 V_{DC}

Current consumption

Device ~~+ Pt100 (optional)~~

Max. current consumption: ≤ 23 mA
Min. current consumption: ≥ 3.6 mA

~~TMT71 temperature head transmitter (optional)~~

- Max. current consumption: ≤ 25 mA
- Min. current consumption: ≥ 3.5 mA

TMT72 temperature head transmitter (optional)

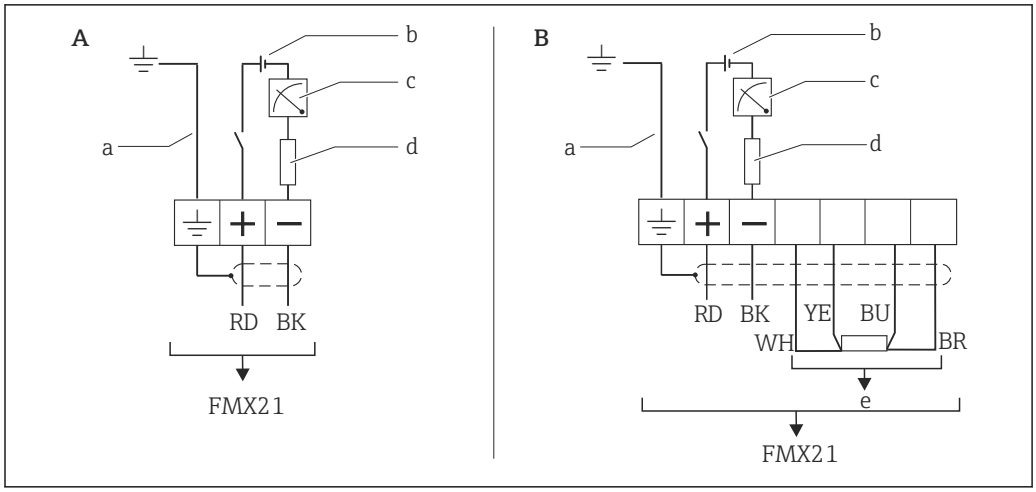
- Max. current consumption: ≤ 23 mA
- Min. current consumption: ≥ 3.5 mA

Connecting the device

- Reverse polarity protection is integrated in the device and the temperature head transmitter. Changing the polarities will not result in damage to the devices.
- The cable must end in a dry room or a suitable terminal box. The terminal box (IP66, IP67) with GORE-TEX® filter from Endress+Hauser is suitable for outdoor installation. The terminal box can be ordered as an accessory via the device order code.

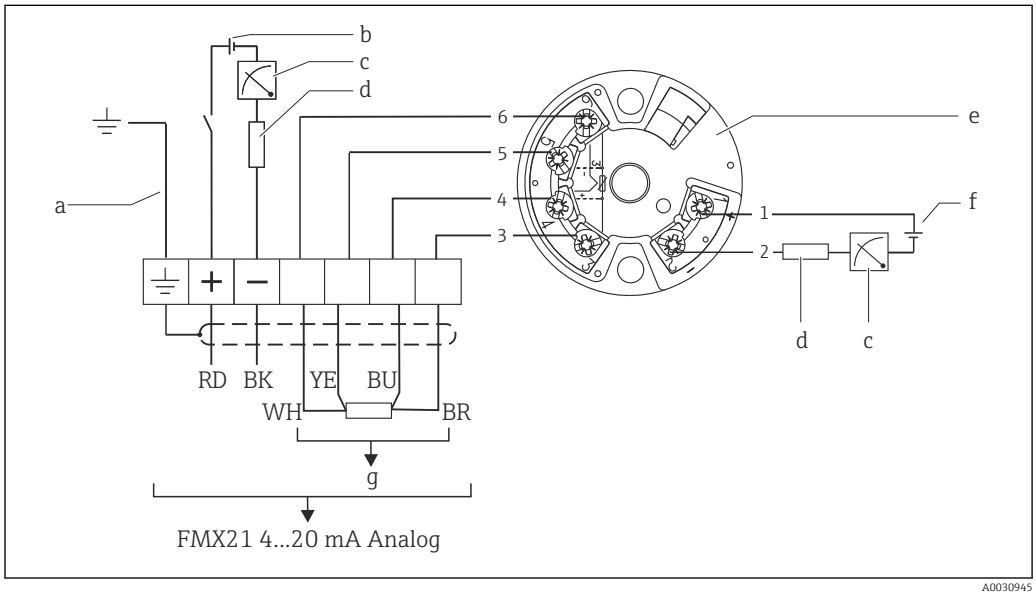
The electrical connection is established with the corresponding wires of the probe cable and with the optional use of the terminal box → 🖹 36 and a power supply (e.g. RN221N active barrier → 🖹 10).

Device with Pt100



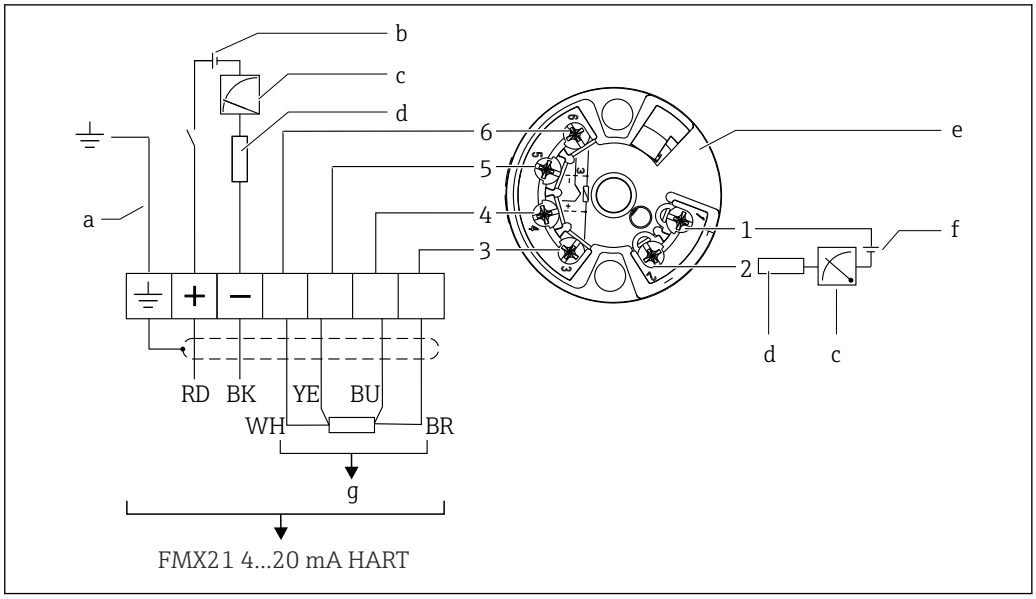
A Device
B Device with Pt100 (not for use in hazardous areas)
a Not for devices with external diameter of 29 mm (1.14 in)
b 10.5 to 30 V_{DC} (hazardous area), 10.5 to 35 V_{DC}
c 4 to 20 mA
d Resistance (R_L)
e Pt100

Device with Pt100 and TMT71 temperature head transmitter



a Not for devices with external diameter of 29 mm (1.14 in)
b 10.5 to 35 V_{DC}
c 4 to 20 mA
d Resistance (R_L)
e TMT71 temperature head transmitter (4 to 20 mA) (not for use in hazardous areas)
f 8 to 35 V_{DC}
g Pt100
1 to 6 Pin assignment

Device with Pt100 and TMT72 temperature head transmitter



a *Not for devices with external diameter of 29 mm (1.14 in)*
b *10.5 to 35 V_{DC}*
c *4 to 20 mA*
d *Resistance (R_L)*
e *TMT72 temperature head transmitter (4 to 20 mA) (not for use in hazardous areas)*
f *11.5 to 35 V_{DC}*
g *Pt100*
1 to 6 *Pin assignment*

Device with RIA15

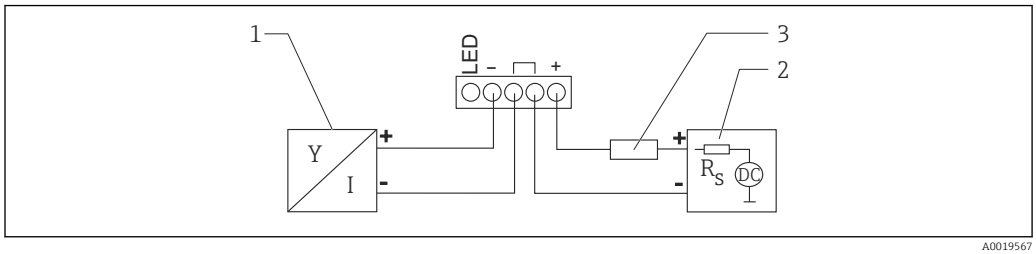
The RIA15 remote display (for Ex or non-Ex area) can be ordered together with the device. See the Product Configurator.

Compensation of the atmospheric pressure must be ensured for the installation. A black, vented cable gland is supplied for this purpose.

The RIA15 process indicator is loop-powered and does not require any external power supply.

The voltage drop to be taken into account is:
- ≤1 V in the standard version with 4 to 20 mA communication
- ≤1.9 V with HART communication
- and an additional 2.9 V if display light is used

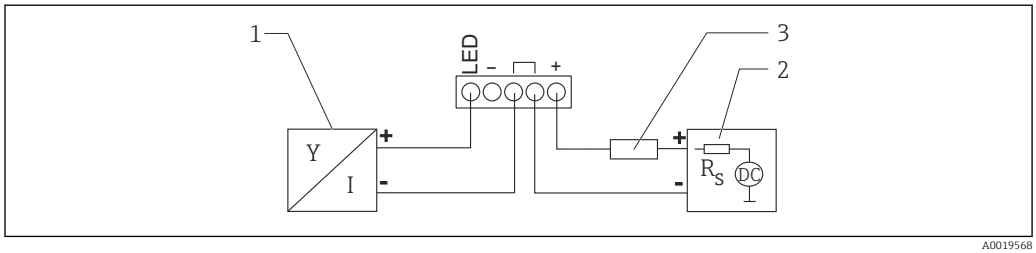
Without backlighting



1 Block diagram; connection of the device with HART communication and RIA15 without backlighting

1 Device
2 Power supply
3 HART resistor

With backlighting



2 Block diagram; connection of the device with HART communication and RIA15 with backlighting

1 Device
2 Power supply
3 HART resistor

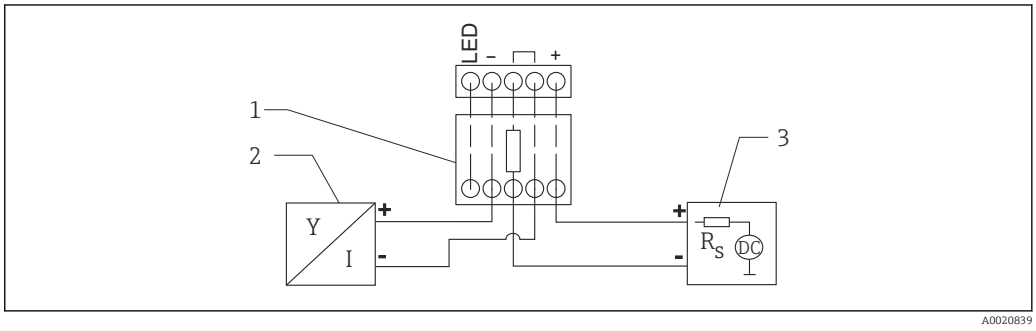
Device, RIA15 with installed HART communication resistor module

The HART communication module for installation in the RIA15 (for Ex or non-Ex areas) can be ordered together with the device.

The **voltage drop** to be taken into account is max. **7 V**

Compensation of the atmospheric pressure must be ensured for the installation. A black, vented cable gland is supplied for this purpose.

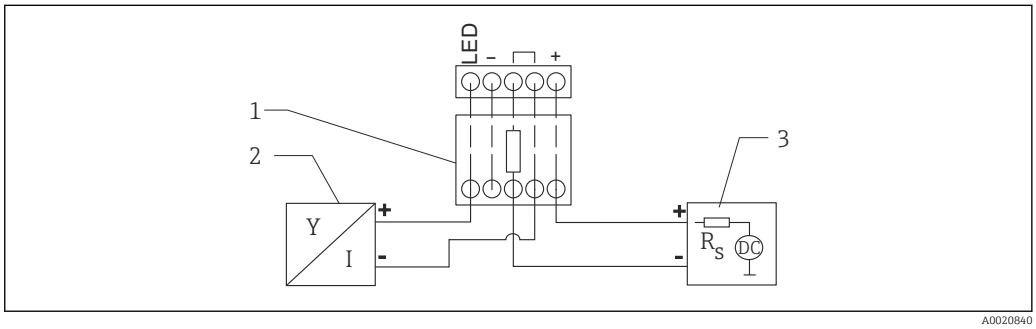
Without backlighting



3 *Block diagram; device connection, RIA15 without light, HART communication resistor*

1 *HART communication resistor module*
2 *Device*
3 *Power supply*

With backlighting



4 *Block diagram; device connection, RIA15 with light, HART communication resistor module*

1 *HART communication resistor module*
2 *Device*
3 *Power supply*

Wire colors

RD = red, BK = black, WH = white, YE = yellow, BU = blue, BR = brown

Connection data

Connection classification as per IEC 61010-1:
- Overvoltage category 1
- Pollution level 1

Connection data in the hazardous area

See relevant XA.

Terminals in the terminal box

- Three terminals as standard in the terminal box (terminal box can optionally be ordered as an enclosed accessory → 🖹 51)
- 4-terminal strip can be ordered as an accessory, order number: 52008938 cable cross-section 0.08 to 2.5 mm² (28 to 14 AWG)

The 4-terminal strip is not designed for use in hazardous areas incl. CSA GP.

Probe cable

- Overall external diameter: 8 mm (0.31 in)±0.25 mm (0.01 in)
- Pressure compensation tube with Teflon filter: External diameter of 2.5 mm (0.1 in), internal diameter of 1.5 mm (0.06 in)

Cross-section

- Device: 3 x 0.2 mm² (3 x 26 AWG) + pressure compensation tube with Teflon filter
- Device with Pt100 (optional): 7 x 0.2 mm² (7 x 26 AWG) + pressure compensation tube with Teflon filter

Cable resistance

Per wire: ≤ 0.09 Ω/m

Cable specifications

Endress+Hauser recommends using shielded, twisted-pair two-wire cables.

The probe cables are shielded for device versions with outer diameters of 22 mm (0.87 in) and 42 mm (1.65 in).

Device + Pt100 (optional)

- Commercially available instrument cable
- Terminals, terminal box: 0.08 to 2.5 mm² (28 to 14 AWG)

TMT71 temperature head transmitter (optional)

- Commercially available instrument cable
- Terminals, terminal box: 0.08 to 2.5 mm² (28 to 14 AWG)
- Transmitter connection: max. 1.75 mm² (15 AWG)

TMT72 temperature head transmitter (optional)

- Commercially available instrument cable
- Terminals, terminal box: 0.08 to 2.5 mm² (28 to 14 AWG)
- Transmitter connection: max. 1.75 mm² (15 AWG)

Residual ripple

Device + Pt100 (optional)

No impact on the 4 to 20 mA signal to ±5 % residual ripple within the permitted voltage range.

TMT71 temperature head transmitter (optional)

$U_{ss} \geq 5$ V at $U \geq 13$ V, $f_{max.} = 1$ kHz

Residual ripple

Device + Pt100 (optional)

No impact on the 4 to 20 mA signal to ±5 % residual ripple within the permitted voltage range (according to HART Hardware Specification HCF_SPEC-54 (DIN IEC 60381-1)).

TMT72 temperature head transmitter (optional)

$U_{ss} \geq 3$ V at $U \geq 13$ V, $f_{max.} = 1$ kHz

Performance characteristics

Reference operating conditions

Device ~~+ Pt100 (optional)~~

- As per IEC 60770
- Ambient temperature T_A = constant, in the range of: +21 to +33 °C (+70 to +91 °F)
- Humidity φ = constant, in the range of: 20 to 80 % rH
- Atmospheric pressure p_A = constant, in the range of: 860 to 1060 mbar (12.47 to 15.37 psi)
- Position of the measuring cell constant, vertical in the range of ±1 °
- Input of LOW SENSOR TRIM and HIGH SENSOR TRIM for lower range value and upper range value (only for HART)
- Supply voltage constant: 21 to 27 V_{DC}
- Load: 250 Ω
- Pt100: DIN EN 60770, T_A = +25 °C (+77 °F)

TMT71 temperature head transmitter (optional)

Calibration temperature: +23 °C (+73 °F) ±5 K

TMT72 temperature head transmitter (optional)

Calibration temperature: +25 °C (+77 °F) ±5 K

Reference accuracy

Device ~~+ Pt100 (optional)~~

The reference accuracy comprises the non-linearity after limit point configuration, hysteresis and non-reproducibility in accordance IEC 60770.

Standard version:
Setting ±0.2 %
- to TD 5:1: < 0.2 % of set span
- from TD 5:1 to TD 20:1 ±(0.02 x TD+0.1)

Platinum version:
- Setting ±0.1 % (optional)
  - to TD 5:1: < 0.1 % of set span
  - from TD 5:1 to TD 20:1 ±(0.02 x TD)
- Class B as per DIN EN 60751
  Pt100: max. ±1 K

TMT71 temperature head transmitter (optional)

- ±0.2 K
- With Pt100: max. ±0.9 K

TMT72 temperature head transmitter (optional)

- ±0.2 K
- With Pt100: max. ±0.9 K

Resolution

Current output: 1 µA

Reading cycle

HART commands: on average 2 to 3 per second

Long-term stability

Device + ~~Pt100 (optional)~~

- ≤ 0.1 % of URL/year
- ≤ 0.25 % of URL/5 years

~~TMT71 temperature head transmitter (optional)~~

≤ 0.1 K per year

~~TMT72 temperature head transmitter (optional)~~

≤ 0.1 K per year

Influence of medium temperature

- Thermal change in the zero output and the output span:
  0 to 30 °C (+32 to 86 °F): < (0.15 + 0.15 x TD)% of set span
  −10 to +70 °C (+14 to 158 °F): < (0.4 + 0.4 x TD)% of set span
- Temperature coefficient (T_K) of the zero output and the output span
  −10 to +70 °C (+14 to 158 °F): 0.1 % / 10 K of URL

Warm-up time

Device + ~~Pt100 (optional)~~

- Device: < 6 s
- Pt100: 300 s

~~TMT71 temperature head transmitter (optional)~~

4 s

~~TMT72 temperature head transmitter (optional)~~

4 s

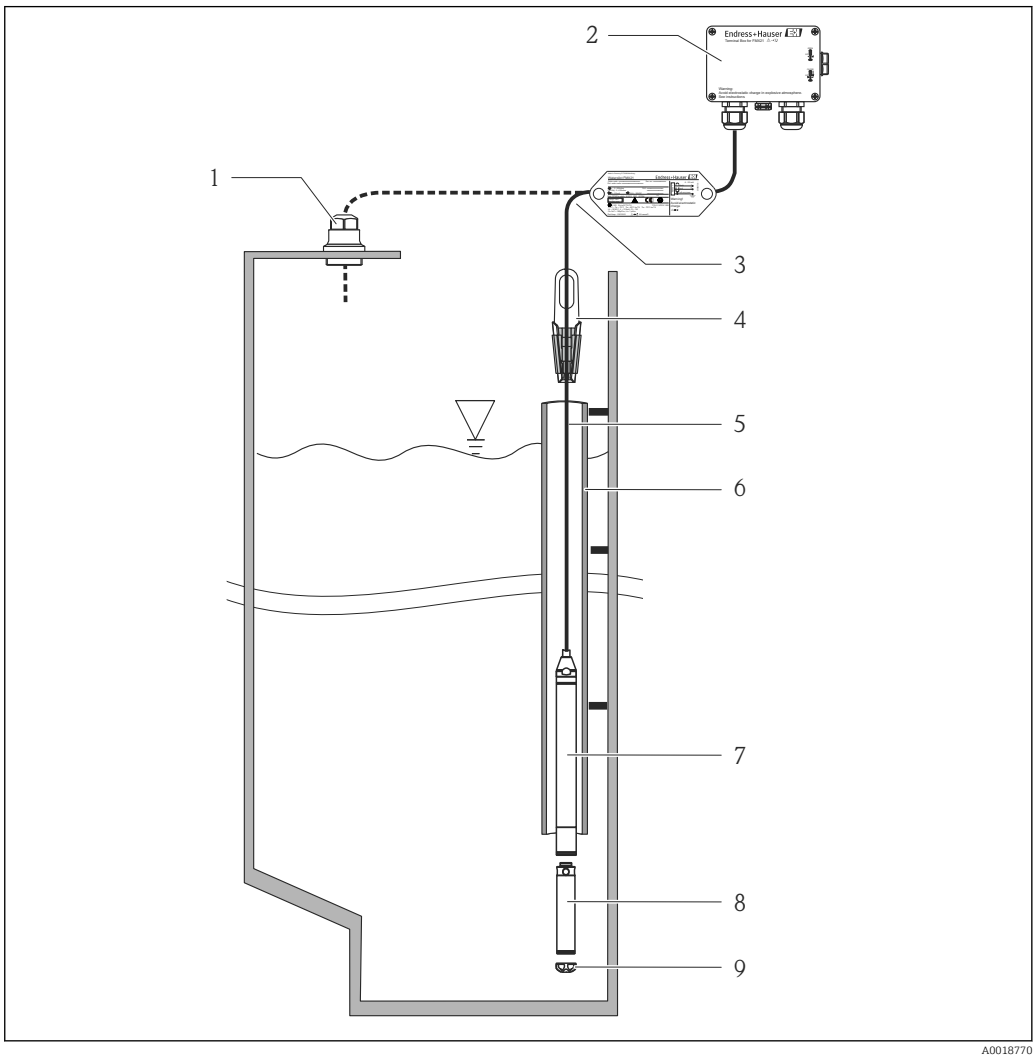
Response time

Device + ~~Pt100 (optional)~~

- Device: 400 ms (T90 time), 500 ms (T99 time)
- Pt100: 160 s (T90 time), 300 s (T99 time)

Mounting

Installation instructions

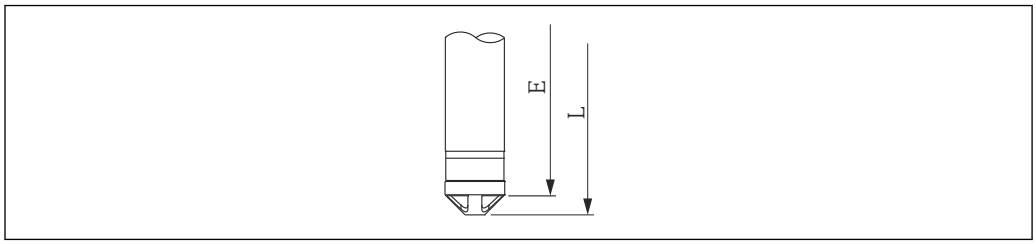


1 *Cable mounting screw can be ordered via the order code or as an accessory → 📄 51*
2 *Terminal box can be ordered via the order code or as an accessory → 📄 51*
3 *Bending radius of extension cable 120 mm (4.72 in)*
4 *Suspension clamp can be ordered via the order code or as an accessory → 📄 51*
5 *Extension cable, cable length → 📄 28*
6 *Guide tube*
7 *Device*
8 *Additional weight can be ordered as an accessory for the device with external diameter of 22 mm (0.87 in) and 29 mm (1.14 in)→ 📄 51*
9 *Protective cap*

Additional installation instructions

- Sideways movement of the level probe can result in measuring errors. For this reason, install the probe at a point free from flow and turbulence, or use a guide tube. The internal diameter of the guide tube should be at least 1 mm (0.04 in) greater than the external diameter of the selected FMX21.
- To avoid mechanical damage to the measuring cell, the device is equipped with a protection cap.
- The cable must end in a dry room or a suitable terminal box. The terminal box from Endress +Hauser provides humidity and climatic protection and is suitable for installation outdoors → 📄 51.
- Cable length tolerance: < 5 m (16 ft): ±17.5 mm (0.69 in); > 5 m (16 ft): ±0.2 %
- If the cable is shortened, the filter at the pressure compensation tube must be reattached. Endress +Hauser offers a cable shortening kit for this purpose → 📄 51 (documentation SD00552P/00/A6).

- Endress+Hauser recommends using twisted, shielded cable.
- In shipbuilding applications, measures are required to restrict the spread of fire along cable looms.
- The length of the extension cable depends on the intended level zero point. The height of the protection cap must be taken into consideration when designing the layout of the measuring point. The level zero point (E) corresponds to the position of the process isolating diaphragm.
  Level zero point = E; tip of probe = L (see the following diagram).
  For dimensions, see "Mechanical construction" section.

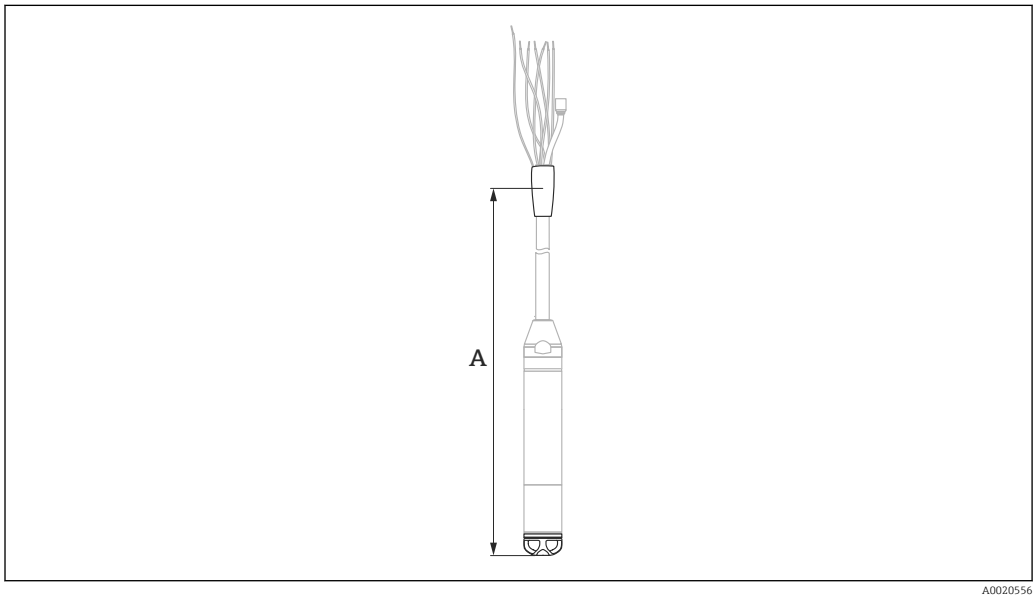


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Cable length

- Pay attention to the "Load"
- Cable lengths available for order
  - Customer-specific in meters or feet
  - Limited cable length when performing installation with freely suspended device with cable mounting screw or suspension clamp, as well as for Ex approval: max. 300 m (984 ft).

When using the measuring device in hazardous areas, installation must also comply with the applicable national standards and regulations and the Safety Instructions or Installation or Control Drawings.



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A Length of extension cable

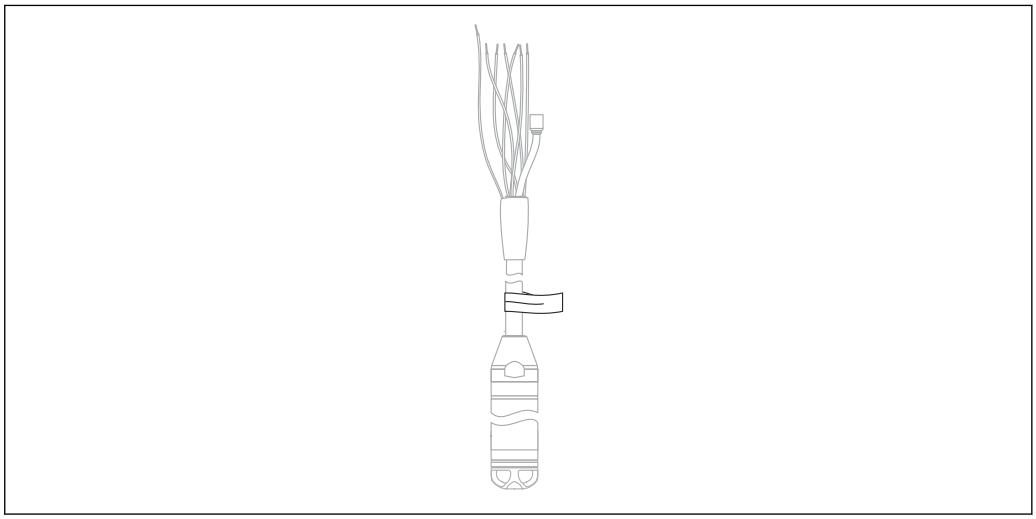
The following cable lengths can be selected in the Product Configurator:
- 10 m cable, can be shortened, PE
- 20 m cable, can be shortened, PE
- ..... m cable, can be shortened, PE
- 30 ft cable, can be shortened, PE
- 60 ft cable, can be shortened, PE
- ..... ft cable, can be shortened, PE
- 10 m cable, can be shortened, FEP
- 20 m cable, can be shortened, FEP
- ..... m cable, can be shortened, FEP
- 30 ft cable, can be shortened, FEP
- 60 ft cable, can be shortened, FEP
- ..... ft cable, can be shortened, FEP
- 10 m cable, can be shortened, PUR

- 20 m cable, can be shortened, PUR
- ..... m cable, can be shortened, PUR
- 30 ft cable, can be shortened, PUR
- 60 ft cable, can be shortened, PUR
- ..... ft cable, can be shortened, PUR

Technical data for cable

- Minimum bending radius: 120 mm (4.72 in)
- Tensile strength: max. 950 N (213.56 lbf)
- Cable extraction force (= tensile force required to extract the cable from the probe):
  - PE, FEP: typically ≥ 400 N (89.92 lbf), PUR: typically ≥ 150 N (33.72 lbf)
  - when used in hazardous area: ≥ 100 N (73.75 lbf)
- UV-resistant (UV = ultraviolet)
- PE: For use in drinking water

Cable marking



A0030955

- To make installation easier, Endress+Hauser marks the extension cable if a customer-specific length has been ordered.
- Cable marking tolerance (distance to lower end of level probe):
  Cable length < 5 m (16 ft): ±17.5 mm (0.69 in)
  Cable length > 5 m (16 ft): ±0.2 %
- Material: PET, stick-on label: acrylic
- Immunity to temperature change: −30 to +100 °C (−22 to +212 °F)

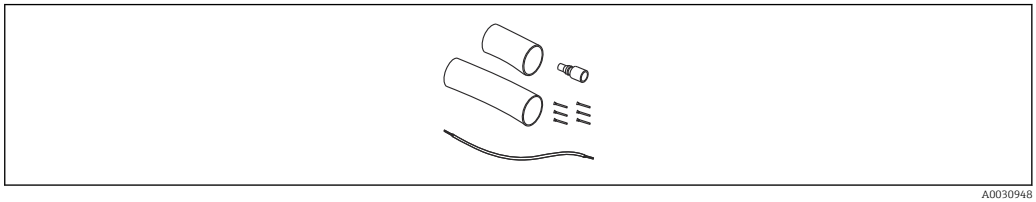
NOTICE

The marking is used exclusively for installation purposes.

▶ The mark must be thoroughly removed without trace in the case of devices with drinking water approval. The extension cable must not be damaged in the process.

Not for the use of the device in hazardous areas.

Cable shortening kit



A0030948

The cable shortening kit is used to shorten a cable easily and professionally.

The cable shortening kit is not designed for the device with FM/CSA approval.

- Ordering information: see Product Configurator
- Associated documentation SD00552P/00/A6.

Environment

Ambient temperature range

Device + Pt100 (optional)

- With external diameter of 22 mm (0.87 in) and 42 mm (1.65 in):
  −10 to +70 °C (+14 to +158 °F) (= medium temperature)
- With external diameter of 29 mm (1.14 in):
  0 to +50 °C (+32 to +122 °F) (= medium temperature)

Cable

(when mounted in a fixed position)
- With PE: −30 to +70 °C (−22 to +158 °F)
- With FEP: −40 to +70 °C (−40 to +158 °F)
- With PUR: −40 to +70 °C (−40 to +158 °F)

Terminal box

−40 to +80 °C (−40 to +176 °F)

TMT71 temperature head transmitter (optional)

−40 to +85 °C (−40 to +185 °F)

Temperature head transmitter 2-wire, configured for a measuring range of −20 to +80 °C (−4 to +176 °F). This configuration offers a temperature range of 100 K which can be easily mapped. Please note that the Pt100 resistance temperature detector is suitable for a temperature range of −10 to +70 °C (14 to +158 °F)

The TMT71 temperature head transmitter is not designed for use in hazardous areas incl. CSA GP.

TMT72 temperature head transmitter (optional)

−40 to +85 °C (−40 to +185 °F)

Temperature head transmitter 2-wire, configured for a measuring range of −20 to +80 °C (−4 to +176 °F). This configuration offers a temperature range of 100 K which can be easily mapped. Please note that the Pt100 resistance temperature detector is suitable for a temperature range of −10 to +70 °C (14 to +158 °F)

The TMT72 temperature head transmitter is not designed for use in hazardous areas incl. CSA GP.

Storage temperature range

Device + Pt100 (optional)

−40 to +80 °C (−40 to +176 °F)

Cable

(when mounted in a fixed position)
- With PE: −30 to +70 °C (−22 to +158 °F)
- With FEP: −30 to +80 °C (−22 to +176 °F)
- With PUR: −40 to +80 °C (−40 to +176 °F)

Terminal box

−40 to +80 °C (−40 to +176 °F)

TMT71 temperature head transmitter (optional)

−40 to +100 °C (−40 to +212 °F)

TMT72 temperature head transmitter (optional)

−40 to +100 °C (−40 to +212 °F)

Degree of protection

Device + Pt100 (optional)

IP68, permanently hermetically sealed at 20 bar (290 psi) (~200 m H_2O)

Terminal box (optional)

IP66, IP67

TMT71 temperature head transmitter (optional)

IP00, condensation permitted

When installed in the optional terminal boxes: IP66/IP67

TMT72 temperature head transmitter (optional)

IP00, condensation permitted

Electromagnetic compatibility (EMC)

Device + Pt100 (optional)

- EMC in accordance with all relevant requirements of EN 61326 series. For details, refer to the Declaration of Conformity.
- Maximum deviation: < 0.5 % of span.

TMT71 temperature head transmitter (optional)

Interference emission to EN 61326 Class B equipment, interference immunity to EN 61326 Appendix A (Industrial). For details, refer to the Declaration of Conformity.

TMT72 temperature head transmitter (optional)

EMC in accordance with all relevant requirements of EN 61326 series. For details, refer to the Declaration of Conformity.

Overvoltage protection

FMX21 + Pt100 (optional)

- Integrated overvoltage protection as per EN 61000-4-5 (500 V symmetrical/1000 V asymmetrical)
- Provide overvoltage protection ≥ 1.0 kV, externally if necessary.

TMT71 temperature head transmitter (optional)

Provide overvoltage protection, externally if necessary → 10.

TMT72 temperature head transmitter (optional)

Provide overvoltage protection, externally if necessary → 10.

Process

Medium temperature range

Device + Pt100 (optional)

- With external diameter of 22 mm (0.87 in) and 42 mm (1.65 in):
  −10 to +70 °C (+14 to +158 °F)
- With external diameter of 29 mm (1.14 in):
  0 to +50 °C (+32 to +122 °F)

TMT71 temperature head transmitter (optional)

−40 to +85 °C (−40 to +185 °F)

(= ambient temperature), install temperature head transmitter outside the medium.

Temperature head transmitter 2-wire, configured for a measuring range of −20 to +70 °C (−4 to +158 °F). This configuration offers a temperature range of 100 K which can be easily mapped. Please note that the Pt100 resistance temperature detector is suitable for a temperature range of −10 to +70 °C (14 to +158 °F)

The TMT71 temperature head transmitter is not designed for use in hazardous areas incl. CSA GP.

TMT72 temperature head transmitter (optional)

−40 to +85 °C (−40 to +185 °F)

(= ambient temperature), install temperature head transmitter outside the medium.

Temperature head transmitter 2-wire, configured for a measuring range of −20 to +80 °C (−4 to +176 °F). This configuration offers a temperature range of 100 K which can be easily mapped. Please note that the Pt100 resistance temperature detector is suitable for a temperature range of −10 to +70 °C (14 to +158 °F)

The TMT72 temperature head transmitter is not designed for use in hazardous areas incl. CSA GP.

Medium temperature limit

Device + Pt100 (optional)

With external diameter of 22 mm (0.87 in) and 42 mm (1.65 in):
−20 to +70 °C (−4 to +158 °F)

In hazardous areas incl. CSA GP, the medium temperature limit is −10 to +70 °C (+14 to +158 °F).

With external diameter of 29 mm (1.14 in): 0 to +50 °C (+32 to +122 °F)

The FMX21 may be operated in this temperature range. The specification values, such as accuracy, may be exceeded.

Pressure specifications

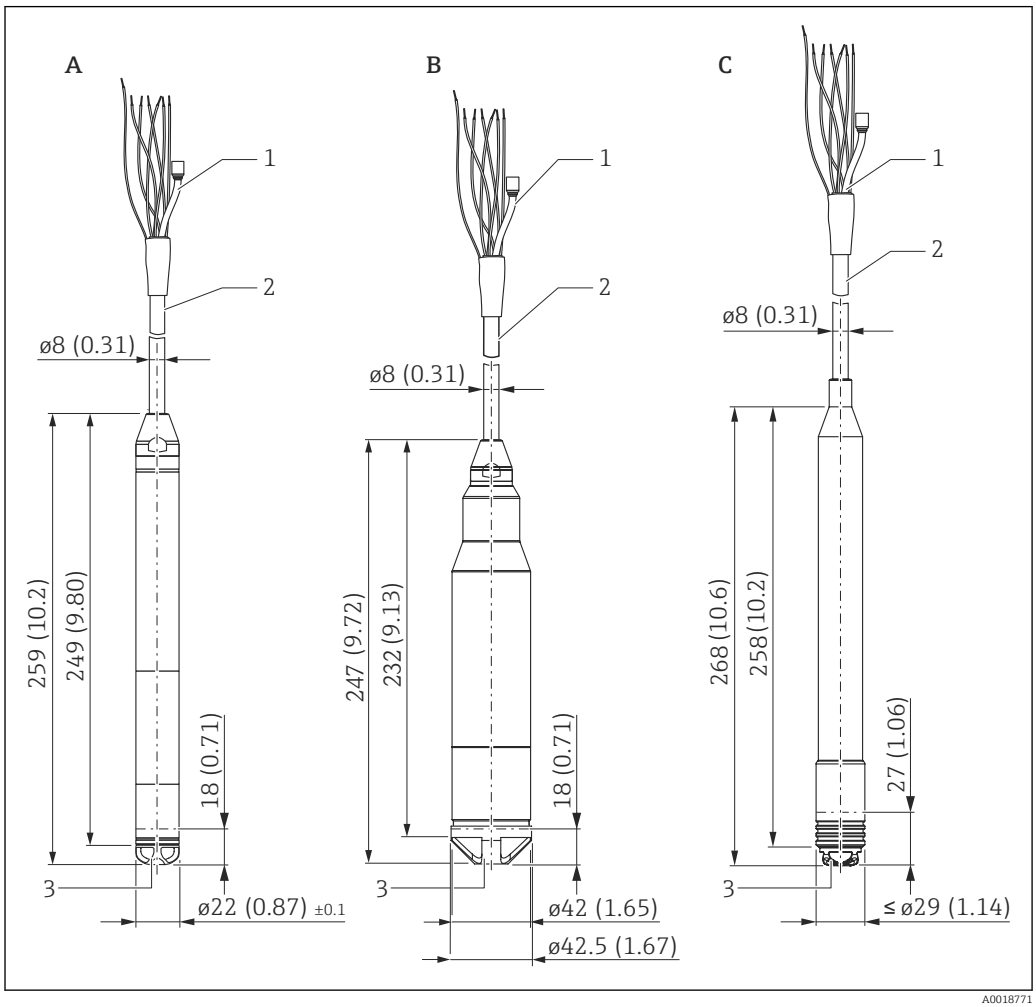
WARNING

The maximum pressure for the measuring device depends on the lowest-rated element with regard to pressure.

- For pressure specifications, see the "Measuring range" section and the "Mechanical construction" section.
- The measuring device must be operated only within the specified limits!
- The Pressure Equipment Directive (2014/68/EU) uses the abbreviation "PS". The abbreviation "PS" corresponds to the MWP (maximum working pressure) of the measuring device.
- MWP (maximum working pressure): The MWP (maximum working pressure) is specified on the nameplate. This value refers to a reference temperature of +20 °C (+68 °F) and may be applied to the device for an unlimited time. Observe the temperature dependency of the MWP.
- OPL (Over Pressure Limit): The overpressure limit is the maximum pressure a device may be subjected to during a test. It is greater than the maximum working pressure by a certain factor. In the case of sensor range and process connection combinations where the over pressure limit (OPL) of the process connection is smaller than the nominal value of the sensor, the device is set at the factory, at the very maximum, to the OPL value of the process connection. If you want to use the entire sensor range, select a process connection with a higher OPL value.
- Avoid steam hammering! Steam hammering can cause zero point drift. Recommendation: Residue (such as condensation or drops of water) can remain on the process membrane after CIP cleaning and lead to local steam hammering if steam cleaning is performed again. In practice, drying the process membrane (e.g. by blowing off excess moisture) has proven to be a successful way of avoiding steam hammering.

Mechanical construction

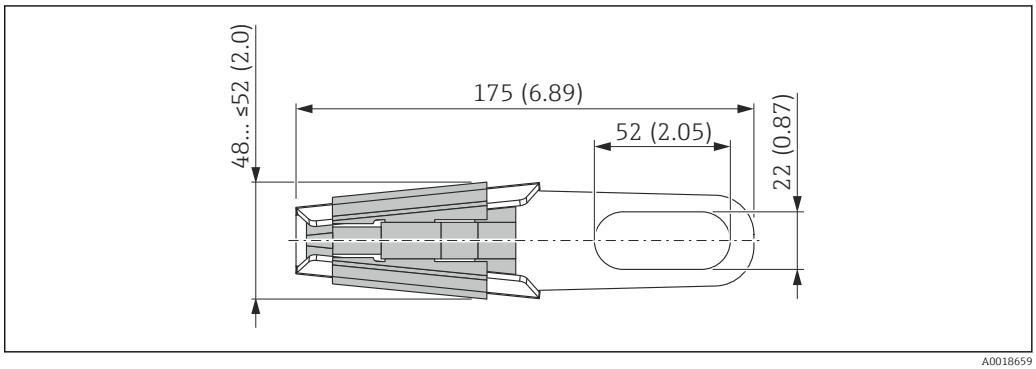
Dimensions of the level probe



Unit of measurement mm (in)

A Probe tube; 316L, outer diameter 22 mm (0.87 in)
B Probe tube; 316L, outer diameter 42 mm, flush mount
C Probe tube; PPS/polyolefin>316L, outer diameter 29 mm, saltwater applications
1 Pressure compensation tube
2 Extension cable (length, see → 28
3 Protective cap

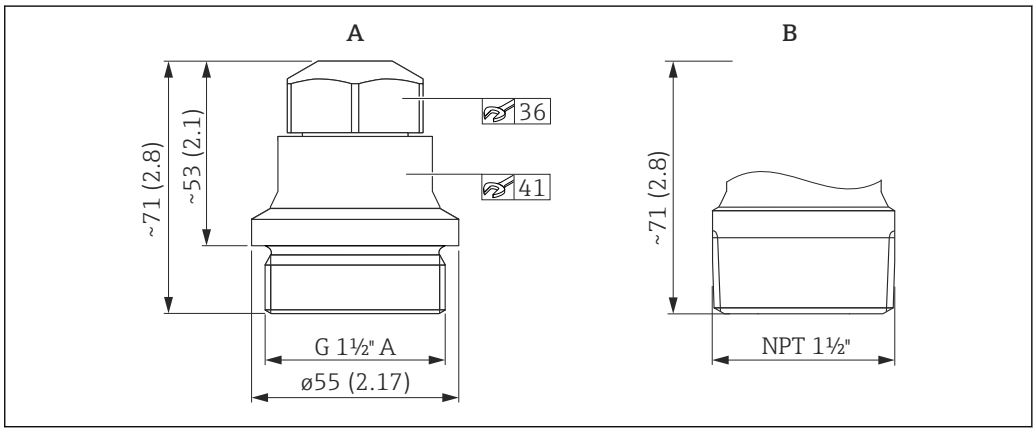
Dimensions of the suspension clamp



Unit of measurement mm (in)

Product Configurator: the suspension clamp is optionally available. → 🖹 51

Dimensions of the cable mounting screw

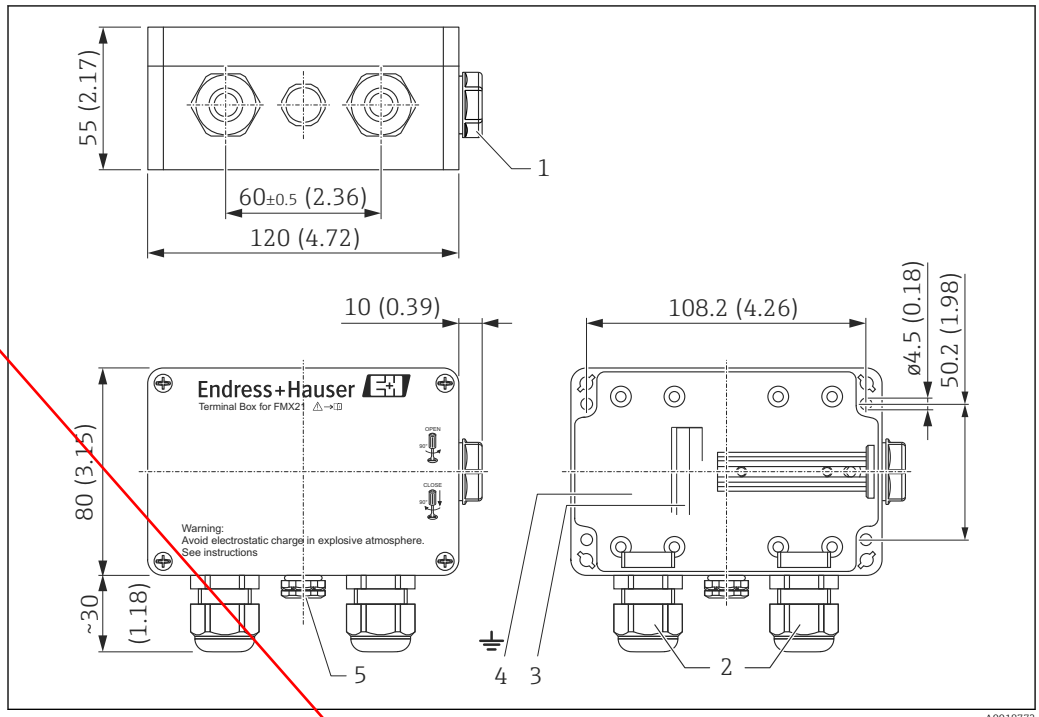


Unit of measurement mm (in)

A G 1½" A → 🖹 51
B NPT 1½" → 🖹 51

- Use only in unpressurized vessels.
- Product Configurator: the cable mounting screw is optionally available.

Dimensions of terminal box IP66, IP67 with filter



Unit of measurement mm (in)

1 *Dummy plug M20x1.5*
2 *Cable gland M20x1.5*
3 *4 to 20 mA; terminals for 0.08 to 2.5 mm (28 to 14 AWG)0.08 to 2.5 mm²*
4 *Ground connection; terminals for 0.08 to 2.5 mm (28 to 14 AWG)0.08 to 2.5 mm²*
5 *GORE-TEX® filter*

Terminal box IP66/IP67 with GORE-TEX® filter incl. 3 integrated terminals. The terminal box is also suitable for the installation of a temperature head transmitter or four other terminals

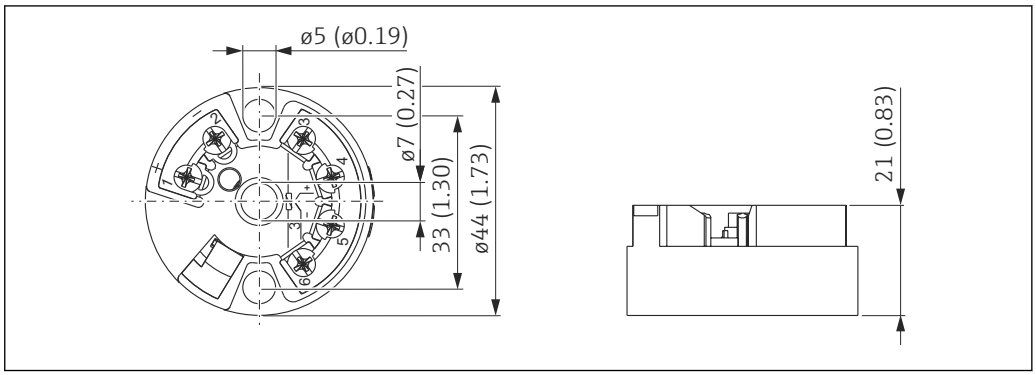
Ordering information:
- Product Configurator: the terminal box is optionally available. → 51
- TMT71: Product Configurator: the temperature head transmitter TMT71 is optionally available. → 51
- TMT72: Product Configurator: the temperature head transmitter TMT72 is optionally available. → 51

The terminal box is not designed for the device with type of protection Ex nA in hazardous areas. If the terminal box is used in a hazardous area, the Safety Instructions of the relevant device must be observed, as well as the applicable regulations for explosion protection.

If the device with optional Pt100 is supplied, a terminal strip is provided with the terminal box for the purpose of wiring the Pt100.

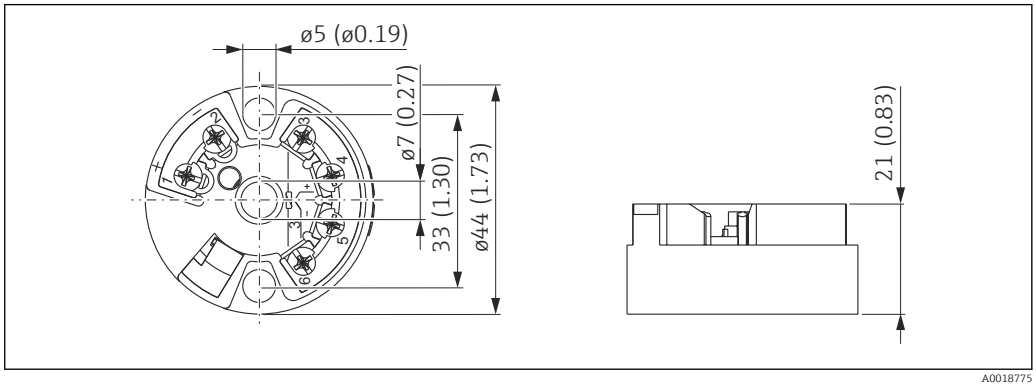
The 4-terminal strip is not designed for use in hazardous areas incl. CSA GP.

Dimensions of the TMT71 temperature head transmitter



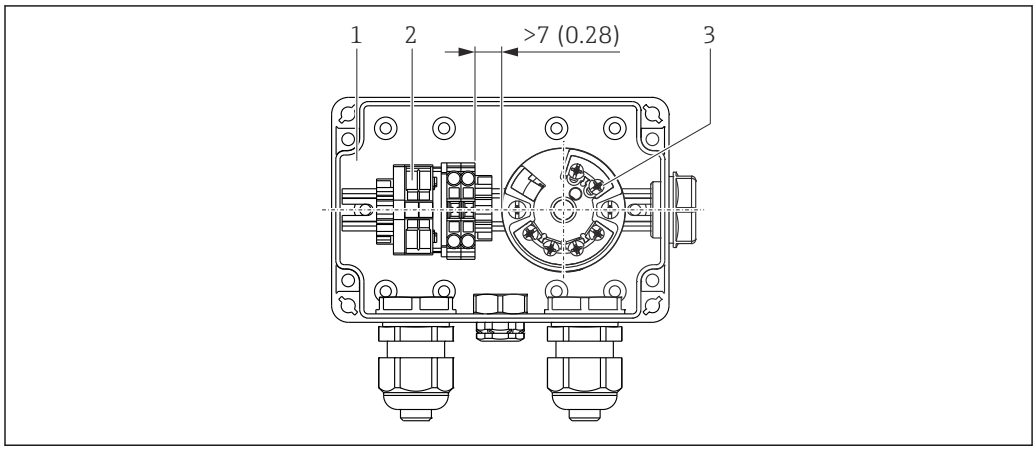
Unit of measurement mm (in)

Dimensions of the TMT72 temperature head transmitter



Unit of measurement mm (in)

Terminal box with integrated TMT71 temperature head transmitter



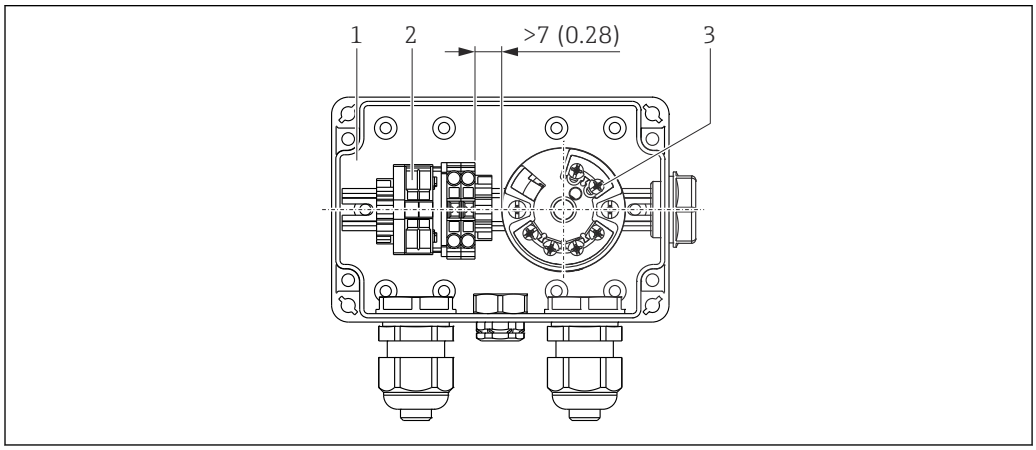
A0018696

Unit of measurement mm (in)

1 *Terminal box*
2 *Terminal strip/terminals*
3 *TMT71 temperature head transmitter*

A distance of > 7 mm (0.28 in) must be maintained between the terminal strip and the TMT71 temperature head transmitter.

Terminal box with integrated TMT72 temperature head transmitter



A0018696

Unit of measurement mm (in)

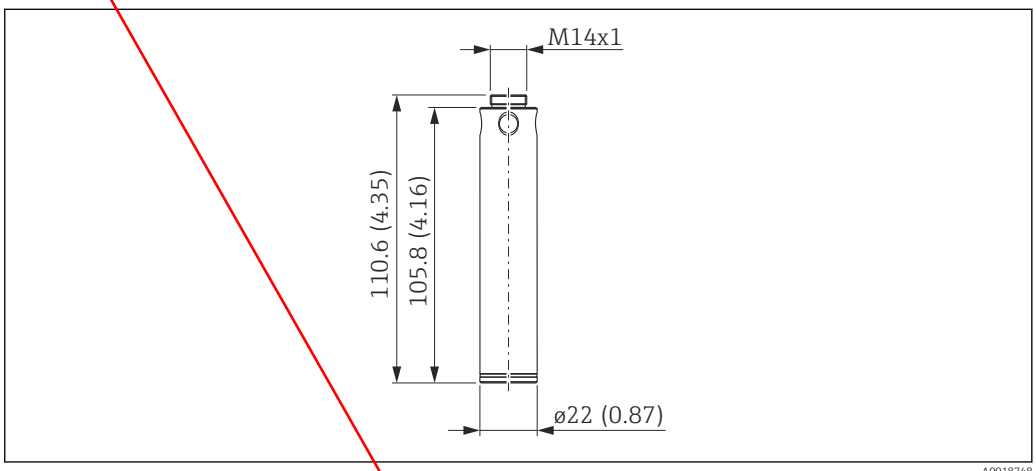
1 *Terminal box*
2 *Terminal strip/terminals*
3 *TMT72 temperature head transmitter*

A distance of > 7 mm (0.28 in) must be maintained between the terminal strip and the TMT72 temperature head transmitter.

Additional weight

For devices with external diameter of 22 mm (0.87 in) or 29 mm (1.14 in)

- Endress+Hauser offers additional weights to prevent sideways movement that results in measuring errors, or to make it easier to lower the device in a guide tube. You can screw several weights together. The weights are screwed directly onto the device. For devices with external diameter of 29 mm (1.14 in), a maximum of 5 weights may be screwed on. In conjunction with the Ex nA approval, a maximum of one additional weight is permitted for devices with external diameter of 29 mm (1.14 in).
- Order number 52006153, Product Configurator: the additional weight is optionally available.

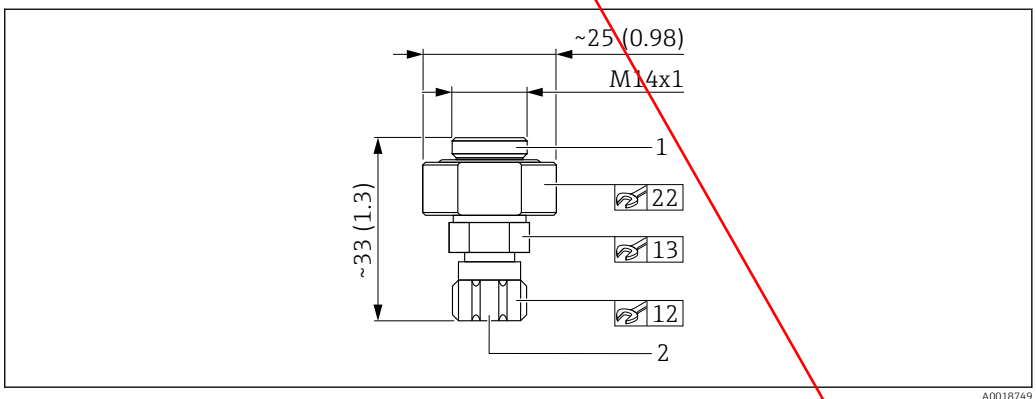


Unit of measurement mm (in)

Testing adapter

For devices with external diameter of 22 mm (0.87 in) or 29 mm (1.14 in)

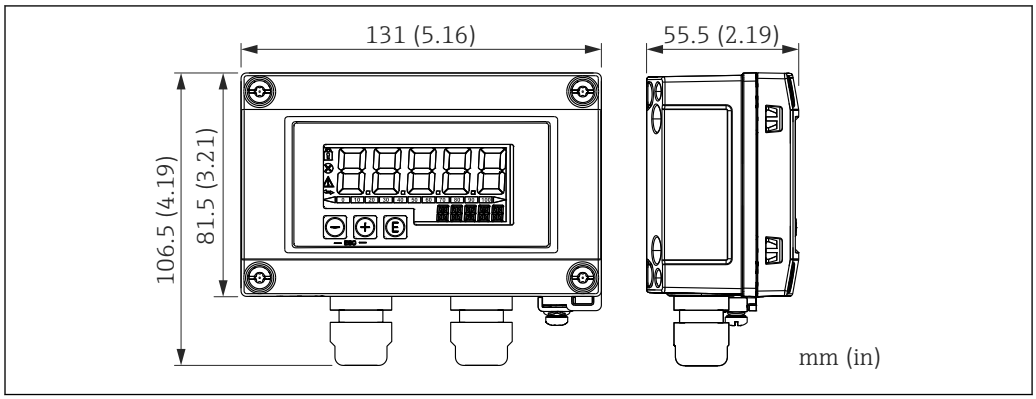
- Endress+Hauser offers a testing adapter to ease function-testing of the level probes.
- Observe the maximum pressure for compressed air hose and maximum overload for level probe → 14
- Maximum pressure for the quick coupling piece provided: 10 bar (145 psi)
- Adapter material: 304 (1.4301)
- Material of quick coupling piece: anodized aluminum
- Order number 52011868
  Product Configurator: the testing adapter is optionally available.



Unit of measurement mm (in)

1 FMX21 level probe connection
2 Compressed air hose connection, internal diameter, quick coupling piece 4 mm (0.16 in)

RIA15 in the field housing

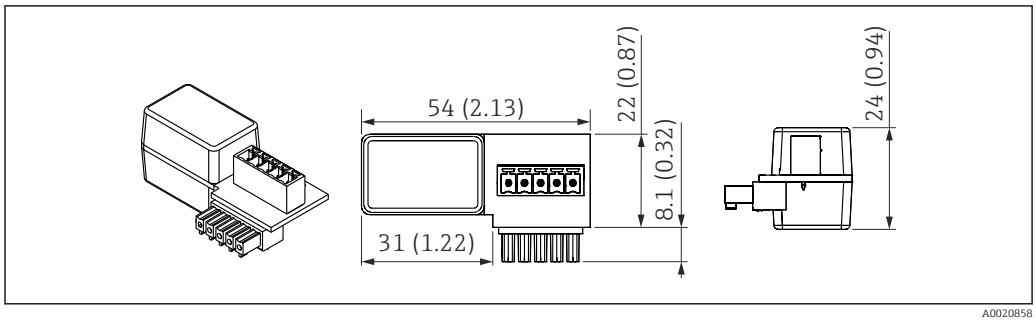


5 Dimensions of RIA15 in field housing. Unit of measurement mm (in)

The RIA15 remote display (for Ex or non-Ex area) can be ordered together with the device. See the Product Configurator.

Alternatively available as an accessory, for details see Technical Information TI01043K and Operating Instructions BA01170K

HART communication resistor

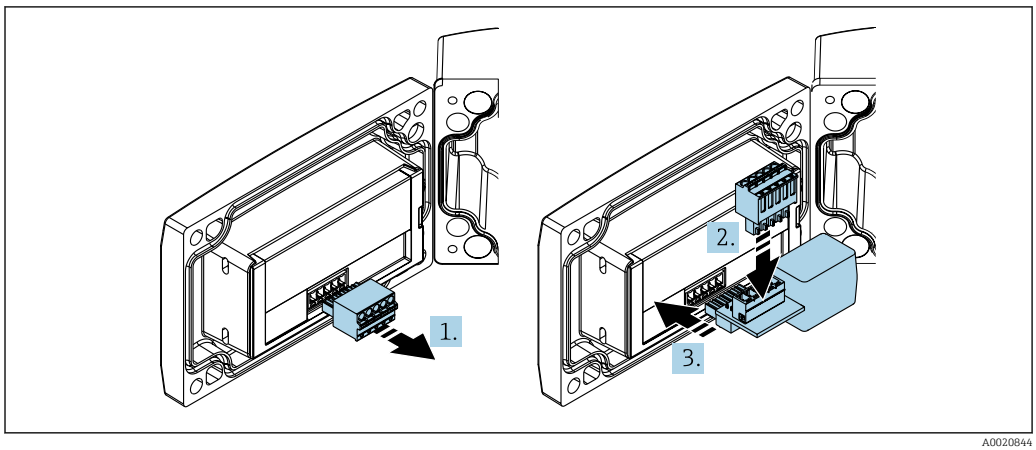


6 Dimensions of HART communication resistor. Unit of measurement mm (in)

A communication resistor is required for HART communication. If this is not already present (e.g. in the power supply RMA, RN221N, RNS221, ...), it can be ordered as an option via the Product Configurator.

Alternatively available as an accessory, for details see Technical Information TI01043K and Operating Instructions BA01170K

The HART communication resistor is specially designed for use with the RIA15 and can be attached easily.



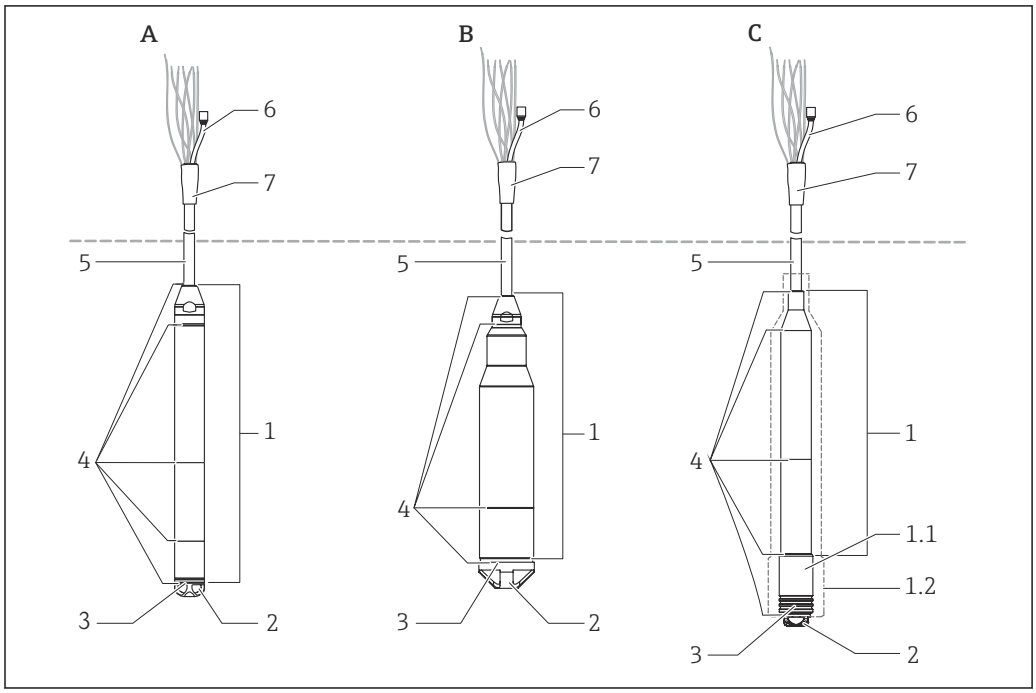
1. Disconnect plug-in terminal block.
2. Insert the terminal block into the slot provided on the HART communication resistor module.

3. Insert the HART communication resistor in the slot in the housing.

Weight

- Level probe, external diameter of 22 mm (0.87 in):
  344 g (12.133 oz)
- Level probe, external diameter of 42 mm (1.65 in):
  1376 g (48.532 oz)
- Level probe, external diameter of 29 mm (1.14 in):
  394 g (13.896 oz)
- Extension cable:
  - PE: 52 g/m (0.035 lbs/1 ft)
  - PUR: 60 g/m (0.040 lbs/1 ft)
  - FEP: 108 g/m (0.072 lbs/1 ft)
- Suspension clamp:
  170 g (5.996 oz)
- Cable mounting screw G 1½" A:
  770 g (27.158 oz)
- Cable mounting screw NPT 1½":
  724 g (25.535 oz)
- Terminal box:
  235 g (8.288 oz)
- TMT71 temperature head transmitter:
  40 g (1.411 oz)
- TMT72 temperature head transmitter:
  40 g (1.411 oz)
- Additional weight:
  300 g (10.581 oz)
- Testing adapter:
  39 g (1.376 oz)

Materials



Materials in contact with process

1 level probe
316L (1.4404/1.4435) [2)]
- **A:** External diameter 22 mm (0.87 in)
- **B:** External diameter 42 mm (1.65 in)
- **C:** External diameter max. 29 mm (1.14 in)

1.1 Sensor sleeve
PPS (Polyphenylene sulfide)

1.2 Heat shrink tube
Polyolefin and hot melt adhesive

The heat-shrink tube around the level probe acts as insulation. It prevents electrical contact between the level probe and the tank. Electrochemical corrosion is thus avoided.

2 Protective cap
- For A and C: with external diameter 22 mm (0.87 in) and 29 mm (1.14 in) (order number: 52008999):
  POM
- For B: device with external diameter 42 mm (1.65 in) (order number: 917755-0000):
  PFA

3 Process ceramic
Al_2O_3 (Aluminum oxide ceramic)

4 Seal
- EPDM
- FKM Viton

5 Seal
Extension cable insulation, choose from:
- PE-LD (Low-density polyethylene)
- FEP (Fluorinated ethylene propylene)
- PUR (Polyurethane)

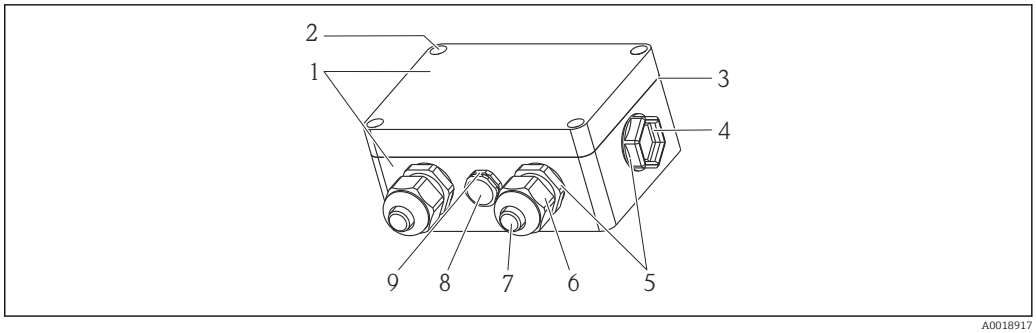
Materials not in contact with process

6 Pressure compensation tube
PA

2) Material 316L (1.4404/1.4435) not in contact with the process in the case of level probe C

7 Heat shrink tube
Polyolefin

Terminal box (not in contact with process)



A0018917

1 Housing
PC

2 Mounting screws (4x)
A2

3 Seal
CR (Chloroprene rubber)

4 Dummy plug M20x1.5
PBT-GF30

5 Cable gland M20x1.5
PE-HD

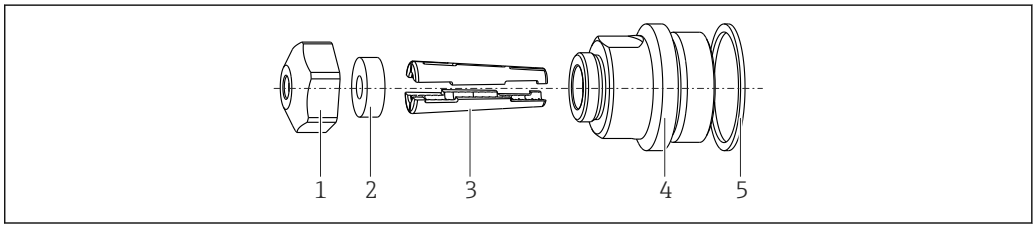
6 Cable gland M20x1.5
PA6

7 Cable gland M20x1.5
PA6-GF30

8 Pressure compensation filter
PA6-GF10, ePTFE

9 Pressure compensation filter, O-ring
Silicone (VMQ)

Cable mounting screw (not in contact with process)



A0018918

1 Cover for cable mounting screw
304 (1.4301)

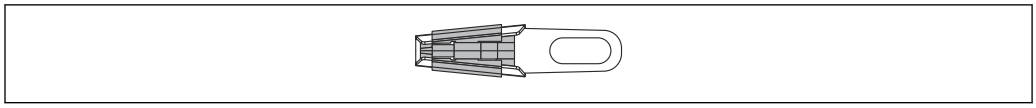
2 Sealing ring
NBR

3 Ferrules
PA66-GF35

4 Adapter for cable mounting screw G 1½" A, NPT 1½"
304 (1.4301)

5 Seal ® Only for G 1½" A
EPDM

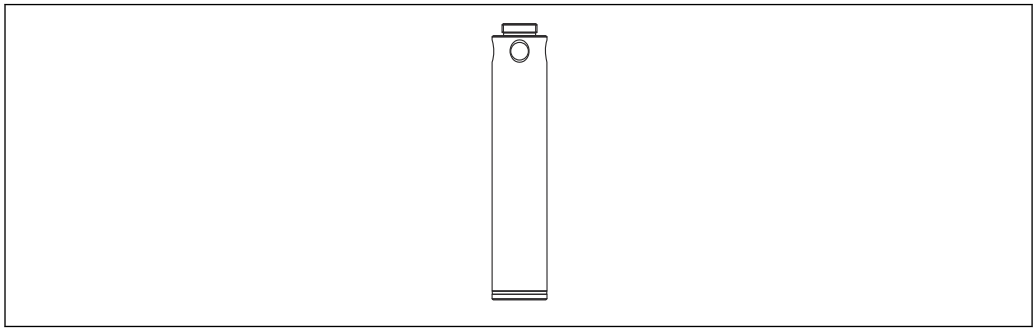
Suspension clamp



A0030950

Material: 316L (1.4404) and fiber-glass reinforced PA (polyamide)

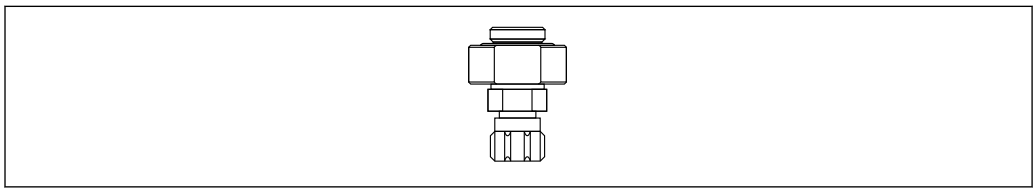
Additional weight



A0030954

Material: 316L (1.4435)

Testing adapter for devices with an external diameter of 22 mm (0.87 in) or 29 mm (1.14 in)

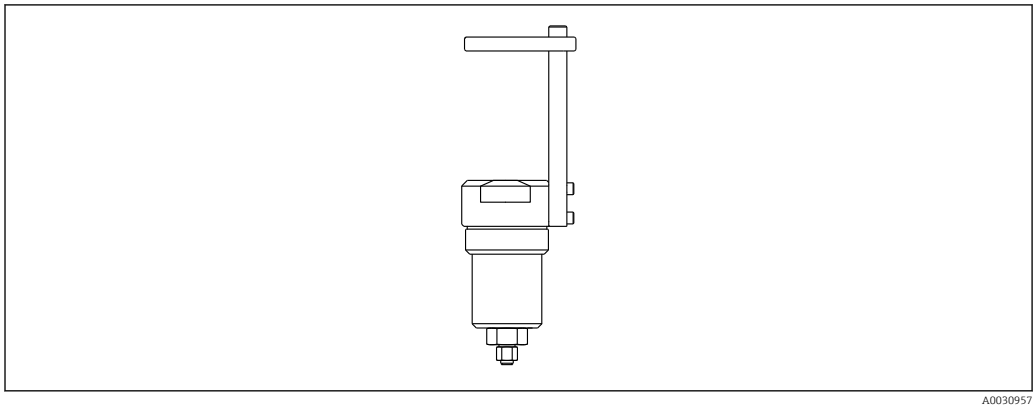


A0030956

Adapter material: 304 (1.4301)

Material of quick coupling piece: anodized aluminum

Testing adapter for devices with an external diameter of 42 mm (1.65 in)



A0030957

Adapter material: 304 (1.4301)

Material of quick coupling piece: anodized aluminum

Extension cable

PE
- Abrasion-resistant extension cable with strain-relief members made of high-strength PE fibers
- Shielded (aluminum)
- Insulated with polyethylene (PE), black
- Copper wires, twisted
- Pressure compensation tube with Teflon filter

PUR
- Abrasion-resistant extension cable with strain-relief members made of high-strength PE fibers
- Shielded (aluminum)
- Insulated with polyurethane (PUR), black
- Copper wires, twisted
- Pressure compensation tube with Teflon filter

FEP
- Abrasion-resistant extension cable
- Shielded with galvanized steel wire netting
- Insulated with fluorinated ethylene propylene (FEP), black
- Copper wires, twisted
- Pressure compensation tube with Teflon filter

Operability

FMX21 4 to 20 mA Analog

No display or other operation facility is required to operate the device. However, the measured values can be read out with optional evaluation units.

FMX21 4 to 20 mA HART

FieldCare

FieldCare is an Endress+Hauser asset management tool based on FDT technology. With FieldCare, you can configure all Endress+Hauser devices as well as devices from other manufacturers that support the FDT standard.

FieldCare supports the following functions:
- Configuration of transmitters in online and offline mode
- Loading and saving device data (upload/download)
- Documentation of the measuring point

Connection options:
- Via Commubox FXA195 and the USB interface of a computer
- Via Fieldgate FXA520

For additional information and free download of FieldCare, see → www.de.endress.com → Download → Text Search: FieldCare

DeviceCare

Function scope

Tool for connecting and configuring Endress+Hauser field devices.

The fastest way to configure Endress+Hauser field devices is with the dedicated "DeviceCare" tool. Together with the device type managers (DTMs) it presents a convenient, comprehensive solution.

For details, see Innovation brochure IN01047S

Field Xpert SFX

Field Xpert SFX is an industrial PDA with integrated 3.5" touchscreen from Endress+Hauser based on Windows Mobile. It offers wireless communication via the optional VIATOR® Bluetooth ® modem as a point-to-point connection to a HART device, or via WiFi and Endress+Hauser's Fieldgate FXA520 to one or more HART devices. Field Xpert also works as a stand-alone device for asset management applications. For details, refer to BA00060S/04/EN.

RIA15

The RIA15 can be used as a local display unit and for the basic commissioning of the Waterpilot FMX21 hydrostatic level sensor via HART.

Certificates and approvals

Current certificates for the product are available on the product page at www.endress.com.

1. Select the product using the filters and search field.
2. Open the product page.
3. Select **Downloads**.
4. Select **Technical Documentation**.
5. Select **ZE (Certificates)** as the filter

A list of all the certificates appears.

Current approvals for the product are available on the product page at www.endress.com.

1. Select the product using the filters and search field.
2. Open the product page.
3. Select **Downloads**.
4. Select **Approvals**.

A list of all the approvals appears.

CE mark

The device meets the legal requirements of the relevant EC directives. Endress+Hauser confirms that the device has been successfully tested by applying the CE mark.

RCM marking

The supplied product or measuring system meets the ACMA (Australian Communications and Media Authority) requirements for network integrity, interoperability, performance characteristics as well as health and safety regulations. Here, especially the regulatory arrangements for electromagnetic compatibility are met. The products bear the RCM marking on the nameplate.



A0029561

EAC conformity

The measuring system meets the legal requirements of the applicable EAC guidelines. These are listed in the corresponding EAC Declaration of Conformity together with the standards applied.

Endress+Hauser confirms successful testing of the device by affixing to it the EAC mark.

Drinking water approval

The following drinking water approvals can be ordered optionally via the Product Configurator for devices with an outer diameter of 22 mm (0.87 in) with an EPDM seal:

- KTW
- NSF61
- ACS

Marine approval

The following marine approvals can be ordered optionally via the Product Configurator for devices with an outer diameter of 22 mm (0.87 in):

- GL
- ABS
- BV
- DNV

Other standards and guidelines

The applicable European guidelines and standards can be found in the relevant EU Declarations of Conformity. The following standards were also applied:

DIN EN 60770 (IEC 60770):

Transmitters for use in industrial process control systems Part 1: Methods for performance evaluation

Methods for evaluating the performance of transmitters for control and regulation in industrial process control systems.

DIN 16086:

Electrical pressure measuring instruments, pressure sensors, pressure transmitters, pressure measuring instruments, concepts, specifications on data sheets

Procedure for writing specifications in data sheets for electrical pressure measuring instruments, pressure sensors and pressure transmitters.

EN 61326:

Electrical equipment for measurement, control and laboratory use – EMC requirements

EN 61010-1 (IEC 61010-1):

Safety requirements for electrical equipment for measurement, control and laboratory use

EN 60529:

Degrees of protection provided by enclosures (IP code)

Calibration

Factory calibration certificate, 5-point
Product Configurator: the 5-point factory calibration certificate is optionally available.

Calibration unit

The following options can be selected in the Product Configurator:
- Sensor range; %
- Sensor range; mbar/bar
- Sensor range; kPa/MPa
- Sensor range; mm/m H2O
- Sensor range; in H2O/ft H2O
- Sensor range; psi
- Customized pressure; see additional specification
- Customized level; see additional specification

Service

The following options can be optionally selected in the Product Configurator:
- Configured min alarm current
- Configured HART Burst Mode PV
- Adjusted density compensation
- ... m cable marking>installation
- ... ft cable marking>installation
- Special version

Downloading the Declaration of Conformity

www.endress.com → Download

Ordering information

Detailed ordering information is available from the following sources:
- In the Product Configurator on the Endress+Hauser website: www.endress.com-> Click "Corporate" -> Select your country -> Click "Products" -> Select the product using the filters and search field -> Open product page -> The "Configure" button to the right of the product image opens the Product Configurator.
- From your Endress+Hauser sales organization: www.addresses.endress.com

Product Configurator - the tool for individual product configuration
- Up-to-the-minute configuration data
- Depending on the device: direct input of information specific to the measuring point, such as the measuring range or operating language
- Automatic verification of exclusion criteria
- Automatic creation of the order code and its breakdown in PDF or Excel output format
- Ability to order directly in the Endress+Hauser Online Shop

Scope of delivery

- Measuring device
- Optional accessories
- Brief Operating Instructions
- Certificates

Test reports, declarations and inspection certificates

All test reports, declarations and inspection certificates are provided electronically in the *W@M Device Viewer*:
Enter the serial number from the nameplate (www.endress.com/deviceviewer)

Product documentation on paper
Test reports, declarations and inspection certificates in hard copy can optionally be ordered with feature 570 "Service", Version I7 "Product documentation on paper". The documents are then provided with the device upon delivery.

Configuration data sheet

Level

The following configuration data sheet must be completed and included with the order if option "K: customized level" has been selected for order code "090: Calibration; unit" in the product structure.

Pressure unit

❑ mbar	❑ mmH_2O	❑ mmHg	❑ Pa
❑ bar	❑ mH_2O		❑ kPa
	❑ ftH_2O		❑ MPa
❑ psi	❑ inH_2O	❑ kgf/cm^2	

Output unit (scaled unit)

Mass	Lengths	Volume	Volume	Percent
❑ kg	❑ m	❑ l	❑ gal	❑ %
❑ t	❑ dm	❑ hl	❑ Igal	
❑ lb	❑ cm			
	❑ mm	❑ m^3		
		❑ ft^3		
	❑ ft	❑ in^3		
	❑ inch			

Empty calibration [a]:
Low pressure value (empty) _____ [pressure engineering unit]

Empty calibration [a]:
Low measured value (empty) _____ [scaled unit]

Full calibration [b]:
High pressure value (full) _____ [pressure engineering unit]

Full calibration [b]:
High measured value (full) _____ [scaled unit]

Damping
Damping: _____ sec

Pressure

The following configuration data sheet must be completed and included with the order if option "J: customized pressure" has been selected for order code "090: Calibration; unit" in the product structure.

Pressure unit			
❑ mbar	❑ mmH_2O	❑ mmHg	❑ Pa
❑ bar	❑ mH_2O		❑ kPa
	❑ ftH_2O		❑ MPa
❑ psi	❑ inH_2O	❑ kgf/cm^2	

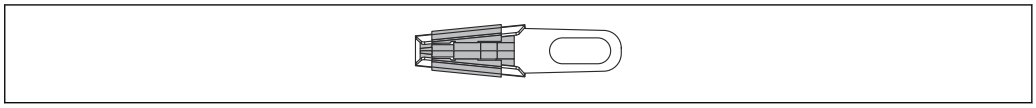
Calibration range / Output		
Lower-range value (LRV):	_____	[pressure engineering unit]
Upper-range value (URV):	_____	[pressure engineering unit)]

Damping
Damping: _____ sec

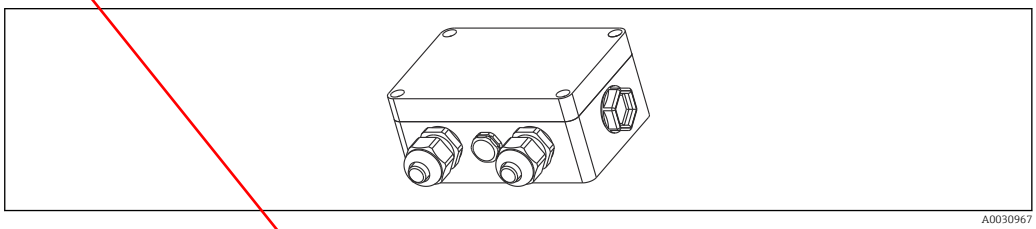
Accessories

- Observe the additional information in the individual sections!
- For additional information, see the sections "Mechanical construction" → 34, "Environment", → 30, "Process" → 32 and "Mounting" → 27.

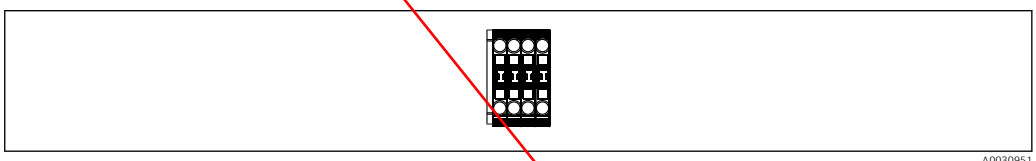
Suspension clamp
For easy installation of the device, Endress+Hauser offers a suspension clamp.
- Product Configurator: the suspension clamp is optionally available
- Order number: 52006151


A0030950

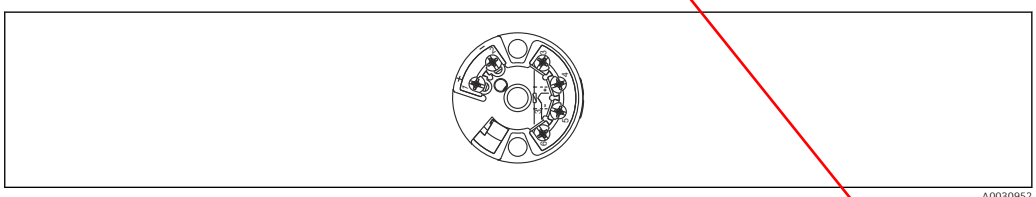
Terminal box
Terminal box for terminal strip, temperature head transmitter and Pt100.
- Product Configurator: the terminal box is optionally available
- Order number: 52006152


A0030967

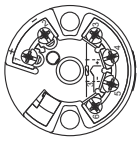
4-terminal strip/terminals
4-terminal strip for wiring
Order number: 52008938


A0030951

Temperature head transmitter TMT71 for FMX21 4 to 20 mA analog
PC-programmable (PCP) temperature head transmitter for the conversion of various input signals.
- Product Configurator: the temperature head transmitter TMT71 is optionally available → 51
- Order number: 52008794

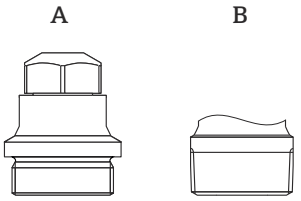

A0030952

Temperature head transmitter TMT72 for FMX21 4 to 20 mA HART
PC-programmable (PCP) temperature head transmitter for the conversion of various input signals.
- Product Configurator: the temperature head transmitter TMT72 is optionally available
- Order number: 51001023



A0030952

Cable mounting screws
Endress+Hauser offers a cable mounting screw for easy device mounting and to seal the measuring aperture.
- G 1½" A
  Order number: 52008264
- NPT 1½"
  Order number: 52009311
- Product Configurator: the cable mounting screws are optionally available



A0030953

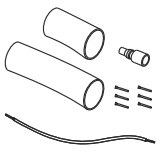
A G 1½" A
B NPT 1½"

Additional weight for device with an outer diameter of 22 mm (0.87 in) or 29 mm (1.14 in)
Endress+Hauser offers additional weights to prevent sideways movement that results in measuring errors, or to make it easier to lower the device in a guide tube.
- Product Configurator: the additional weight is optionally available
- Order number: 52006153



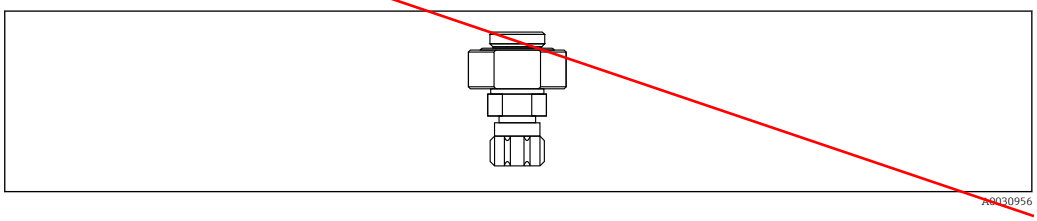
A0030954

Cable shortening kit
The cable shortening kit is used to shorten a cable easily and professionally.
- Product Configurator: the cable shortening kit is optionally available
- Order number: 71222671

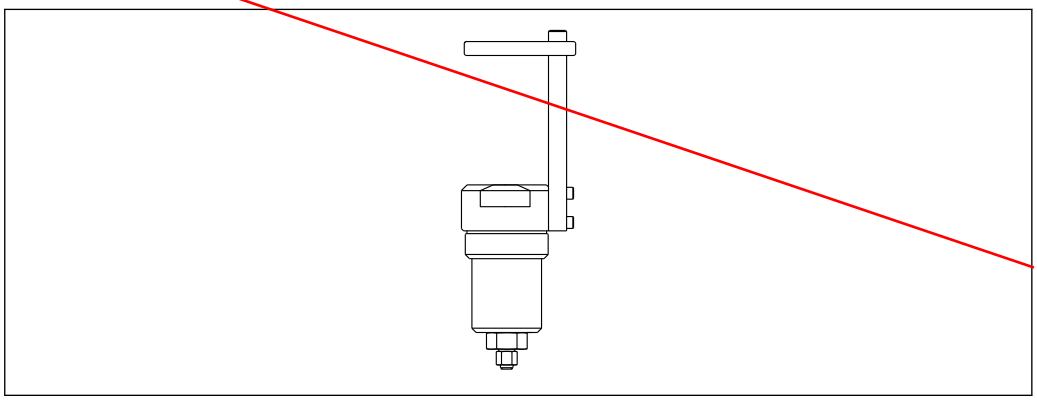


A0030948

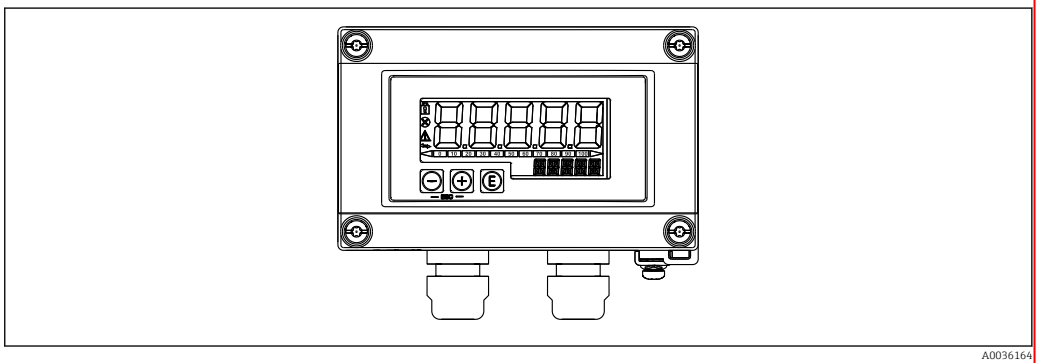
Testing adapter for devices with an external diameter of 22 mm (0.87 in) or 29 mm (1.14 in)
Endress+Hauser offers a testing adapter to ease function-testing of the level probes.
- Product Configurator: the testing adapter is optionally available
- Order number: 52011868



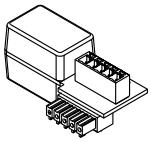
Testing adapter for devices with an external diameter of 42 mm (1.65 in)
Endress+Hauser offers a testing adapter to ease function-testing of the level probes.
- Observe the maximum pressure for compressed air hose and maximum overload for level probe
- Maximum pressure for the quick coupling piece provided: 10 bar (145 psi)
- Order number: 71110310



RIA15 in the field housing
- Remote display RIA15 non-hazardous
  ↳ Product structure: the display is optionally available
- Remote display RIA15 hazardous
  ↳ Product structure: the display is optionally available



HART communication resistor
- HART communication resistor hazardous / non-hazardous area, for use with RIA15
- Product structure: the HART communication resistor is optionally available



A0036165

Service-specific accessories

Accessories	Description
DeviceCare SFE100	Configuration tool for HART, PROFIBUS and FOUNDATION Fieldbus field devices Technical Information TI01134S DeviceCare is available for download at www.software-products.endress.com. You need to register in the Endress+Hauser software portal to download the application.
FieldCare SFE500	FDT-based plant asset management tool FieldCare can configure all smart field units in your plant and helps you manage them. By using the status information, FieldCare is also a simple but effective way of checking the status and condition of the field devices. Technical Information TI00028S

Supplementary documentation

The following document types are also available in the Downloads area of the Endress+Hauser website: www.endress.com → Downloads

Field of Activities
- Pressure measurement: FA00004P/00/EN
- Recording technology: FA00014R/09/EN
- System components: FA00016K/09/EN

Technical Information
- Deltapilot M: TI00437P/00/EN
- Temperature head transmitter iTEMP TMT71: TI01393T
- Temperature head transmitter iTEMP HART TMT72: TI01392T
- RIA15: TI01043K/09/EN

Operating Instructions
- Waterpilot FMX21 4 to 20 mA Analog: BA01605P/00/EN
- Waterpilot FMX21 4 to 20 mA HART: BA00380P/00/EN
- RIA15: BA01170K/09/EN
- Cable shortening kit: SD00552P/00/A6
- Field Xpert: BA01211S/04/EN

Brief Operating Instructions
- Waterpilot FMX21 4 to 20 mA Analog: KA01244P/00/EN - Brief Operating Instructions for the device
- Waterpilot FMX21 4 to 20 mA HART: KA01189P/00/EN - Brief Operating Instructions for the device

Safety Instructions (XA)

Depending on the approval, Safety Instructions (XA) are supplied with the device. The Safety Instructions are an integral part of the Operating Instructions.

The nameplate indicates the Safety Instructions (XA) that are relevant to the device.

Drinking water approval
- SD00289P/00/A3 (NSF)
- SD00319P/00/A3 (KTW)
- SD00320P/00/A3 (ACS)

Registered trademarks

GORE-TEX® Trademark of W.L. Gore & Associates, Inc., USA.

TEFLON® Trademark of E.I. Du Pont de Nemours & Co., Wilmington, USA.

HART® Registered trademark of the FieldComm Group, Austin, USA

FieldCare® Trademark of Endress+Hauser Process Solutions AG.

DeviceCare® Trademark of Endress+Hauser Process Solutions AG.

iTEMP® Trademark of Endress+Hauser Wetzer GmbH + Co. KG, Nesselwang, D..



www.addresses.endress.com

Endress+Hauser

People for Process Automation

INS-07

TURBIDITY SENSOR

For Earth, For Life
Kubota

Submittal Transmittal

Turbidity Sensor

Project Name	TAYLOR BAY BEACH CLUB WWTF UPGRADE
Project Site	8220 178TH AVENUE, LONGBRANCH, WA 98351
Engineer	Gray & Osborne, Inc 1130 RAINIER AVENUE SOUTH, SUITE 300
Submit to	Gray & Osborne, Inc
Prepared by	Shingo Kubo | Lead Project Manager KUBOTA Water and Environment U.S.A. Corporation 19910 N Creek Pkwy, Suite 100 Bothell, WA 98011
KMU Project #	KMU-OPID85
Issued Date	August 24, 2025
Package #	OPID85- INS-07-B-Turbidity Sensor
Item	Tag # 01 TM 01

Clarifications;

1. Section1 contains Kubota scope list. The subjected item for this submittal is marked in red.

2. Section2 contains the manufacture submittal and datasheet for review.

Response to 60% review comment;

1) General – Make Corrections Noted

a. Note that BABA certifications from manufacturers should be included in the final

Kubota Response: Hach instruments do not comply with BABA requirement as shown in ATTACHMENT B.

ATTACHMENT B

SCOPE OF SUPPLY COMPONENTS THAT DO NOT COMPLY WITH BABA REQUIREMENTS

Part Identification (Name)	Equipment Description and Type	Manufacturer	Number of Units	Total Lump Sum Equipment Cost for Line Item
Kubota SMU Equipment	FS150 SMU Units + Associated Lifting Tool	Kubota	4 SMUs 1 Lifting Tool + Chains	$80,400.00
SMU Basin Associated Endress + Hauser Instrumentation	1. Air Pressure Transmitters 2. Blower Flow Meters 3. Permeate Flow Meter 4. Pump Pressure Transmitter 5. Level Transmitter	Endress + Hauser	Type 1 - QTY 3 Type 2 - QTY 2 Type 3 - QTY 1 Type 4 - QTY 2 Type 5 - QTY 2	$33,896.00
SMU Basin Hach Instrumentation	1. Air Pressure Transmitters 2. Blower Flow Meters 3. Permeate Flow Meters	Hach	Type 1 - QTY 1 Type 2 - QTY 1 Type 3 - QTY 1	$12,633.00
Kubota Standard CIP System	Kubota CIP system based around Mazzei injector, rotometer and flow control valve	Various	1 System of Supply	$18,500.00
PVC Isolation Valves + Check Valves	3 inch PVC Ball Valves 3 inch PVC Check Valves	Asahi	11 Ball Valves 3 Check Vavles	$11,072.00

b. Note that manufacturer services should be included in the final submittal.

Kubota Response: Manufacturer service is included per the specifications. For the items that Kubota is certified to provide service, Kubota will provide it.

For Earth, For Life
Kubota

SECTION 1

KUBOTA Water and Environment U.S.A. Corporation
19910 N Creek Pkwy, Suite 100 Bothell, WA 98011| Phone: 425 898 2858 | Fax: 425-898-2853

No	Equipment Location	Tag	Category	Function	Name	Type	Chosen Size/Capacity	Unit	Material	Manufacturer	Model/ Specification	Motor HP	Voltage	FLA	QTY
	MBR Equipment	**x**													
1	MBR	02 MBR 01 02 MBR 02 02 MBR 03 02 MBR 04	SMU	Membrane Filtration	MBR SMU	Flat Plate			304SS	KUBOTA	FS150				4
2	MBR	n/a	SMU	SMU Maintenance	MBR SMU Lifting Tool	Lifting Tool			CS, SS	KUBOTA	TG150				1
3	MBR	n/a	SMU	SMU Maintenance	MBR SMU Lifting Chain	Lifting Tool			304SS	KUBOTA	CS30M				4
4	MBR	02 MOV 03 02 MOV 04	Auto Valve	Diffuser Cleaning	MBR Diffuser Cleaning Valve	ON/OFF Plug	3	inch	CI/CI	Auma/Pratt	SQ12.2-AC01.2/S601 w/extention stem	1/12	120 VAC	2.9	2
5	MBR	n/a	Other Valve	Isolation Valve	SMU Air Isolation Valve(inlet)	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S30				4
6	MBR	n/a	Other Valve	Isolation Valve	SMU Air Isolation Valve(outlet)	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S30				4
7	MBR	BV281 BV282 BV283 BV284	Other Valve	Isolation Valve	SMU PRMT Isolation Valve	Manual Butterfly	2	inch	DI, EPDM, Nylon Coat	Bray	S30				4
8	MBR	n/a	Other Valve	Manual Valves	Isolation Valves for CIP injection	Manual Ball	1	inch	PVC	ASAHI	Type21 True Union				4
9	MBR	02 LS 03 02 LS 04 02 LS 05 02 LS 06	Gauge, Switch	Level Measurement	MBR Level Switch	Float			PP, PU	Conery	2902-B8S1 w/ counter weight and brackets		Loop power		4
10	MBR	n/a	Fabrication	Fabrication	MBR SMU Guide & Stabilizer + Seismic Bracing				304SS	TBD					4
11	MBR	n/a	Fabrication	Fabrication	MBR SMU Fasteners				304SS	TBD					40
12	MBR	n/a	Fabrication	Fabrication	MBR In-Basin Pipe&Supports (Permeate Drop Pipe)				PVC	TBD					4
13	MBR	n/a	Fabrication	Fabrication	MBR In-Basin Pipe&Supports (Air Drop Pipe)				304SS	TBD					8
	Permeate (PRMT) Control Equipment	**x**													
14	PRMT	01 PMP 01 01 PMP 02 01 PMP 03	Permeate Pump	Permeate Extraction	PRMT Pump	Rotary Lobe	45	gpm		Boerger	AN 70 w/ piggyback mount	5	460 VAC	6.6	3
15	PRMT	PI169 PI170 PI171	Gauge, Switch	Pressure Gauge	PRMT Pump Pressuge Gauge(Inlet)		-15 - +15	psig	SS	Ashcroft or equivalent	1279 w/ grycelin filled				3
16	PRMT	PI172 PI173 PI174	Gauge, Switch	Pressure Gauge	PRMT Pump Pressuge Gauge (Inlet)		-15 - +15	psig	SS	Ashcroft or equivalent	1279 w/ grycelin filled				3
17	PRMT	01 PTR 01 01 PTR 02	Pressure Sensor	TMP Measurement	PRMT Pump Pressure Transmitter	Diaphragm	-15 - +15	psi	SS	Endress & Hauser	Cerabar PMCB51		Loop power		2
18	PRMT	01 MFM 01 01 MFM 02	Flow Sensor	Flow Measurement	PRMT Flow Meter	Electromagnetic	3	inch	PU	Endress & Hauser	Promag W 400		24VDC		2
19	MBR	n/a	Other Valve	Isolation Valve	MBR PRMT Pump isolation valve	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S30				8
20	MBR	CV261 CV261 CV261	Other Valve	Check valve	MBR PRMT Pump discharge check valve	Manual ball	3	inch	PVC, EPDM	ASAHI	True Union Ball Check				3
21	PRMT	01 TM 01	Other Instrument	Turbidity Measurement	PRMT Turbidity Meter	Laser	0-5	NTU		HACH	TU5300sc				1
22	PRMT	01 TM 01	Other Instrument	Turbidity Measurement	PRMT Turbidity Transmitter					HACH	SC4500		24VDC		1
23	PRMT	n/a	Other Instrument	Turbidity Measurement	Turbidity Meter Maintenance Kit					HACH					1
	Return Activated Sludge (RAS) Control	**x**													
24	MBR	Relocated from MBR 02 SLS02 02 SLS03	Other Instrument	Level Measurement	MBR Level Sensor	Hydrostatic	15	ft	SS	Endress & Hauser	Waterpilot FMX21 w/ brackets		Loop power		2
	MBR Blower	**x**													
25	MBR BLW	01 MSB 01 01 MSB 02 01 MSB 03	Blower	Blower	MBR Blower	Positive Displacement	114	scfm	CI	Aerzen	GM 4S DN 80	5	460 VAC	6.6	3

No	Equipment Location	Tag	Category	Function	Name	Type	Chosen Size/Capacity	Unit	Material	Manufacturer	Model/ Specification	Motor HP	Voltage	FLA	QTY
26	MBR BLW	n/a	Option	Noise Suppression	MBR Blower Sound Enclosure	With Blower									3
27	MBR BLW	n/a	Option	Blower Temperature	MBR Blower Temperature Gauge	With Blower									3
28	MBR BLW	n/a	Option	Blower Pressure	MBR Blower Pressure Gauge	With Blower									3
29	MBR BLW	n/a	Option	Blower Temperature	MBR Blower Temperature Switch	With Blower									3
30	MBR BLW	01 AFM 01 01 AFM 02	Flow Sensor	Air Flow Measurement	MBR Blower Flow Meter	Thermal Mass	3	inch	PU	Endress & Hauser	t-mass I 300, w/ flow conditioner plate		24VDC		2
31	MBR BLW	n/a	Other Valve	Manual Valves	Air Scour Blower Isolation Valves	Manual Butterfly	3	inch	DI, FKM, SS Disk	Bray	S30				4
	Clean-In-Place Equipment	**x**													
32	SMU CIP	n/a	Chemical Injection	Chemical Injection	SMU CIP System PVC pipes		1	inch	PVC	KUBOTA	Loose ship parts shown on xxx				1
33	SMU CIP	n/a	Flow Sensor	Flow Measurement	CIP solution Flow Meter	Electromagnetic	1	inch	PU				24 VDC		1
34	SMU CIP	n/a	Flow Sensor	Flow Measurement	CIP shelf chenical Flow Meter	Electromagnetic	3/8	inch	PU	Keyence	FD-Q10C		24VDC		1
35	SMU CIP	n/a	Auto Valve	Flow Control	CIP Flow Control Valve	ON/OFF Ball	1	inch	DI	ASAHI	S19-120VAC--1"-C20/S20		120VAC	0.18	1
36	SMU CIP	n/a	Other Valve	Manual Valves	Isolation Valves on CIP Station	Manual Ball	1, 0.5	inch	PVC	ASAHI	Type21 True Union				1
37	SMU CIP	n/a	Other Valve	Manual Valves	Pressure reducing valve	Pressure Reducing	1.5	inch	CI	Zurn	ZW209				1
	System Control Equipment	**x**													
38	CONTROL	n/a	Control Panel	Control Panel	Control Panel	OIT, PLC					NEMA 4/12, 72" x 72" x 18" floor mount enclosure (estimated size) , Allen Bradley 1756-L81E PLC (BABA-Version), FactoryTalk View SE		120VAC	TBD	1
39	D. SERVICE	n/a	D. Service	Direct Service	Direct Service						Design support, start-up, field service, remote service				1

SECTION 2

TU5 SERIES TURBIDIMETERS

Applications
- Drinking Water
- Power
- Beverage
- Pharmaceutical



The next standard in the evolution of turbidity

Only the new TU5 Series Lab & Process Turbidimeters with 360° x 90° Detection™ deliver unprecedented confidence that a change in your reading is a change in your water.

Groundbreaking 360° x 90° Detection™ Technology

The TU5 Series employs a patented optical design that sees more of your sample than any other turbidimeter, delivering the best low level precision and sensitivity while minimizing variability from test to test.

Matching lab and online results

For the first time you will be able to remove the uncertainty of which measurement to trust, thanks to identical 360° x 90° Detection™ Technology in both instruments.

Everything about turbidity – faster

The TU5 Series dramatically reduces the time needed to get a turbidity measurement you can rely on, with 98% less online sample surface area to clean, sealed vials for calibration, and the elimination of the need for indexing and silicone oil in the lab. Not to mention, a smaller online sample volume means you will detect events almost immediately.

No surprises

Prognosys™ monitors your TU5 Series online instrument, proactively alerting you to maintenance needs before your measurement becomes questionable. And a Hach Service Agreement protects your investment and helps ensure that you stay in compliance and on budget.

USEPA and ISO 7027 reporting: The TU5 Series Turbidimeters apply the instrument design and meet performance criteria established by EPA Approved Hach Method 10258 and ISO 7027-1:2016, making them suitable for regulatory reporting.

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Technical Data*

TU5200

Light Source	Class 2 laser product, with embedded 650 nm (EPA 0.43 mW) or Class 1 laser product, with embedded 850 nm (ISO), max. 0.55 mW (complies with IEC/EN 60825-1 and to 21 CFR 1040.10 in accordance with Laser Notice No. 50)
Range	EPA: 0 - 700 NTU / FNU / TE/F / FTU 0 - 100 mg/L 0 - 175 EBC ISO: 0 - 1000 NTU / FNU / TE/F / FTU 0 - 100 mg/L 0 - 250 EBC
Accuracy	±2 % plus 0.01 NTU from 0 - 40 NTU; ±10 % of reading from 40 - 1000 NTU based on Formazin primary standard (at 25 °C)
Resolution	0.0001 NTU / FNU / TE/F / FTU / EBC / mg/L
Repeatability	<40 NTU: Better than 1% of reading or ±0.002 NTU on Formazin at 25 °C, whichever is greater >40 NTU: Better than 3.5% of reading on Formazin at 25 °C
Stray Light	<10 mNTU
Units	NTU, FNU, TE/F, FTU, EBC; mg/L if calibrated with Degrees calibration curve
Operating Temperature Range	10 - 40 °C (50 - 104 °F)
Operating Humidity	80% at 30 °C (non condensing)
Sample Temperature	4 - 70 °C (39 - 158 °F)
Storage Conditions	-30 - 60 °C (-22 - 140 °F)
Power Requirements (Voltage)	100 - 240 VAC
Power Requirements (Hz)	50/60 Hz
Certifications	CE compliant US FDA accession number: 1420493-000 EPA version, 1420492-000 ISO version Complies with IEC/EN 60825-1 and to 21 CFR 1040.10 in accordance with Laser Notice No. 50) Australian ACMA Marking
Dimensions (H x W x D)	195 mm x 409 mm x 278 mm
Weight	2.4 kg (5.29 lbs.)
Warranty	1 year

TU5300 sc / TU5400 sc

Light Source	Class 2 laser product, with embedded 650 nm (EPA 0.43 mW) or Class 1 laser product, with embedded 850 nm (ISO), max. 0.55 mW (complies with IEC/EN 60825-1 and to 21 CFR 1040.10 in accordance with Laser Notice No. 50)
Range	EPA: 0 - 700 NTU / FNU / TE/F / FTU 0 - 100 mg/L 0 - 175 EBC ISO: 0 - 1000 NTU / FNU / TE/F / FTU 0 - 100 mg/L 0 - 250 EBC
Accuracy	±2% or 0.01 NTU from 0 - 40 NTU ±10% of reading from 40 - 1000 NTU based on Formazin primary standard
Resolution	0.0001 NTU / FNU / TE/F / FTU / EBC
Repeatability	Better than 1% of reading or ±0.002 NTU (TU5300) or ±0.0006 NTU (TU5400) on Formazin at 25 °C (77 °F), whichever is greater
Stray Light	<10 mNTU
Units	NTU, FNU, TE/F, FTU, EBC
Signal Average Time	5 - 90 seconds
Response Time	T90 <30 seconds at 100 mL/min
Sample Temperature	2 - 60 °C (35 - 140 °F)
Sample Pressure	6 bar (87 psi) maximum, compared to air at sample temperature range from 2 - 40 °C (35.6 - 104 °F)
Sample Flow Rate	100 - 1000 mL/min; optimal flow rate: 200 - 500 mL/min
Operating Temperature Range	0 - 50 °C (32 - 122 °F)
Operating Humidity	Relative humidity: 5 - 95% at different temperatures, non-condensing
Storage Conditions	-40 - 60 °C (-40 - 140 °F)
Certifications	CE compliant US FDA accession number: 1420493-000 EPA version, 1420492-000 ISO version Complies with IEC/EN 60825-1 and to 21 CFR 1040.10 in accordance with Laser Notice No. 50) Australian ACMA Marking
Dimensions (H x W x D)	249 mm x 268 mm x 190 mm
Weight	5.95 lbs. (2.7 kg); 11 lbs. (5.0 kg) with all accessories
Warranty	1 year

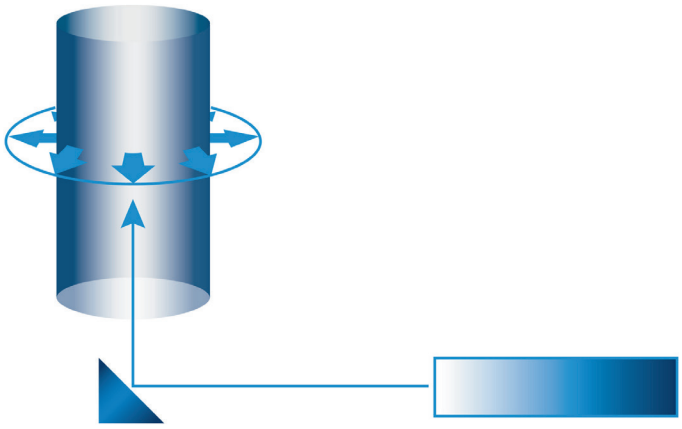
*Subject to change without notice.

Principle of Operation

The TU5 Series turbidimeters measure turbidity by directing a laser into a sample to scatter off suspended particles. The light that is scattered at a 90° angle from the incident beam is reflected through a conical mirror in a 360° ring around the sample before it is captured by a detector.

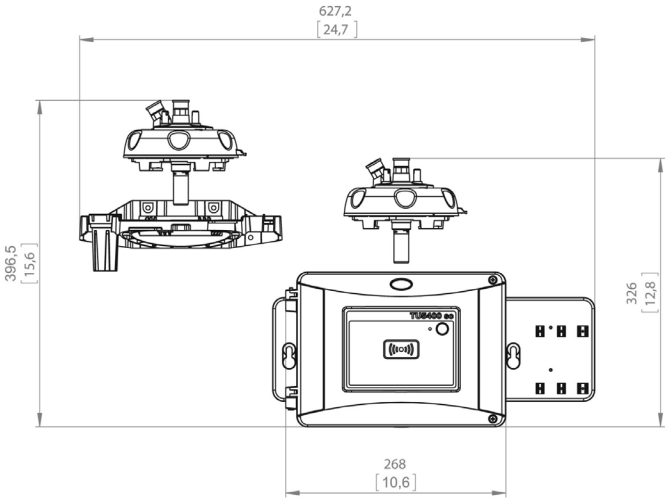
The amount of light scattered is proportional to the turbidity of the sample. If the turbidity of the sample is negligible, little light will be scattered and detected by the photocell and the turbidity reading will be low. High turbidity, on the other hand, will cause a high level of light scattering and result in a high reading.

The 360° x 90° optics of the TU5 series were optimized for high accuracy at low turbidity ranges and therefore the TU5 does not include ratio technology. Ratio technology is only applicable for high turbidity applications which have interference from color and large particles.

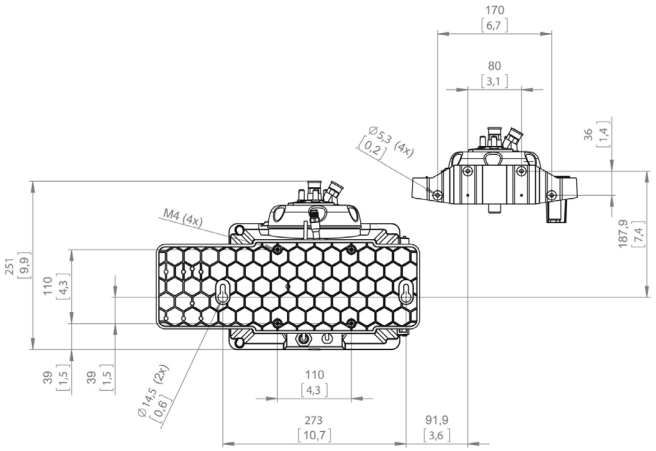


Dimensions

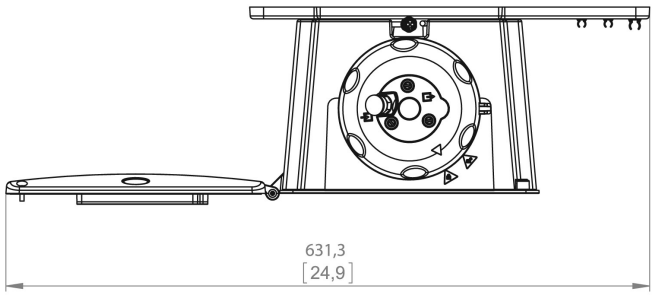
TU5300 sc and TU5400 sc front view



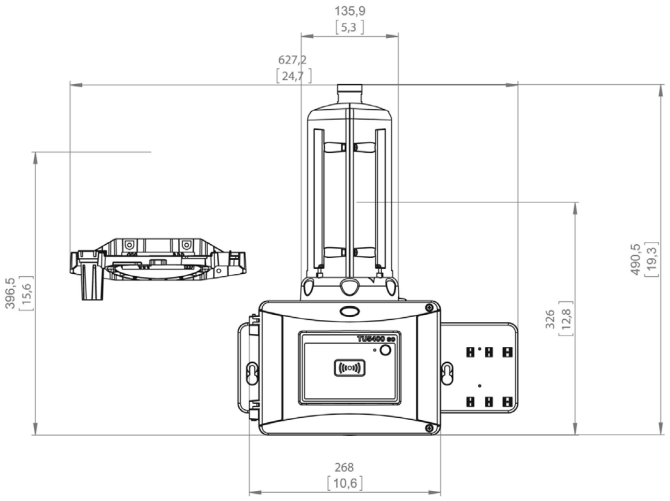
TU5300 sc and TU5400 sc rear view



TU5300 sc and TU5400 sc top view



TU5300 sc and TU5400 sc with automatic cleaning module



Order Information

TU5200 Benchtop Laser Turbidimeters

LPV442.99.03012	TU5200 Benchtop Laser Turbidimeter with RFID, EPA Version
LPV442.99.01012	TU5200 Benchtop Laser Turbidimeter without RFID, EPA Version
LPV442.99.03022	TU5200 Benchtop Laser Turbidimeter with RFID, ISO Version
LPV442.99.01022	TU5200 Benchtop Laser Turbidimeter without RFID, ISO Version

TU5300 sc/TU5400 sc Online Laser Turbidimeters

LXV445.99.10112	TU5300 sc Low Range Laser Turbidimeter, EPA Version
LXV445.99.10212	TU5400 sc Ultra-High Precision Low Range Laser Turbidimeter, EPA Version
LXV445.99.53112	TU5300 sc with Flow Sensor, Automatic Cleaning, RFID, and System Check, EPA Version
LXV445.99.53212	TU5400 sc with Flow Sensor, Automatic Cleaning, RFID, and System Check, EPA Version

Please note: Other turbidimeter configurations are available and RFID may not be available in all areas. Please contact your local Hach representative.

Please note: an SC controller is required for operation of the TU5300 sc or TU5400 sc.





Calibration and Verification

LZY835	StablCal® Calibration Set with RFID
LZY898	StablCal® Calibration Set without RFID
LZY901	Glass Rod Secondary Turbidity Standard <0.1 NTU/FNU
LZY834	Replacement Vial for TU5300 sc and TU5400 sc
LZV946	Sample Vials for TU5200

TU5 Series Accessories

LQV159.97.00002	Automatic Cleaning Module for TU5300 sc and TU5400 sc
LQV160.99.00002	Flow Sensor for TU5300 sc and TU5400 sc
LZY876	Desiccant Cartridge for TU5300 sc and TU5400 sc
LZY907.97.00002	Maintenance Kit for TU5300 sc and TU5400 sc
LQV157.99.50002	SIP10 Sipper Unit for TU5200
LZY903	Manual Vial Wiper for TU5200, TU5300 sc, and TU5400 sc

Other Options included;
LZY873 Service Bracket

calibration standard is included in #LZY907.97.00002

Service Options

Start-Up:

Instrument start-up, Basic instrument training to help you learn how to use your instrument from the first day you use it.

Service Agreement:

Hach offers a wide range of agreements for bench or field service to help you maximize your measurement reliability and instrument uptime.

Contact us to learn about what Hach Service option is right for you.

DOC050.53.10053.Mar17

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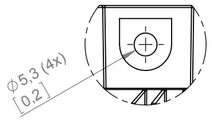
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anyone without direct permission from HACH LANGE GmbH.

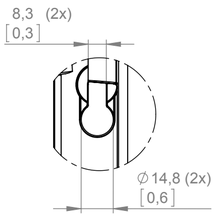
Ohne unsere vorherige Zustimmung darf diese Unterlage
weder vervielfältigt noch Dritten zugänglich gemacht werden.
Insbesondere darf sie auch durch Einsichtnahme Dritten auch nicht in
anderer Weise mißbräuchlich verwertet werden.

Controller

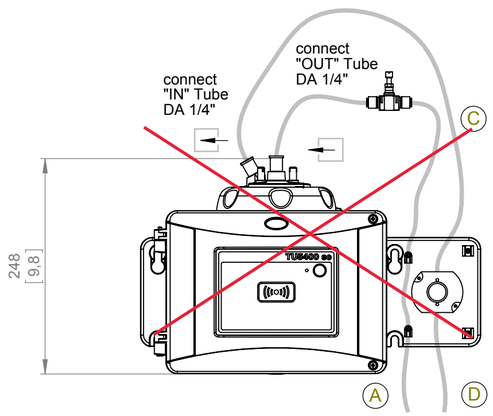
DETAIL Y
SCALE 1 : 1



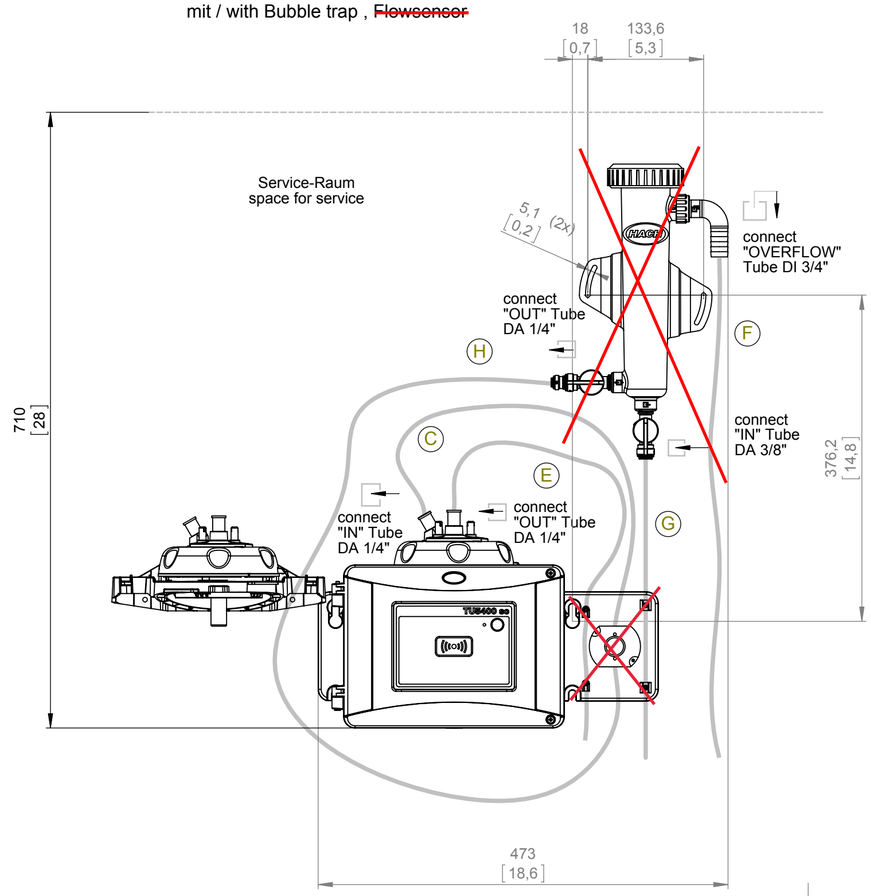
DETAIL Z
SCALE 1 : 2

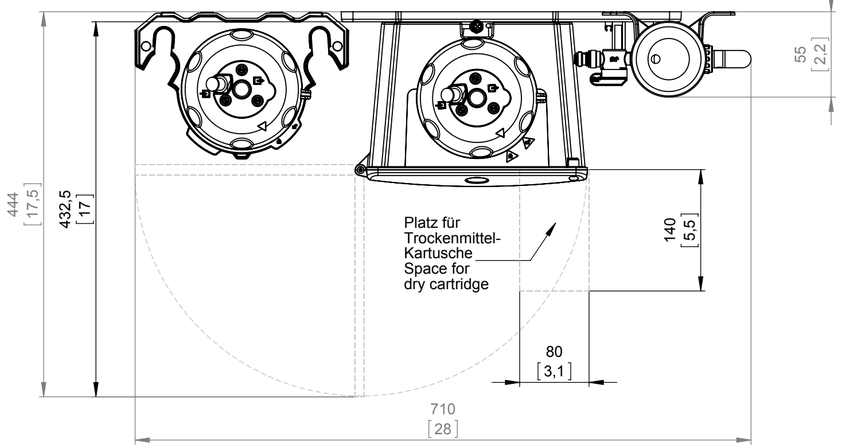


~~mit / with Flowsensor~~



mit / with Bubble trap , ~~Flowsencer~~





	Länge / length mm / inch between clip and instrument Zwischen Befestigungsclip und Instrument	Typ
A	550 [21,6]	1/4"
B	900 [35,4]	1/4"
C	supplied by Hach	1/4"
D	customer	1/4"
E	700 [27,6]	1/4"
F	customer	3/4" DI
G	170 [6,7]	3/8"
H	supplied by Hach 750 [29,5] / ohne / without Flowsensor 560 [22]	1/4"
J	1150 [45,3]	1/4"
K	defined by Hach shortened: 640 [25]	1/4"
L	600 [23,6]	1/4"
M	370 [14,6]	3/8"

SolidWorks

Maße ohne Toleranzangaben General Tolerance		Maßeinheit/Dim.unit mm [inch]	Verwendung Application
		Volumen/Volume 3627086.88	Werkstoff, Halbzeug: Material:
	Datum/Date	Name	
Bearb./Dwn.	13.11.2014	Kra.	
Gepr./Chk.	12.08.2015	Baar	
Rev.-Chk.			

Zust./Rev.	Änderung / Rev.No.	Datum/Date	Name
01		25.03.2015	Kra.

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Maßstab / Scale: 1:5 (1:2 , 1:1)

Benennung / Designation

TU5x00sc
Transmittal-Drawing
without ACM

Zeichnungsnummer / Dwg.No.:
LXV445.TD.00000

Blatt/Sheet 1 v. of 2 Bl. Sht.

Größe / Size: A2

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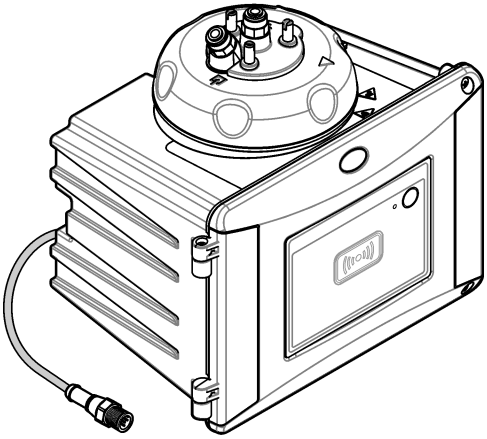
Ausgabe

DOC343.53.90501

TU5300 sc/TU5400 sc

03/2017, Edition 4

User Manual



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Specifications

Specifications are subject to change without notice.

Specification	Details
Measurement method	Nephelometry with scattered light collected at a 90-degree angle to the incident light and 360 degrees around the sample vial
Primary compliance method	EPA approved Hach Method 10258[1]
Enclosure	Material: ASA Luran S 777K / RAL7000, TPE RESIN Elastocon® STK40, Thermoplastic Elastomer TPS-SEBS (60 Shore) and stainless steel
Dimensions (W x D x H)	268 x 249 x 190 mm (10.6 x 9.8 x 7.5 in.)
Weight	Instrument with the process head: 2.7 kg (6.0 lb); Instrument with the optional automatic cleaning module: 5.0 kg (11.0 lb)
Power requirements	12 VDC, 14 VA supplied by the SC controller
Protection class	III
Pollution degree	2
Installation category	II
Mounting	Indoor on a wall
Operating temperature	0 to 50 °C (32 to 122 °F)
Storage temperature	–40 to 60 °C (–40 to 140 °F)
Humidity	5 to 95% relative humidity, non-condensing
Sensor cable length	1.6 m (5.25 ft)[2]
Laser	**Class 2 laser product:** Contains a non user-serviceable class 2 laser.
Optical light source	650 nm, maximum 0.43 mW
Fittings	Sample inlet and outlet: ¼-in. OD tubing
Tubing requirements	Polyethylene, polyamide or polyurethane tubing. Calibrated ¼ in. OD, +0.03 or –0.1 mm (+0.001 or –0.004 in.)
Measurement units	TU5300 sc: NTU, FNU, TE/F, EBC or FTU; TU5400 sc: NTU, mNTU[3], FNU, mFNU, TE/F, EBC, FTU or mFTU.
Range	0 to 700 NTU, FNU, TE/F and FTU; 0 to 175 EBC
Method detection limit	TU5300 sc: 0.002 NTU at 25 °C (77 °F) (< 0.025 NTU range); TU5400 sc: 0.0001 NTU at 25 °C (77 °F) (< 0.025 NTU range)
Response time	T90 < 30 seconds at 100 mL/min
Accuracy	± 2% or ± 0.01 NTU (the larger value) from 0 to 40 NTU ± 10% of reading from 40 to 700 NTU based on Formazin primary standard at 25 °C (77 °F)
Linearity	Better than 1% for 0 to 40 NTU based on Formazin primary standard at 25 °C (77 °F).

1 http://www.hach.com

2 Extension cables are available. The maximum sensor cable length is 50 m (164 ft) when no accessories are connected to the instrument.

3 1 mNTU = 0.001 NTU

Specification	Details
Repeatability	TU5300 sc: 0.002 NTU or 1% (the larger value) at 25 °C (77 °F) (> 0.025 NTU range); TU5400 sc: 0.0006 NTU or 1% (the larger value) at 25 °C (77 °F) (> 0.025 NTU range)
Stray light	< 0.01 NTU
Resolution	0.0001 NTU (0.0001 to 0.9999/1.000 to 9.999/10.00 to 99.99/100.0 to 700 NTU) Default: TU5300 sc: 0.001 NTU and TU5400 sc: 0.0001 NTU
Air bubble compensation	Physical, mathematical
Sample requirements	Temperature: 2 to 60 °C (35.6 to 140 °F) Conductivity: 3000 µS/cm maximum at 25 °C (77 °F) Flow rate[4]: 100 to 1000 mL/min; optimal flow rate: 200 to 500 mL/min Pressure: 6 bar (87 psi) maximum compared to air, 2 to 40 °C (35.6 to 104 °F) sample; 3 bar (43.5 psi) maximum compared to air, 40 to 60 °C (104 to 140 °F) sample
Calibration options	StablCal® or Formazin: 1-point calibration (20 NTU) for 0 to 40 NTU measurement range, 2-point calibration (20 and 600 NTU) for 0 to 700 NTU (full) measurement range or 2- to 6-point custom calibration for a measurement range of 0 NTU to the highest calibration point.
Verification options	Glass verification rod (solid secondary standard) ≤ 0.1 NTU, StablCal or Formazin
Verification (RFID or Link2SC®)	Verification of the measurement value by comparison of the process and lab measurements with RFID or Link2SC.
Certifications	CE compliant; US FDA accession number: 1420493-xxx. This product complies with IEC/EN 60825-1 and to 21 CFR 1040.10 in accordance with Laser Notice No. 50. Australian RCM.
Warranty	1 year (EU: 2 years)

General information

In no event will the manufacturer be liable for direct, indirect, special, incidental or consequential damages resulting from any defect or omission in this manual. The manufacturer reserves the right to make changes in this manual and the products it describes at any time, without notice or obligation. Revised editions are found on the manufacturer's website.

Safety information

NOTICE

The manufacturer is not responsible for any damages due to misapplication or misuse of this product including, without limitation, direct, incidental and consequential damages, and disclaims such damages to the full extent permitted under applicable law. The user is solely responsible to identify critical application risks and install appropriate mechanisms to protect processes during a possible equipment malfunction.

Please read this entire manual before unpacking, setting up or operating this equipment. Pay attention to all danger and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment.

Make sure that the protection provided by this equipment is not impaired. Do not use or install this equipment in any manner other than that specified in this manual.

[4] For the best results, operate the instrument at a flow rate of 200 mL/min when the maximum particle size is 20 µm. For larger particles (150 µm maximum), the best flow rate is 350 to 500 mL/min.

Use of hazard information

⚠ DANGER
Indicates a potentially or imminently hazardous situation which, if not avoided, will result in death or serious injury.

⚠ WARNING
Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION
Indicates a potentially hazardous situation that may result in minor or moderate injury.

NOTICE
Indicates a situation which, if not avoided, may cause damage to the instrument. Information that requires special emphasis.

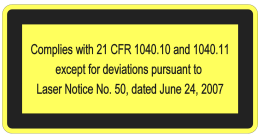
Precautionary labels

Read all labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed. A symbol on the instrument is referenced in the manual with a precautionary statement.

	Electrical equipment marked with this symbol may not be disposed of in European domestic or public disposal systems. Return old or end-of-life equipment to the manufacturer for disposal at no charge to the user.
	This symbol, if noted on the instrument, references the instruction manual for operation and/or safety information.
	This symbol indicates the need for protective eye wear.
	This symbol indicates a laser device is used in the equipment.
	This symbol indicates that the marked item can be hot and should not be touched without care.
	This symbol identifies a risk of chemical harm and indicates that only individuals qualified and trained to work with chemicals should handle chemicals or perform maintenance on chemical delivery systems associated with the equipment.
	This symbol indicates radio waves.

Class 2 laser product

⚠ DANGER	
	Personal injury hazard. Never remove covers from the instrument. This is a laser-based instrument and the user risks injury if exposed to the laser.

	Class 2 laser product, IEC60825-1:2014, 650 nm, maximum 0.43 mW Location: Rear of the instrument.
	Conforms to U.S. regulations 21 CFR 1040.10 and 1040.11 in accordance with Laser Notice No. 50. Location: Rear of the instrument.
	Caution—Class 2 laser radiation when the lid is open. Do not look into the laser beam. Location: Top of the vial compartment.

This instrument is a Class 2 Laser product. There is only visible laser radiation when the instrument is defective and when the instrument lid is open. This product complies with EN 61010-1, "Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use" and with IEC/EN 60825-1, "Safety of Laser Products" and with 21 CFR 1040.10 in accordance with Laser Notice No. 50. Refer to the labels on the instrument that supply laser information.

RFID module

Instruments with the optional RFID module receive and transmit information and data. The RFID module operates with a frequency of 13.56 MHz.

RFID technology is a radio application. Radio applications are subject to national conditions of authorization. The use of instruments with the optional RFID module is currently permitted in the regions that follow:

EU (European Union) countries, EFTA (European Free Trade Association) countries, Turkey, Serbia, Macedonia, Australia, Canada, US, Chile, Ecuador, Venezuela, Mexico, Brazil, South Africa, India, Singapore, Argentina, Columbia, Peru and Panama

The use of instruments with the optional RFID module outside of the above-mentioned regions can violate national laws. The manufacturer reserves the right also to get authorization in other countries. In case of doubt, contact the manufacturer.

Safety information for RFID modules

⚠ WARNING



Multiple hazards. Do not disassemble the instrument for maintenance. If the internal components must be cleaned or repaired, contact the manufacturer.

⚠ WARNING



Electromagnetic radiation hazard. Do not use the instrument in dangerous environments.

NOTICE

This instrument is sensitive to electromagnetic and electromechanical interference. These interferences can have an effect on the analysis performance of this instrument. Do not put this instrument near equipment that can cause interference.

Obey the safety information that follows to operate the instrument in accordance with local, regional and national requirements.

- Do not operate the instrument in hospitals and equivalent establishments or near medical equipment, such as pace makers or hearing aids.
- Do not operate the instrument near highly flammable substances, such as fuels, highly flammable chemicals and explosives.
- Do not operate the instrument near combustible gases, vapors or dust.
- Keep the instrument away from strong vibration or shock.
- The instrument can cause interference in immediate proximity to televisions, radios and computers.
- The warranty does not cover improper use or wear.

FCC conformance for RFID

This instrument may contain a registered radio frequency identification device (RFID). Refer to Table 1 for the Federal Communications Commission (FCC) registration information.

Table 1 Registration information

Parameter	Value
FCC identification number (FCC ID)	YCB-ZBA987
IC	5879A-ZBA987
Frequency	13.56 MHz

Certification

Canadian Radio Interference-Causing Equipment Regulation, IECS-003, Class A:

Supporting test records reside with the manufacturer.

This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de classe A répond à toutes les exigences de la réglementation canadienne sur les équipements provoquant des interférences.

FCC Part 15, Class "A" Limits

Supporting test records reside with the manufacturer. The device complies with Part 15 of the FCC Rules. Operation is subject to the following conditions:

1. The equipment may not cause harmful interference.
2. The equipment must accept any interference received, including interference that may cause undesired operation.

Changes or modifications to this equipment not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at their expense. The following techniques can be used to reduce interference problems:

1. Disconnect the equipment from its power source to verify that it is or is not the source of the interference.
2. If the equipment is connected to the same outlet as the device experiencing interference, connect the equipment to a different outlet.
3. Move the equipment away from the device receiving the interference.

4. Reposition the receiving antenna for the device receiving the interference.
5. Try combinations of the above.

Product overview

⚠ DANGER	
	Chemical or biological hazards. If this instrument is used to monitor a treatment process and/or chemical feed system for which there are regulatory limits and monitoring requirements related to public health, public safety, food or beverage manufacture or processing, it is the responsibility of the user of this instrument to know and abide by any applicable regulation and to have sufficient and appropriate mechanisms in place for compliance with applicable regulations in the event of malfunction of the instrument.

The TU5300 sc and the TU5400 sc turbidimeters are used with an SC controller to measure low-range turbidity mostly in finished drinking water applications. Refer to Figure 1.

The TU5300 sc and the TU5400 sc turbidimeters measure scattered light at an angle of 90° in a 360° radius around the axis of the incident light beam.

An optional RFID module and an automatic system check option are available[5]. The RFID module is shown in Figure 1. The RFID module lets process and laboratory turbidity measurements be easily compared. A description of the automatic system check option is given in Configure the instrument on page 22.

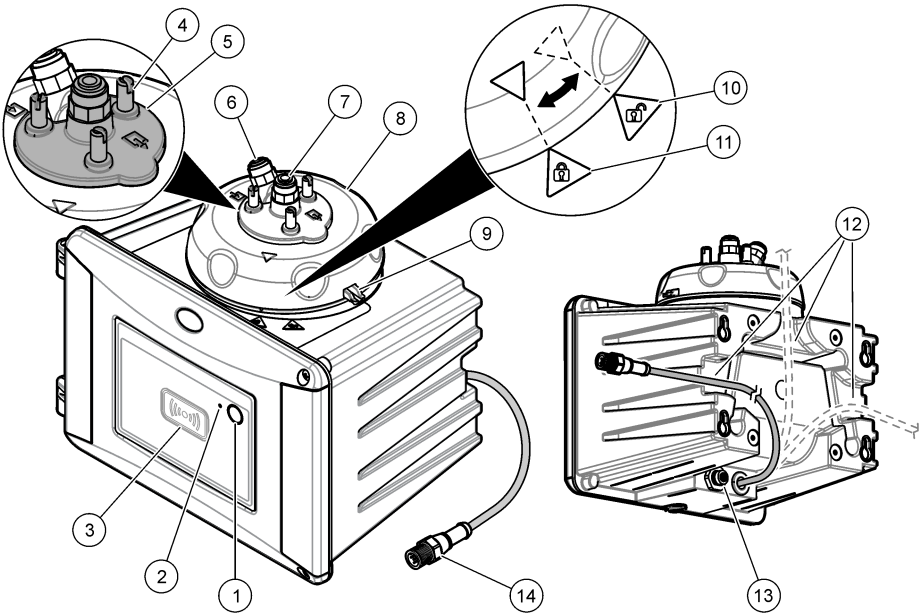
PROGNOSYS predictive diagnostic software is available for the TU5300 sc and TU5400 sc turbidimeters. To use PROGNOSYS, connect the turbidimeter to an SC controller with PROGNOSYS.

Videos on how to install, operate and do maintenance and troubleshooting on the TU5300 sc and the TU5400 sc turbidimeters are available on the *TU5 Series Turbidimeters* playlist at http://www.youtube.com/user/hachcompany.

The accessories are shown in Installation overview on page 11.

[5] The RFID module and automatic system check option is only available at the time of purchase.

Figure 1 Product overview



1 Programmable button	**8** Process head
2 Status indicator light (refer to Status indicator light on page 9)	**9** Overflow drain
3 RFID module indicator (optional)	**10** Process head (open)
4 Cleaning lid screws (3x)	**11** Process head (closed)
5 Cleaning lid	**12** Channels for cables
6 Sample inlet	**13** Extension connector for accessories
7 Sample outlet	**14** Sensor cable

Status indicator light

The status indicator light shows the instrument status. Refer to Table 2 for status descriptions.

Note: *The status indicator light is only on when the SC controller power is set to on and the sensor cable is connected to the sc controller.*

Table 2 Status indicator light

Color	Status
Green (stable)	The instrument is in operation. The instrument status is ok—no warnings, errors or reminders.
Green (flashes)	Calibration is complete. The instrument status is ok.
	Verification is complete. The instrument status is ok.
Yellow (stable)	Read the warning that shows on the controller display. Refer to Warnings on page 47 for the warning description and solution.
Yellow (flashes)	The instrument is in Service Mode.
	An automatic cleaning is in progress.

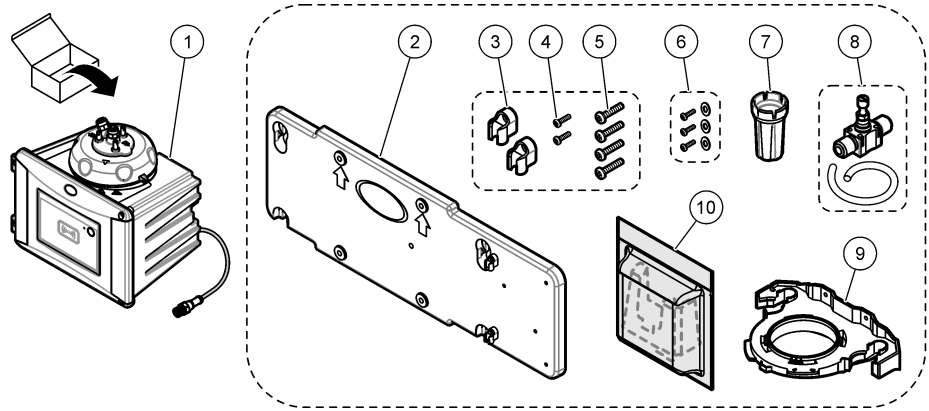
Table 2 Status indicator light (continued)

Color	Status
Yellow (flashes slow)	The optional flow sensor has identified that there is no sample flow or the sample flow is lower than the limit. Read the warning that shows on the controller display. Refer to Warnings on page 47 for the warning description and solution.
Yellow (flashes fast)	The optional flow sensor has identified that the sample flow rate is higher than the limit. Read the warning that shows on the controller display. Refer to Warnings on page 47 for the warning description and solution.
Red (stable)	Read the error that shows on the controller display. Refer to Errors on page 48 for the error description and solution.
Red (flashes)	Calibration or verification was not completed.
	The instrument cannot start calibration or verification for one or more reason that follows. • The standard expired. • The first measurement of the verification standard was done with a different method (EPA/ISO). • The first measurement value of the verification standard is missing.
Blue (stable)	A calibration or verification is started.
Blue (flashes)	A calibration or verification measurement is started.
Blue (flashes fast)	A calibration or verification is started with RFID.

Product components

Make sure that all components have been received. Refer to Figure 2. If any items are missing or damaged, contact the manufacturer or a sales representative immediately.

Figure 2 Product components



1 TU5300 sc or TU5400 sc	**6** Cleaning lid screws and washers for hot water applications
2 Wall mount bracket (two tubing clips on bracket)	**7** Vial replacement tool
3 Tubing clips	**8** Flow regulator
4 Tubing clip screws, 2.2 x 6 mm	**9** Service bracket
5 Mounting screws, 4 x 16 mm	**10** Desiccant cartridge

Installation

⚠ CAUTION

Multiple hazards. Only qualified personnel must conduct the tasks described in this section of the document.

Installation guidelines

NOTICE

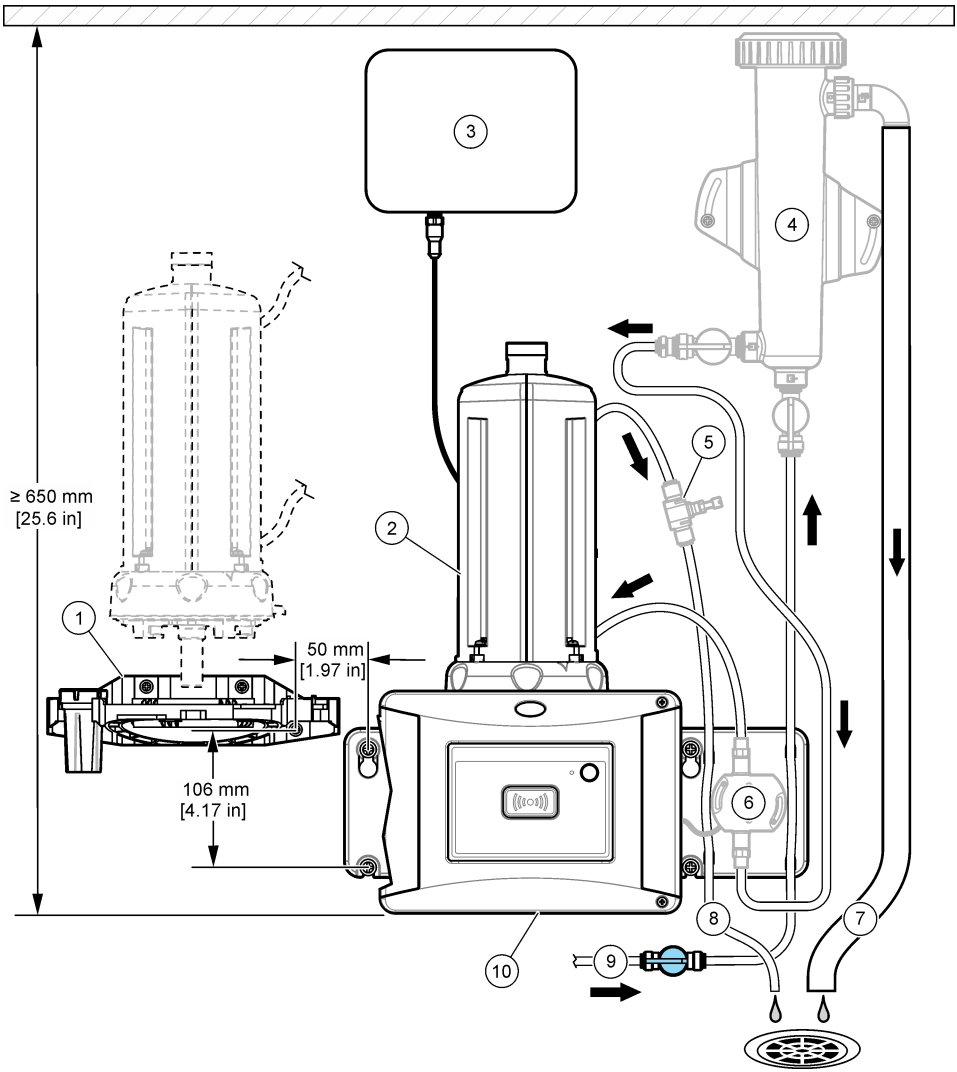
Make sure that there is a floor drain near the instrument. Examine the instrument daily for leaks.

This instrument is rated for an altitude of 3100 m (10,710 ft) maximum. Use of this instrument at an altitude higher than 3100 m can slightly increase the potential for the electrical insulation to break down, which can result in an electric shock hazard. The manufacturer recommends that users with concerns contact technical support.

Installation overview

Figure 3 shows the installation overview with all of the accessories and the clearances necessary.

Figure 3 Installation overview with accessories



1 Service bracket	**6** Flow sensor (accessory)
2 Automatic cleaning module (accessory)	**7** Bubble trap overflow
3 SC controller	**8** Sample outlet
4 Bubble trap (accessory)	**9** Sample inlet
5 Flow regulator[6]	**10** TU5300 sc or TU5400 sc

[6] Not used with the bubble trap.

Wall mount

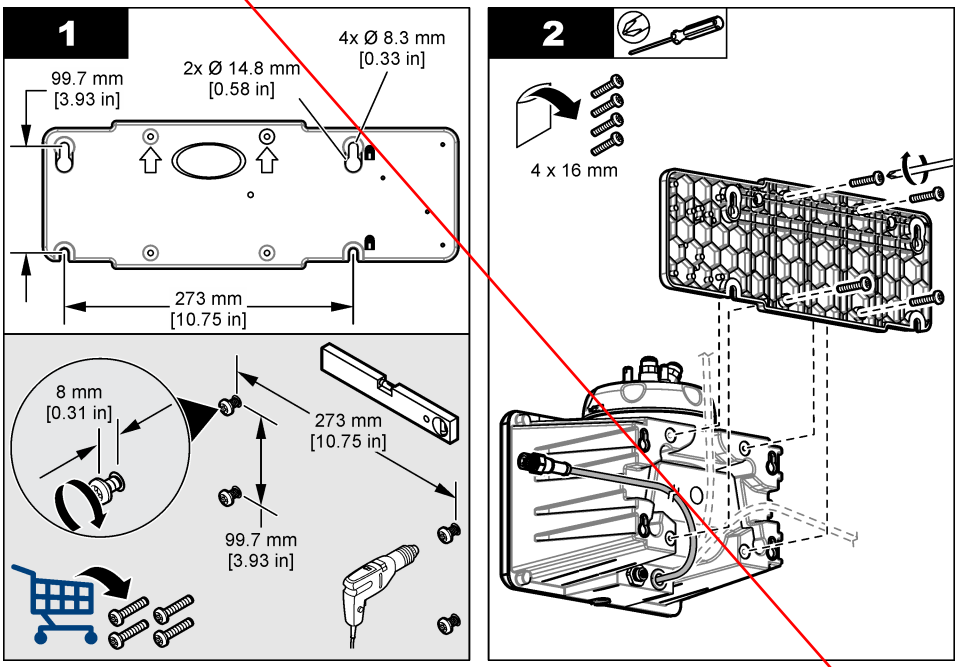
Install the instrument on a wall in a vertical position. Install the instrument so that it is level.

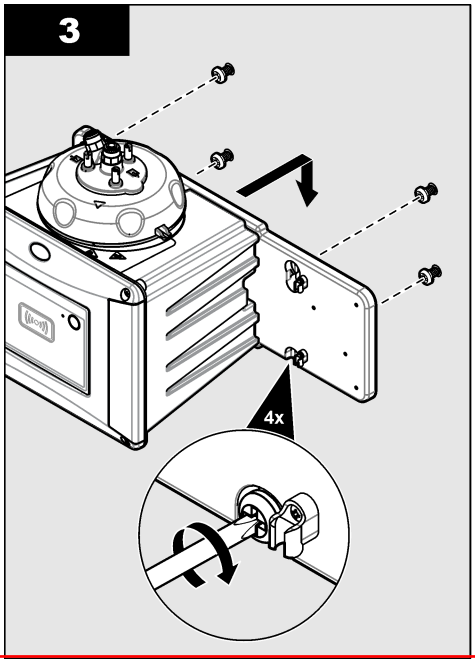
Install with the wall mount bracket

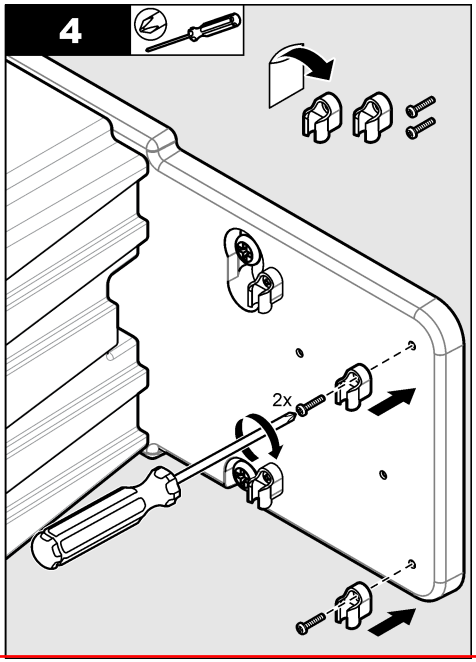
Refer to the illustrated steps that follow to install the instrument on a wall with the wall mount bracket. The mounting hardware to install the wall mount bracket on a wall is supplied by the user.

If a 1720D, 1720E, or FT660 instrument is replaced, remove the instrument from the wall. Then do steps 2 to 4 of the illustrated steps that follow to install the instrument on the existing hardware.

Note: *When the accessories are used, the installation location of the tubing clips is different. Refer to the documentation supplied with the accessories for tubing clip installation.*

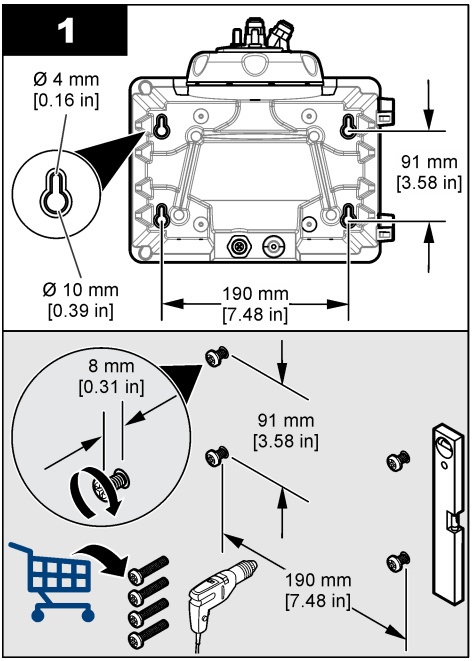


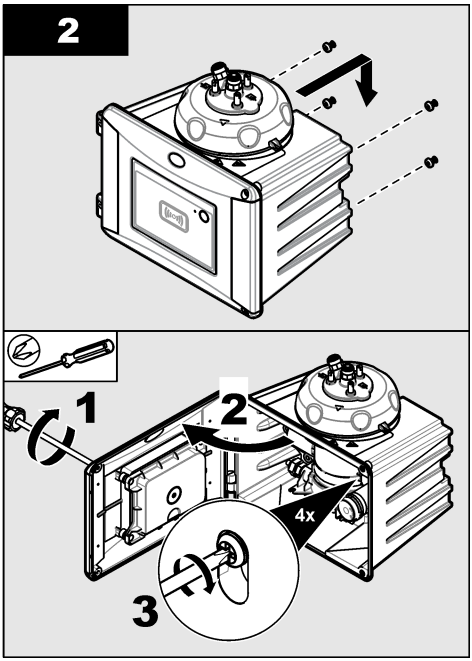




Install directly on a wall

As an alternative, refer to the illustrated steps that follow to install the instrument directly on a wall. The mounting hardware is supplied by the user. Remove the thin, plastic film from the mounting holes on the back of the instrument.





Install the desiccant cartridge

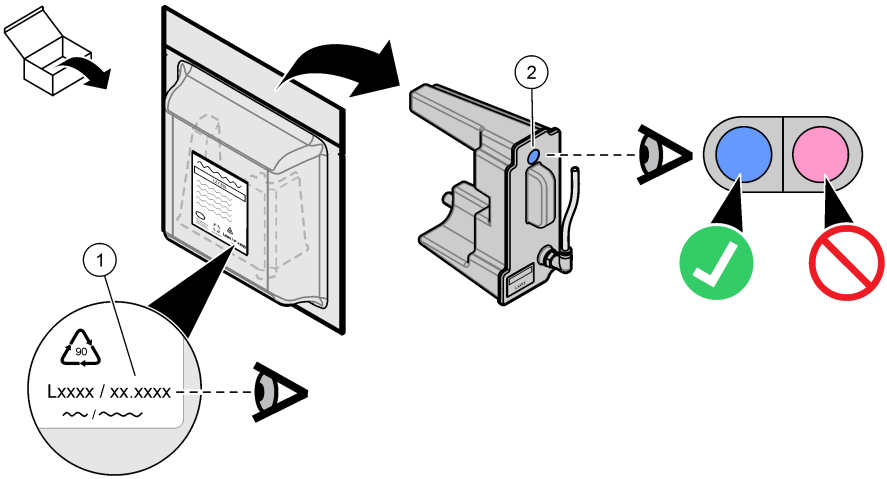
NOTICE

Make sure that the desiccant cartridge is installed or damage to the instrument will occur.

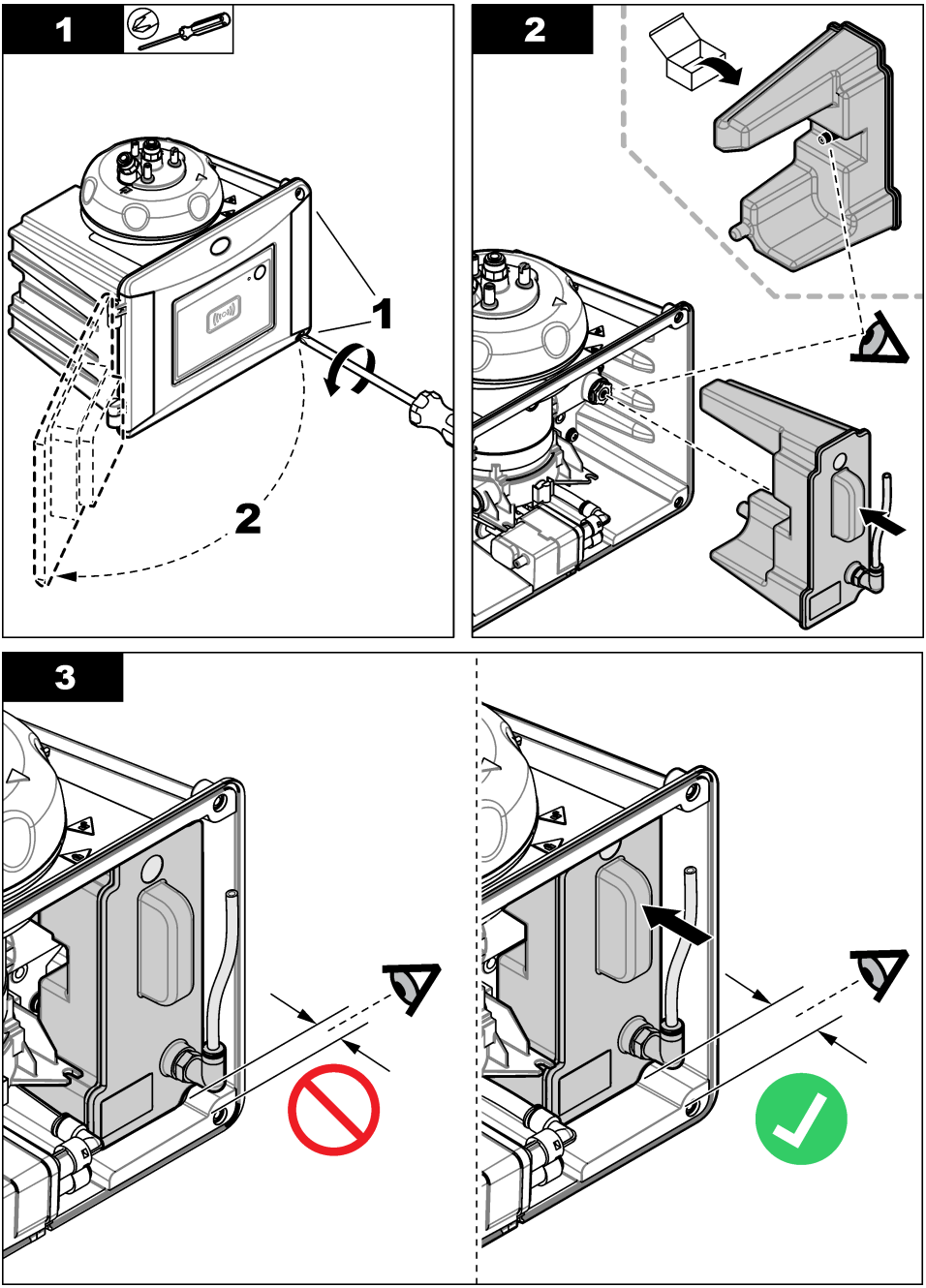
For initial installation, complete the steps below. For replacement, refer to the documentation supplied with the desiccant cartridge.

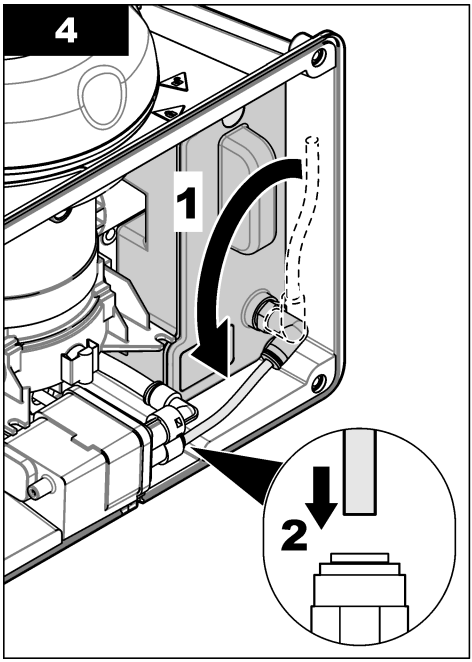
1. Look at the install by date on the packaging. Refer to Figure 4. Do not use if the current date is past the install by date.
2. Make sure that the indicator on the new desiccant cartridge is blue. Refer to Figure 4.
3. Install the new desiccant cartridge. Refer to the illustrated steps that follow.

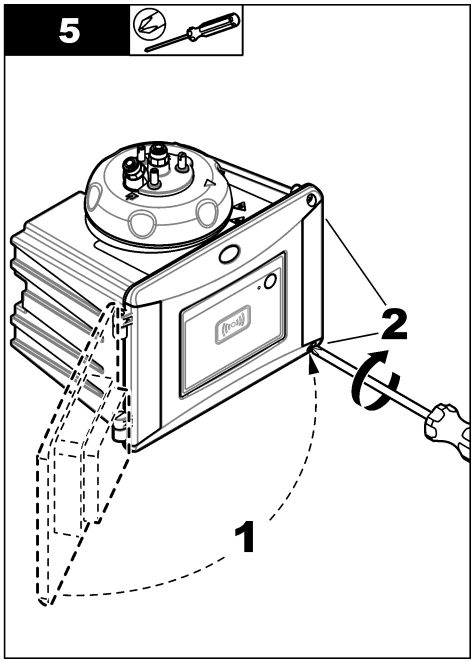
Figure 4 Examine the desiccant cartridge



1 Install by date (mm.yyyy = month and year)	**2** Indicator (blue = not expired, pink = expired)


1
1
2
2
3





Replace the cleaning lid screws

NOTICE

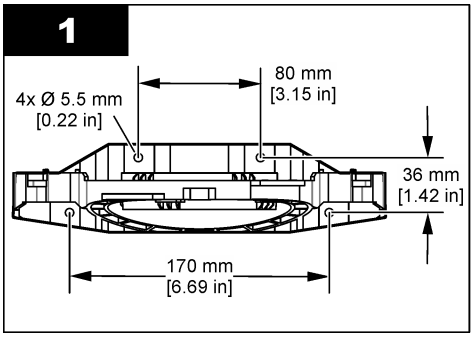
Do not overtighten the screws or breakage will occur. Hand tighten the screws.

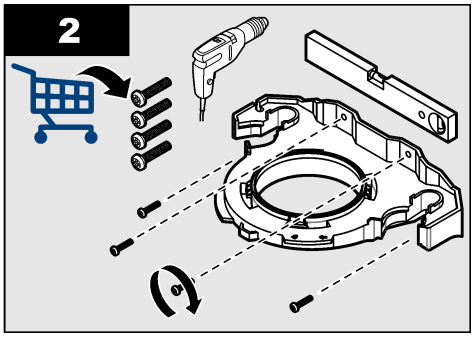
If the sample temperature is 40 to 60 °C (104 to 140 °F), the cleaning lid screws will become hot. To prevent burns, replace the standard cleaning lid screws with the cleaning lid screws and washers for hot water. Refer to Figure 1 on page 9 for the location of the cleaning lid screws.

Install the service bracket

The service bracket holds the process head (or the optional automatic cleaning module) when it is not installed on the instrument.

Refer to Installation overview on page 11 to install the service bracket the correct distance from the instrument. Refer to the illustrated steps that follow to install the service bracket.





Install the flow sensor (optional)

The optional flow sensor identifies if the sample flow is within specifications. A warning shows on the controller display and the status indicator light when a no flow, low flow or high flow warning occurs.

Install the optional flow sensor. Refer to the documentation supplied with the optional flow sensor.

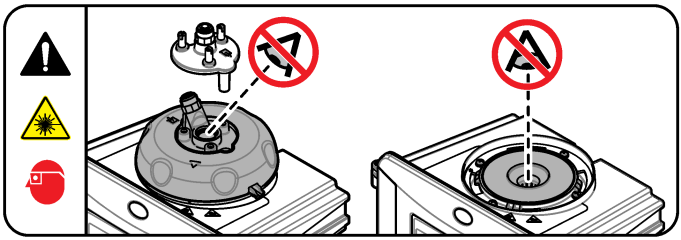
Install the automatic cleaning module (optional)

The automatic cleaning module cleans the inside of the process vial at a selected time interval. Install the optional automatic cleaning module. Refer to the documentation supplied with the automatic cleaning module.

Connect to an SC controller

⚠ CAUTION

Personal injury hazard. Do not look into the vial compartment when the instrument is connected to power.



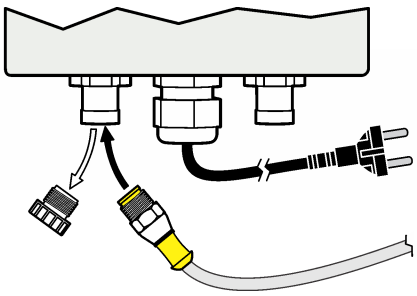
1. Install the latest software version on the SC controller before the instrument is connected to the SC controller. Get the latest software version from www.hach.com.

   Refer to the software installation instructions supplied in the box or supplied in the software download for the SC controller.
2. Remove power to the SC controller.
3. Connect the sensor cable to the quick-connect fitting of the SC controller. Refer to Figure 5. Keep the connector cap for later use.
4. Supply power to the SC controller.

   The SC controller looks for the instrument.
5. When the SC controller finds the instrument, push **enter**.

   On the main screen, the controller shows the turbidity value measured by the turbidimeter.

Figure 5 Connect the sensor cable to the SC controller



Plumbing

Plumb the instrument

⚠ WARNING



Explosion hazard. Make sure that the drain tube is free of all obstructions. If the drain tube has a blockage or is pinched or bent, high pressure can build up in the instrument.

⚠ WARNING



Personal injury hazard. The sample line contains water under high water pressure that can burn skin if hot. Qualified personnel must remove the water pressure and wear personal protective equipment during this procedure.

NOTICE

Do not let water get in the vial compartment or instrument damage will occur. Before the process head is installed on the instrument, make sure that there are no water leaks. Make sure that all tubing is fully seated. Make sure that the vial nut is tight.

NOTICE

Before the instrument is plumbed, make sure that the desiccant cartridge and vial are installed.

Items supplied by the user:

- Flow shutoff valve
- Tubing[7]
- Tubing cutter

1. Plumb the instrument. Refer to the illustrated steps that follow and Figure 6.

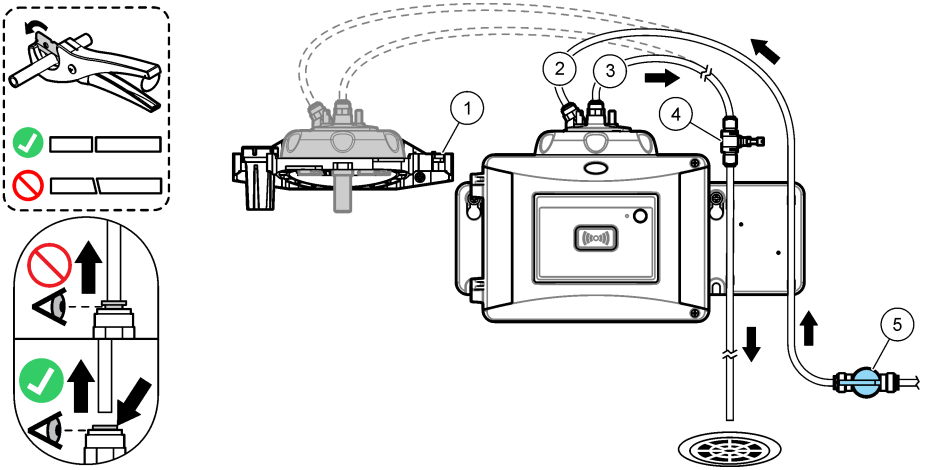
   Note: *To plumb the instrument with accessories, refer to the documentation supplied with the accessories.*

2. If a service bracket is not installed near the instrument, do the steps that follow:

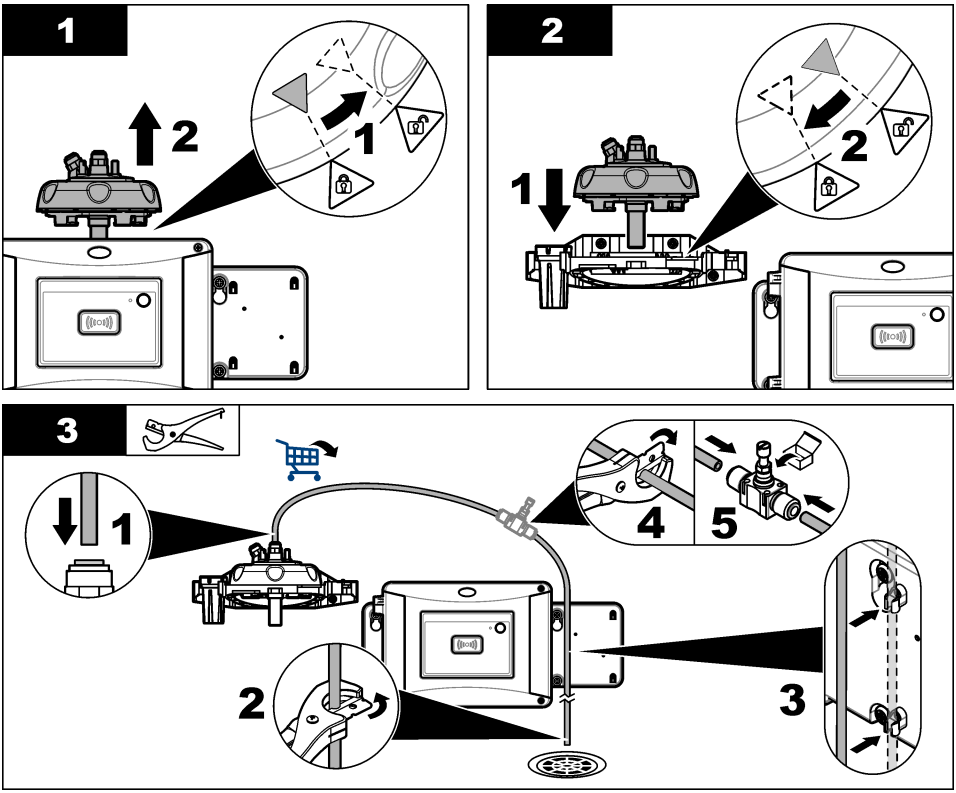
   a. Do not do illustrated steps 1 and 2.
   b. Do illustrated steps 3 and 4 with the process head on the instrument.
   c. Before step 5, remove the process head from the instrument.
   d. Hold the process head so that it is not above the instrument or put the process head on the optional process head holder.
   e. Do illustrated steps 5 and 6.
   f. When there are no leaks from the process head or the flow regulator, install the process head on the instrument (illustrated step 8).

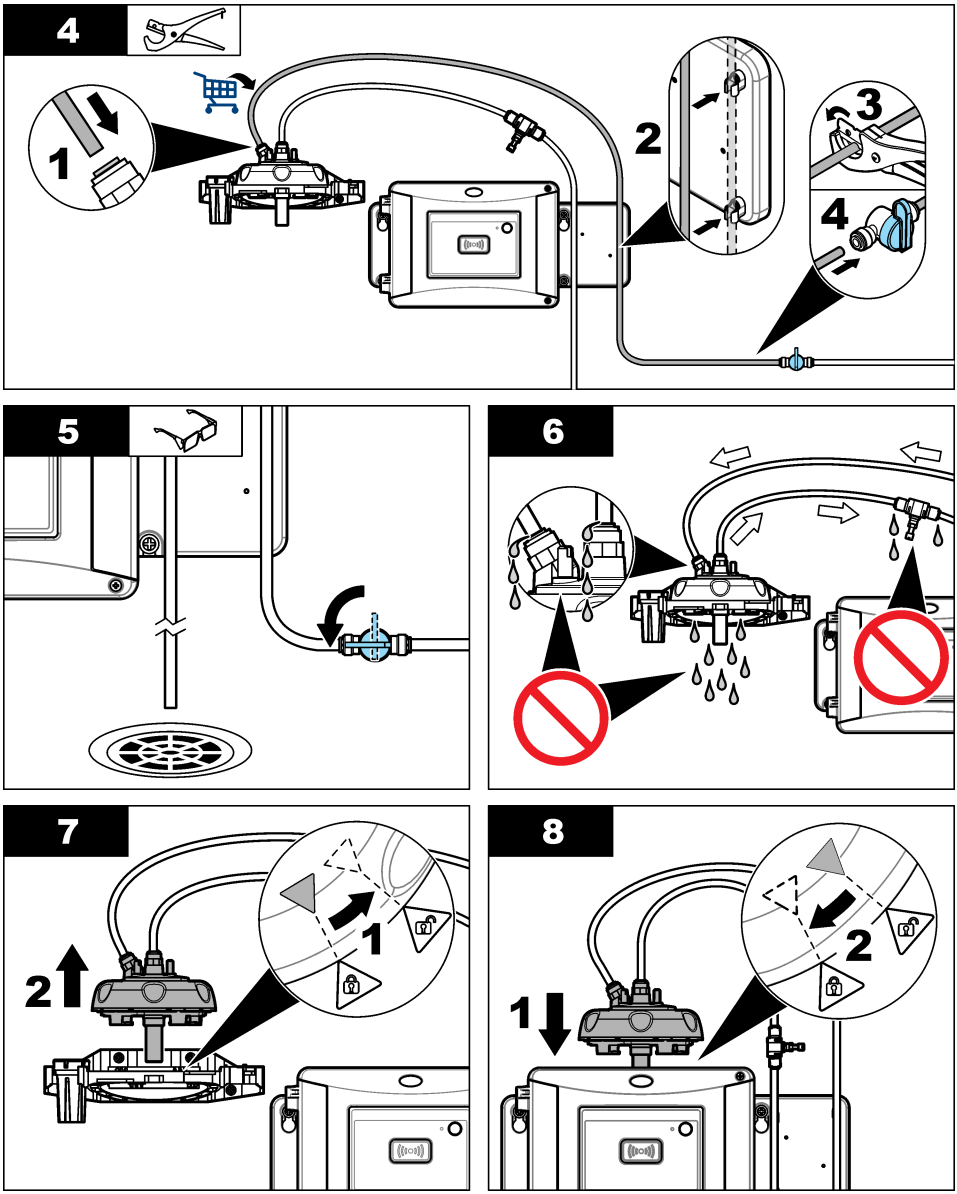
[7] Refer to Specifications on page 3 for the tubing requirements.

Figure 6 Plumbing overview – no accessories



1 Service bracket	**4** Flow regulator
2 Sample inlet	**5** Flow shutoff valve
3 Sample outlet	





Set the flow rate

1. Measure the flow with the flow regulator fully open. Make sure that the flow is in the middle of the flow specification. Refer to Specifications on page 3.
2. Slowly close the flow regulator until the flow decreases by 20 to 30%.
   Note: *The flow regulator causes back pressure in the tubing and decreases the quantity of bubbles that can form in the vial.*

User navigation

Refer to the controller documentation for keypad description and navigation information.

Operation

Configure the instrument

Select the location name, signal averaging, measurement units, resolution, bubble reject, logger interval, programmable button function and more.

1. Push **menu**.
2. Select SENSOR SETUP>TU5x00 sc>CONFIGURE.
3. Select an option.

Option	Description
LOCATION	Sets the name or location of the sample source. The name or location entered shows on the measurement screen (16 characters maximum, default: serial number).
SIGNAL AVG	When enabled, the turbidity reading that shows on the controller display is an average of the values measured during the time interval selected. Options: 5 to 90 seconds (default: 30 seconds). ***Note:*** *The manufacturer recommends that the Signal Average setting be set to 30 seconds or less because of the fast response of the instrument.*
MEAS UNITS	Selects the measurement units that show on the controller display and that are recorded to the data log. TU5300 sc options: NTU, FNU, TE/F, EBC or FTU. TU5400 sc options: NTU, mNTU, FNU, mFNU, TE/F, EBC, FTU or mFTU. Default: NTU.
RESOLUTION	Selects the number of decimal places that show on the controller display. Options: 0.001 or 0.0001. TU5300 sc default: 0.001. TU5400 sc default: 0.0001.
BUBBLE REJECT	Sets the bubble reject to on (default) or off. When set to on, high turbidity readings caused by bubbles in the sample are not shown or saved to the data log.
LOGGER INTERVAL	Sets the frequency that the turbidity reading is saved to the data log. Options: 5 or 30 seconds or 1, 2, 5, 10 (default), 15 or 30 minutes.
CLEANING	Configures the optional automatic cleaning module settings. Refer to the documentation supplied with the automatic cleaning module to configure the CLEANING setting. This option only shows when CLEANING MODULE is set to ON.
SET DEFAULTS	Sets the instrument settings to the factory defaults.
BUTTON FUNCTION	Sets the function of the programmable button. Refer to Figure 1 on page 9. **SERVICE**—When the button is pushed, changes the output mode to HOLD if the output mode is currently ACTIVE and changes the output mode to ACTIVE if the output mode is currently HOLD. **LINK2SC**—When the button is pushed, makes a Link2SC job file. Refer to Compare measurements with Link2SC on page 24. **OFF** (default) —Disables the button. In addition, when CLEANING MODULE is set to ON, the options that follow show. **START WIPE**—When the button is pushed, start a wiper cleaning cycle. **WIPER REPLACE**—When the button is pushed, puts the wiper in the position for wiper replacement.
FLOW SENSOR	Enables or disables the flow signal to show on the measurement screen and the DIAG/TEST>SIGNALS screen. Enables or disables flow signal warnings and errors to occur. When the optional flow sensor is installed, set to ON (default: OFF).

Option	Description
CLEANING MODULE	Enables or disables the automatic cleaning module menu options. When the optional automatic cleaning module is installed, set to ON (default: OFF). When this option is set to ON, the START WIPE option shows in the main SENSOR SETUP menu.
AUTO-CHECK	Sets the time interval and sensitivity of the automatic system check. This option only shows when the instrument has the automatic system check option. **CHECK INTERVAL**—Sets the time interval between automatic system checks. The automatic system check examines the condition of the vial. If the condition of the vial is bad, a warning message shows on the controller display. Options: OFF, 1, 2 (default), 3, 6, 12 hours or 1 day. **SENSITIVITY**—Sets the sensitivity of the automatic system check to the condition of the vial. Options: HIGH or LOW.

Show instrument information

Show instrument information and the instrument status to get diagnostic information.

1. Push **menu**.
2. Select SENSOR SETUP>TU5x00 sc>DIAG/TEST.
3. Select an option.

Option	Description
SENSOR INFO	Shows the sensor name, location, serial number, type (EPA or ISO), model number, software version and measurement device version.
SIGNALS	Shows real-time values for turbidity, flow rate[8], the humidity set point and the air system humidity and temperature. Shows the vial condition (condensation and clarity) and the vial status (installed or not installed). Shows the lid type installed (calibration lid or process head).
COUNTERS	Shows the total operational time of the instrument, remaining number of wiper cycles, date the vial was installed/replaced, date the vial was cleaned, date of calibration, date of verification, operational time of the desiccant, remaining desiccant life, operational time of the air pump and date factory service was done. ***Note:*** *The counters are reset when menu-guided maintenance is done. Refer to the MAINTENANCE option that follows.*
MAINTENANCE	Starts menu-guided maintenance to replace or clean the vial, replace the wiper or replace the desiccant cartridge. **START WIPE**—Starts a wiper cleaning when the optional automatic cleaning module is installed. **OUTPUT MODE**—Selects the output behaviour during maintenance (default: HOLD). **FACTORY SERVICE**—For service use only.

Compare process and laboratory measurements

Compare process and laboratory measurements with RFID or Link2SC. Make sure that the process and lab instrument are calibrated with the same number of calibration points and with the same standards. Make sure that the calibrations are not expired.

Collect a grab sample

Collect a 100-mL sample (minimum) from the sample outlet tubing of the process instrument. Collect the sample in a clean glass bottle with a tight-fitting cap. Do not collect samples directly into a sample vial.

1. Rinse the glass bottle a minimum of three times with water from the sample outlet tubing of the process instrument. Let the bottle overflow with the sample.
2. Collect a 100-mL sample (minimum) in the glass bottle from the sample outlet tubing of the process instrument.

[8] A value less than 0.1 shows if the optional flow sensor is not installed.

3. Put the cap on the sample bottle.
4. Analyze the grab sample immediately with the laboratory instrument to prevent settling, bacteria growth and temperature changes.

Compare measurements with RFID

When the process instrument and laboratory instrument have the optional RFID module, compare process and laboratory measurements with RFID.

Items to collect:

- TU5300 sc or TU5400 sc with the optional RFID module
- TU5200 with the optional RFID module
- TU5200 sample vials
- Glass sample bottle with a sample RFID sticker
- Operator RFID tag (optional)

1. At the process instrument, put the operator RFID tag (if available) near the RFID module. Refer to Figure 1 on page 9 for the location of the RFID module.
2. Put a sample RFID sticker on the sample bottle.
3. Collect a grab sample. Refer to Collect a grab sample on page 23.
4. At the process instrument, put the RFID sticker that is on the sample bottle near the RFID module.

   The instrument gives a sound signal. The status indicator light changes to blue.

   The turbidity reading, operator ID (if available), location of the process instrument and the date and time are recorded on the RFID sticker.
5. Move the grab sample bottle to the laboratory instrument.
6. On the TU5200, push **Options**>**Reading Setup**.
7. Push **Bubble Reject**, then set bubble reject to on.
8. If the grab sample is 1 NTU or less, push **Reading**>**Minimum Mode**, then select 60 seconds.

   Note: *In minimum mode, readings are done continuously for 60 seconds when a measurement is done. The smallest reading within 60 seconds is saved to the data log.*
9. At the laboratory instrument, put the operator RFID tag (if available) near the RFID module to log in.
10. Put the RFID sticker that is on the sample bottle near the RFID module.

    The instrument gives a sound signal. The turbidity reading from the process instrument shows on the display.
11. Prepare a grab sample vial. Refer to *Prepare a sample vial* in the TU5200 documentation.
12. Measure the turbidity of the grab sample with the laboratory instrument. Refer to the TU5200 documentation.

    If the difference between the process and laboratory measurements is not more than the selected acceptance range, "Measurement values match." shows on the display. Refer to the TU5200 documentation to select the acceptance range.

    If "Measurement values do not match." shows on the display, click the link to show the troubleshooting steps.
13. To show the compare log, push **Options**>**Compare Log**. Refer to the TU5200 documentation for more options.
14. To send the verification data to external devices that are connected to the instrument, push **Options**>**Send Data**. Refer to the TU5200 documentation for more options.

Compare measurements with Link2SC

When the process instrument and laboratory instrument do not have the optional RFID module, compare the process and laboratory measurements with Link2SC.

Items to collect:

- TU5300 sc or TU5400 sc
- TU5200
- TU5200 sample vials
- SD card[9] (or a LAN connection at the SC controller[10] and the laboratory instrument[11])
- USB adapter for the SD card (if used)

1. Collect a grab sample. Refer to Collect a grab sample on page 23.
2. If the SC controller and laboratory instrument do not have a LAN connection, install the SD card in the SC controller. Refer to the SC controller documentation to install the SD card.
3. At the SC controller, make a Link2SC job file as follows:

   a. Push **menu**.
   b. Select LINK2SC>CREATE A NEW JOB>TU5x00 sc.
   The SC controller makes a Link2SC job file. The turbidity reading, operator ID (if available), location of the process instrument and the date and time are recorded to the job file.

   In addition, the temperature, calibration settings, bubble reject setting, vial clarity and desiccant cartridge life are recorded to the Link2SC job file.
4. Push **OK**, then **YES**.
5. Select JOB>LAB.
   The Link2SC job file is saved to the SD card (if available) or sent to the laboratory instrument (when the SC controller and laboratory instrument have a LAN connection).

   To see the Link2SC job files on the SD card, select JOBS FROM CARD.
6. If the SC controller and laboratory instrument do not have a LAN connection, complete the steps that follow.

   a. Remove the SD card from the SC controller.
   b. At the laboratory instrument, put the SD card in the USB adapter. Then put the USB adapter in a USB port type A on the laboratory instrument.
7. Move the grab sample bottle to the laboratory instrument.
8. On the TU5200, push **Options**>**Reading Setup**.
9. Push **Bubble Reject**, then set bubble reject to on.
10. If the grab sample is 1 NTU or less, push **Reading**>**Minimum Mode**, then select 60 seconds.

    Note: *In minimum mode, readings are done continuously for 60 seconds when a measurement is done. The smallest reading within 60 seconds is saved to the data log.*
11. At the laboratory instrument, push the **LINK2SC** to show the job list.
12. Select the latest Link2SC job file.

    The turbidity measurement from the process instrument shows on the right side of the display.
13. Prepare a grab sample vial. Refer to *Prepare a sample vial* in the TU5200 documentation.
14. Measure the turbidity of the grab sample with the laboratory instrument. Refer to the TU5200 documentation.

    If the difference between the process and laboratory measurements is not more than the selected acceptance range, "Measurement values match." shows on the display. Refer to to select the acceptance range.

    If "Measurement values do not match." shows on the display, click the link to show the troubleshooting steps.

[9] Refer to the SC controller documentation for the SD card requirements.
[10] Refer to the SC controller documentation to set up a LAN connection at the SC controller.
[11] Refer to the TU5200 documentation to set up a LAN connection at the laboratory instrument.

15. To show the compare log, push **Options**>**Compare Log**. Refer to the TU5200 documentation for more options.
16. To send the verification data to external devices that are connected to the instrument, push **Options**>**Send Data**. Refer to the TU5200 documentation for more options.

Configure the Link2SC settings

Select the acceptance range permitted when process and laboratory measurements are compared with Link2SC.

1. Push **menu**.
2. Select SENSOR SETUP>TU5x00 sc>LINK2SC.
3. Select an option.

Option	Description
ACCEPT. UNIT	Sets the units used to compare the process and laboratory measurements. Options: %, NTU or LAB. Select LAB when the acceptance range is supplied by the laboratory instrument.
ACCEPT. RANGE	Sets the maximum difference permitted between the process and laboratory measurements. Options: 1 to 50% (default: 10%). This option only shows when ACCEPT. UNIT is set to % or NTU.

Calibration

⚠ WARNING



Chemical exposure hazard. Obey laboratory safety procedures and wear all of the personal protective equipment appropriate to the chemicals that are handled. Refer to the current safety data sheets (MSDS/SDS) for safety protocols.

When the instrument is used for US EPA regulatory reporting, calibrations must be done according to US EPA guidance documents and methodologies. Contact local regulating authorities for additional compliance regulations.

The instrument is factory calibrated and the laser light source is stable. The manufacturer recommends that a calibration verification be done periodically to make sure that the system operates as intended. The manufacturer recommends calibration as local regulations require and after repairs or comprehensive maintenance work.

Use the optional calibration lid and a vial(s) with a StablCal standard or Formazin standard to calibrate the instrument. As an alternative, use a syringe and StablCal standard or Formazin standard to calibrate the instrument.

Configure the calibration settings

Select the calibration curve, calibration interval, output behavior during calibration and more.

1. Push **menu**.
2. Select SENSOR SETUP>TU5x00 sc>CALIBRATION>SETUP.
3. Select an option.

Option	Description
MENU GUIDED	Sets menu-guided calibration to SEALED VIAL, SYRINGE or OFF (default). Calibration instructions show on the controller display during calibration when set to SEALED VIAL or SYRINGE.

Option	Description
CAL CURVE	Selects the type of standard and the calibration curve (range). **STABLCAL 0–40 NTU** (default)—1-point calibration (20 NTU) with StablCal. **STABLCAL 0–700 NTU**—2-point calibration (20 NTU and 600 NTU) with StablCal. **FORMAZIN 0–40 NTU**—2-point calibration (20 NTU and dilution water) with Formazin. **FORMAZIN 0–700 NTU**—3-point calibration (20 NTU and 600 NTU and dilution water) with Formazin. **CUSTOM**—2- to 6-point calibration (0.02 to 700 NTU) with StablCal or Formazin. The user selects the number of calibration points and the value of each calibration point.
VER AFTER CAL	Sets the instrument to start a verification immediately after the instrument is calibrated. When set to on, the verification standard is measured immediately after a calibration is done. Default: ON.
CAL REMINDER	Sets the time interval between calibrations. The controller will show a reminder when a calibration is due. When a calibration is done, the calibration time is set to zero. Options: OFF(default), 1 day, 7 days, 30 days or 90 days.
OUTPUT MODE	Selects the output behavior during calibration. **ACTIVE**-The outputs continues to agree with the operating conditions. **HOLD** (default)-Keeps the outputs at the last known value when communication is lost. **SET TRANSFER**-Sets the outputs to the Set Transfer value selected in the controller settings.
CAL POINTS	When the CAL CURVE setting is set to CUSTOM, this option sets the number of calibration points (2 to 6). This option only shows when the CAL CURVE setting is set to CUSTOM.
VALUES	Selects the value of each custom calibration point (0 to 700 NTU). This option only shows when the CAL CURVE setting is set to CUSTOM.
SET FACT CAL	Sets the calibration settings to the factory defaults.

Calibrate with a syringe

Pre-requisite: Configure the calibration settings. Refer to Configure the calibration settings on page 26.

⚠ WARNING



Chemical exposure hazard. Obey laboratory safety procedures and wear all of the personal protective equipment appropriate to the chemicals that are handled. Refer to the current safety data sheets (MSDS/SDS) for safety protocols.

Items to collect:

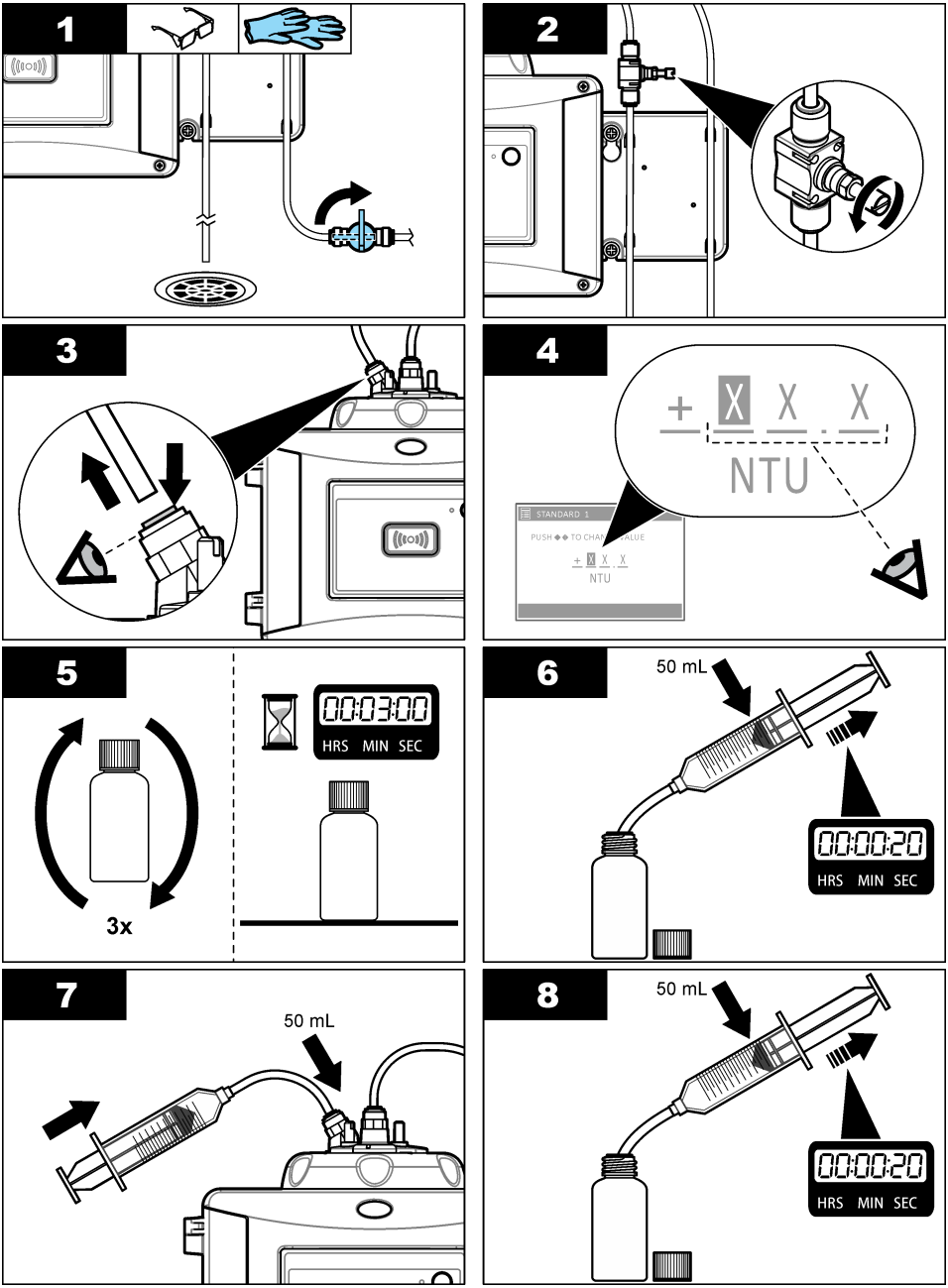
- StablCal standard or prepared Formazin standard at the same ambient temperature as the sensor
- Calibration syringe and tubing

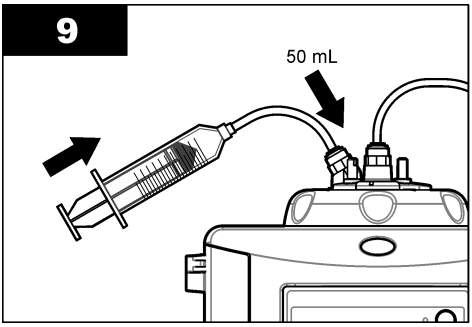
To prepare a Formazin standard(s), refer to Prepare Formazin standards on page 30. To make 4000-NTU Formazin stock solution, refer to Make 4000-NTU Formazin stock solution on page 30.

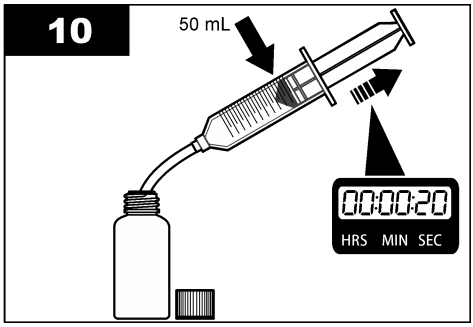
1. Push **menu**.
2. Select SENSOR SETUP>TU5x00 sc>CALIBRATION>SETUP>MENU GUIDED>SYRINGE.
3. Select SENSOR SETUP>TU5x00 sc>CALIBRATION>START.
4. Complete the steps shown on the display.
   Refer to the illustrated steps that follow to complete the steps shown on the display.

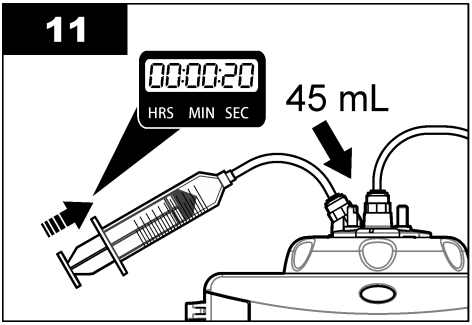
   At illustrated step 4, enter the measured turbidity value of the standard. If the standard value that shows on the display is correct, push confirm. The status indicator light changes to blue.

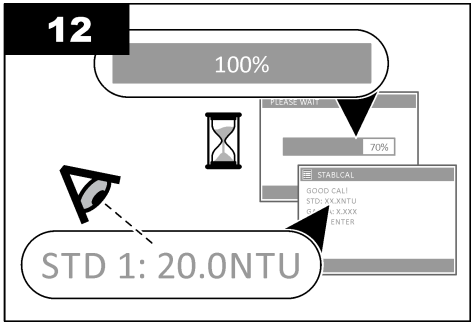
At illustrated step 15, fully open the flow regulator. Then slowly close the flow regulator until the flow decreases by 20 to 30%.

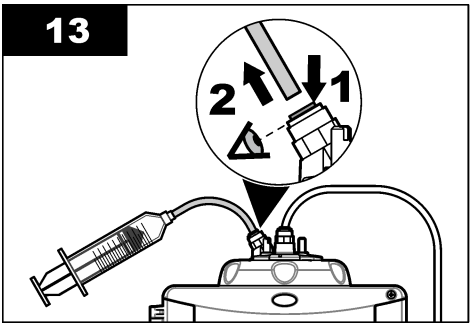


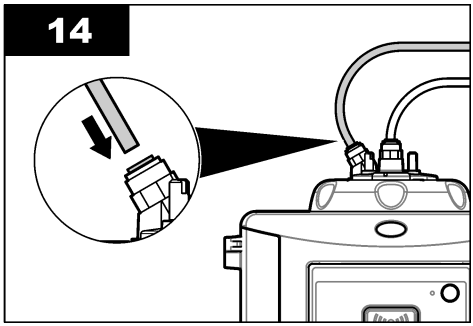

9
50 mL

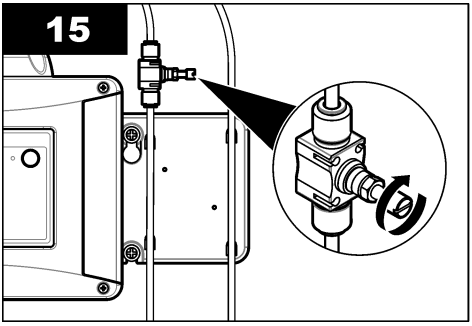

10
50 mL
00:00:20
HRS MIN SEC

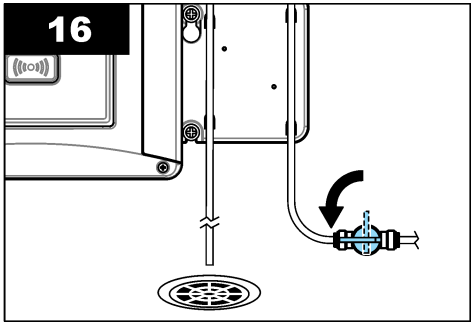

11
00:00:20
HRS MIN SEC
45 mL


12
100%
70%
STABLCAL
STD 1: 20.0NTU


13
2
1


14


15


16

Make 4000-NTU Formazin stock solution

⚠ WARNING



Chemical exposure hazard. Obey laboratory safety procedures and wear all of the personal protective equipment appropriate to the chemicals that are handled. Refer to the current safety data sheets (MSDS/SDS) for safety protocols.

Note: *The manufacturer recommends that Formazin stock solution is not made from raw materials. Preparation of Formazin stock solution is temperature and technique sensitive. Use Hach Formazin stock solution to get the best instrument performance and analytical standard accuracy.*

1. Dissolve 5.000 grams of reagent grade hydrazine sulfate ($(NH_2)_2$–H_2SO_4) in about 400 mL of demineralized water.
2. Dissolve 50.000 grams of reagent grade hexamethylenetetramine in approximately 400 mL of demineralized water.
3. Quantitatively, pour the two solutions in a 1-liter volumetric flask, and dilute to volume with demineralized water. Mix fully.
4. Let the solution stand for 48 hours at 25 ± 1 °C (77 ± 1 °F).

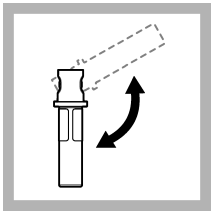
Prepare Formazin standards

Prepare Formazin standards immediately before a calibration and discard after use.

1. Prepare a 20 NTU Formazin standard as follows:
   a. Use a pipet to add 5.0 mL of 4000 NTU Formazin standard solution in a 1-L volumetric flask.
   b. Dilute to the mark with deionized water or distilled water with a turbidity of less than 0.5 NTU. Put in the stopper and mix well.
2. When the sample turbidity range is 40 to 700 NTU[12], prepare a 600 NTU Formazin standard as follows:
   a. Use a pipet to add 15.0 mL of 4000 NTU Formazin standard solution in a 100-mL volumetric flask.
   b. Dilute to the mark with deionized water or distilled water with a turbidity of less than 0.5 NTU. Put in the stopper and mix well.

[12] 1 mNTU = 0.001 NTU

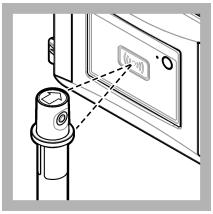
Calibrate with StablCal vials with RFID



1. Invert the 20 NTU StablCal vial for 2 to 3 minutes. Refer to the documentation supplied with the StablCal vials.

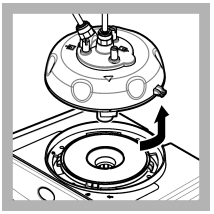


2. Clean and dry the vial with a no-lint cloth. Refer to Prevent vial contamination on page 32.

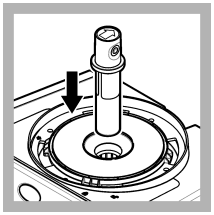


3. Put the vial in front of the RFID module. The status indicator light flashes blue.

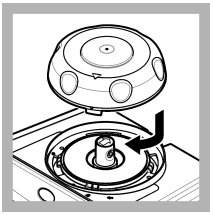
The instrument records the value, the lot number, the expiration date and the Certificate of Analysis information from the RFID vial to the data log.



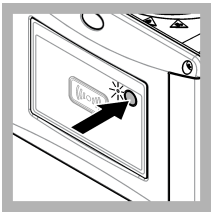
4. Remove the process head (or the automatic cleaning module).



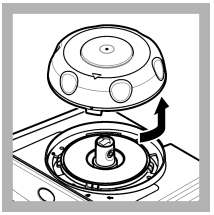
5. Put the vial in the vial compartment.



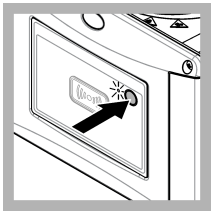
6. Install the calibration lid. Make sure that the calibration lid is in the closed position.



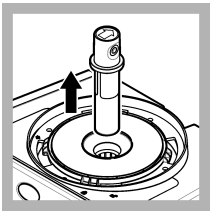
7. Push the button on the front of the instrument.



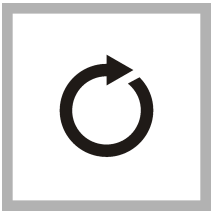
8. When the status indicator light flashes green, remove the calibration lid.



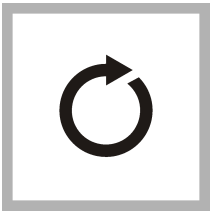
9. Push the button on the front of the instrument to accept the calibration value.



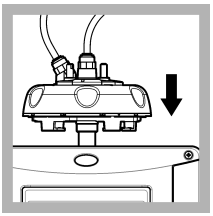
10. Remove the vial.



11. If the display shows 600 NTU (or 600 FNU), do steps 1 to 10 again with the 600 NTU StablCal vial.



12. When the value of the verification standard shows on the display, do steps 2 to 10 again to measure the verification standard.



13. Install the process head (or the automatic cleaning module).

Prevent vial contamination

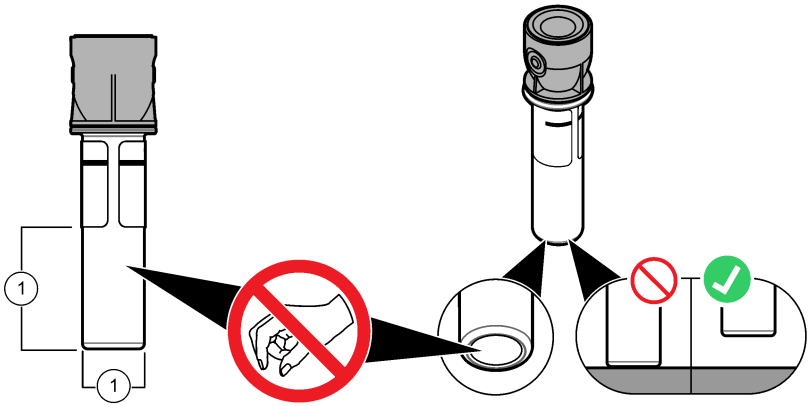
NOTICE

Do not to touch or scratch the glass of the sample vial. Contamination or scratches on the glass can cause measurement errors.

The glass must stay clean and have no scratches. Use a no-lint cloth to remove dirt, fingerprints or particles from the glass. Replace the sample vial when the glass has scratches.

Refer to Figure 7 to identify where not to touch the sample vial. Always keep the sample vials in the vial stand to prevent contamination on the bottom of the vial.

Figure 7 Sample vial overview



1 Measurement surface—Do not touch.

Calibrate with vials without RFID

Prepare the standard vial(s)

⚠ CAUTION

Chemical exposure hazard. Dispose of chemicals and wastes in accordance with local, regional and national regulations.

NOTICE

Always put a cap on the sample vial to prevent spills in the vial compartment.

To use sealed vials for calibration, immediately go to Calibration procedure—vials without RFID on page 35. To use unsealed vials for calibration, prepare the standard vial(s) as follows:

1. For formazin calibration, prepare the formazin standards with 4000-NTU formazin stock solution. Refer to Prepare Formazin standards on page 30.

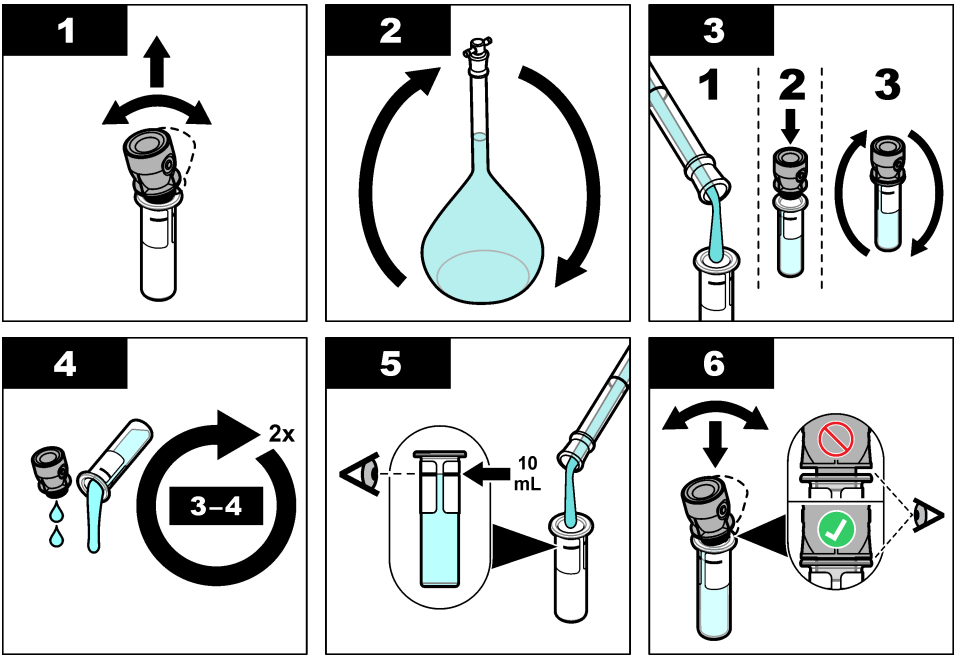
   Note: *To make 4000-NTU formazin stock solution, refer to* Make 4000-NTU Formazin stock solution on page 30.

2. Prepare the standard vial(s). Refer to the illustrated steps that follow.

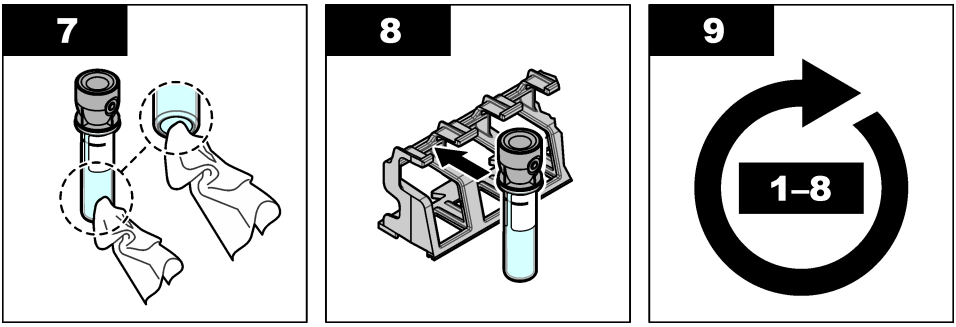
   - **FORMAZIN 0–40 NTU (or 0–40 FNU) calibration**—Two vials: formazin 20 NTU and dilution water[13] used to prepare the formazin standard.
   - **FORMAZIN 0–700 NTU (or 0–1000 FNU) calibration**—Three vials: formazin 20 NTU, formazin, 600 NTU and the dilution water[13] used to prepare the formazin standards
   - **STABLCAL 0-40 NTU (or 0–40 FNU) calibration**—One vial: StablCal 20 NTU
   - **STABLCAL 0-700 NTU (or 0–1000 FNU) calibration**—Two vials: StablCal 20 NTU and StablCal 600 NTU

   Make sure that the standard is at the same ambient temperature as the sensor.

   If there is contamination in the sample vial after it is rinsed with the sample, clean the sample vial. Refer to the TU5200 documentation for vial cleaning instructions.



[13] Make sure that the vial contains dilution water for a minimum of 12 hours before the procedure.



Make 4000-NTU Formazin stock solution

⚠ WARNING

Chemical exposure hazard. Obey laboratory safety procedures and wear all of the personal protective equipment appropriate to the chemicals that are handled. Refer to the current safety data sheets (MSDS/SDS) for safety protocols.

Note: *The manufacturer recommends that Formazin stock solution is not made from raw materials. Preparation of Formazin stock solution is temperature and technique sensitive. Use Hach Formazin stock solution to get the best instrument performance and analytical standard accuracy.*

1. Dissolve 5.000 grams of reagent grade hydrazine sulfate ($(NH_2)_2–H_2SO_4$) in about 400 mL of demineralized water.
2. Dissolve 50.000 grams of reagent grade hexamethylenetetramine in approximately 400 mL of demineralized water.
3. Quantitatively, pour the two solutions in a 1-liter volumetric flask, and dilute to volume with demineralized water. Mix fully.
4. Let the solution stand for 48 hours at 25 ± 1 °C (77 ± 1 °F).

Prepare Formazin standards

Prepare Formazin standards immediately before a calibration and discard after use.

1. Prepare a 20 NTU Formazin standard as follows:
   a. Use a pipet to add 5.0 mL of 4000 NTU Formazin standard solution in a 1-L volumetric flask.
   b. Dilute to the mark with deionized water or distilled water with a turbidity of less than 0.5 NTU. Put in the stopper and mix well.
2. When the sample turbidity range is 40 to 700 NTU[14], prepare a 600 NTU Formazin standard as follows:
   a. Use a pipet to add 15.0 mL of 4000 NTU Formazin standard solution in a 100-mL volumetric flask.
   b. Dilute to the mark with deionized water or distilled water with a turbidity of less than 0.5 NTU. Put in the stopper and mix well.

[14] 1 mNTU = 0.001 NTU

Calibration procedure—vials without RFID

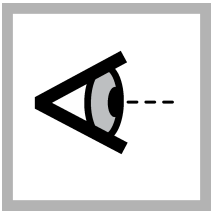


1. Push **menu**. Select SENSOR SETUP> TU5x00 sc> CALIBRATION> SETUP> MENU GUIDED> SEALED VIAL.

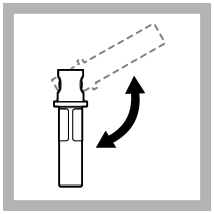


2. Select SENSOR SETUP> TU5x00 sc> CALIBRATION> START.

The status indicator light changes to blue.



3. Read the controller display to identify which vial to put in the vial compartment.

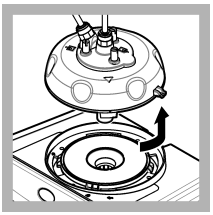


4. Carefully invert the vial a minimum of three times.

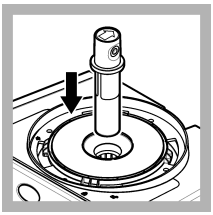
For StablCal vials, invert the 20 NTU StablCal vial for 2 to 3 minutes. Refer to the documentation supplied with the StablCal vials.



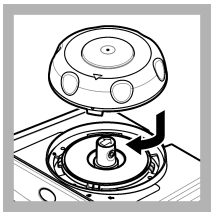
5. Clean and dry the vial with a no-lint cloth. Refer to Prevent vial contamination on page 32.



6. Remove the process head (or the automatic cleaning module).



7. Put the vial in the vial compartment.

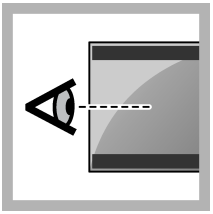


8. Install the calibration lid. Make sure that the calibration lid is in the closed position.

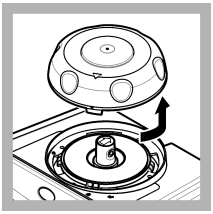


9. If the standard value that shows on the display is not correct, enter the accurate turbidity value of the standard from the certificate of analysis.

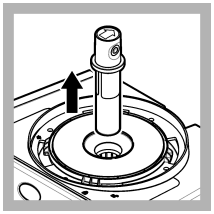
If the standard value that shows on the display is correct, push **enter**.



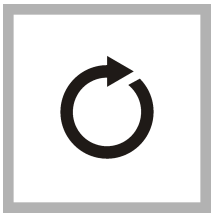
10. Complete the steps that show on the controller display.



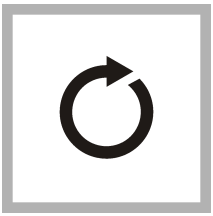
11. When the status indicator light changes to green, remove the calibration lid.



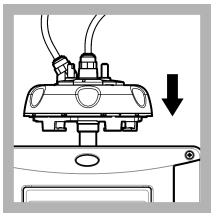
12. Remove the vial.



13. Do steps 3 to 12 again until all of the standard vials are measured.



14. If the value of the verification standard shows on the display, do steps 4 to 12 again to measure the verification standard.



15. Install the process head (or the automatic cleaning module).

Verification

Use the optional calibration lid and a sealed-vial 10-NTU StablCal standard (or a StablCal 10 NTU standard and a syringe) to do a primary calibration verification. As an alternative, use the optional calibration lid and the optional glass verification rod (< 0.1 NTU) to do a secondary calibration verification.

Do a calibration verification immediately after each calibration to measure the verification standard and record the measured value to the instrument.

Do calibration verifications between calibrations according to the regulatory recommendations to identify if the instrument operates correctly and is calibrated.

When a calibration verification is done between calibrations, the verification standard is measured. The measured value is compared to the recorded value of the verification standard.

Configure the verification settings

Measure the value of the verification standard. Set the acceptance range and measurement units for verification. Set the verification reminder and type of menu guided verification. Set the output behavior during verification.

1. Push **menu**.
2. Select SENSOR SETUP>VERIFICATION>SETUP.
3. Select an option.

Option	Description
MENU GUIDED	Sets menu-guided verification to SEALED VIAL, SYRINGE or OFF (default). Verification instructions show on the controller display during verification when set to SEALED VIAL or SYRINGE. Select SEALED VIAL for verification with the glass verification rod.
DEFINE STD VAL	Measures the verification standard. The results are recorded to the instrument. For the best results, measure the verification standard immediately after calibration.
ACCEPT. UNIT	Sets the acceptance range for verification to a percentage (1 to 99%) or an NTU value (0.015 to 100.00 NTU). Options: % or NTU (or mNTU).
ACCEPT. RANGE	Sets the maximum difference permitted between the recorded value of the verification standard and the measured value of the verification standard during verification. Options: 1 to 99% or 0.015 to 100.00 NTU.

Option	Description
VERIF REMINDER	Sets the time interval between calibration verifications. The display will show a reminder when a verification is due. Options: OFF(default), 1 day, 7 days, 30 days or 90 days. When a verification is done, the verification time is set to zero.
OUTPUT MODE	Sets the output behavior during verification. **ACTIVE**-The outputs continues to agree with the operating conditions. **HOLD** (default)-Keeps the outputs at the last known value when communication is lost. **SET TRANSFER**-Sets the outputs to the Set Transfer value selected in the controller settings.

Do a calibration verification with a syringe

Pre-requisite: Configure the verification settings. Refer to Configure the verification settings on page 36.

⚠ WARNING



Chemical exposure hazard. Obey laboratory safety procedures and wear all of the personal protective equipment appropriate to the chemicals that are handled. Refer to the current safety data sheets (MSDS/SDS) for safety protocols.

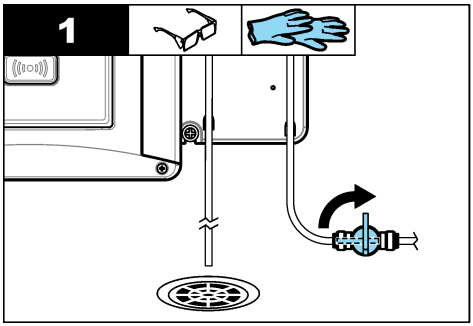
Items to collect:

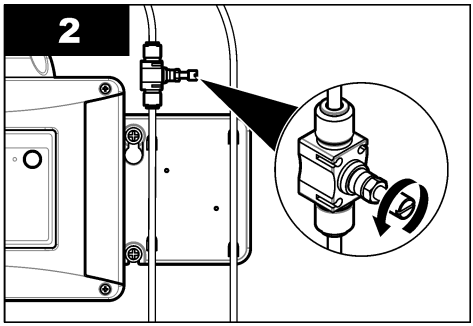
- StablCal 10 NTU standard at the same ambient temperature as the sensor
- Calibration syringe and tubing

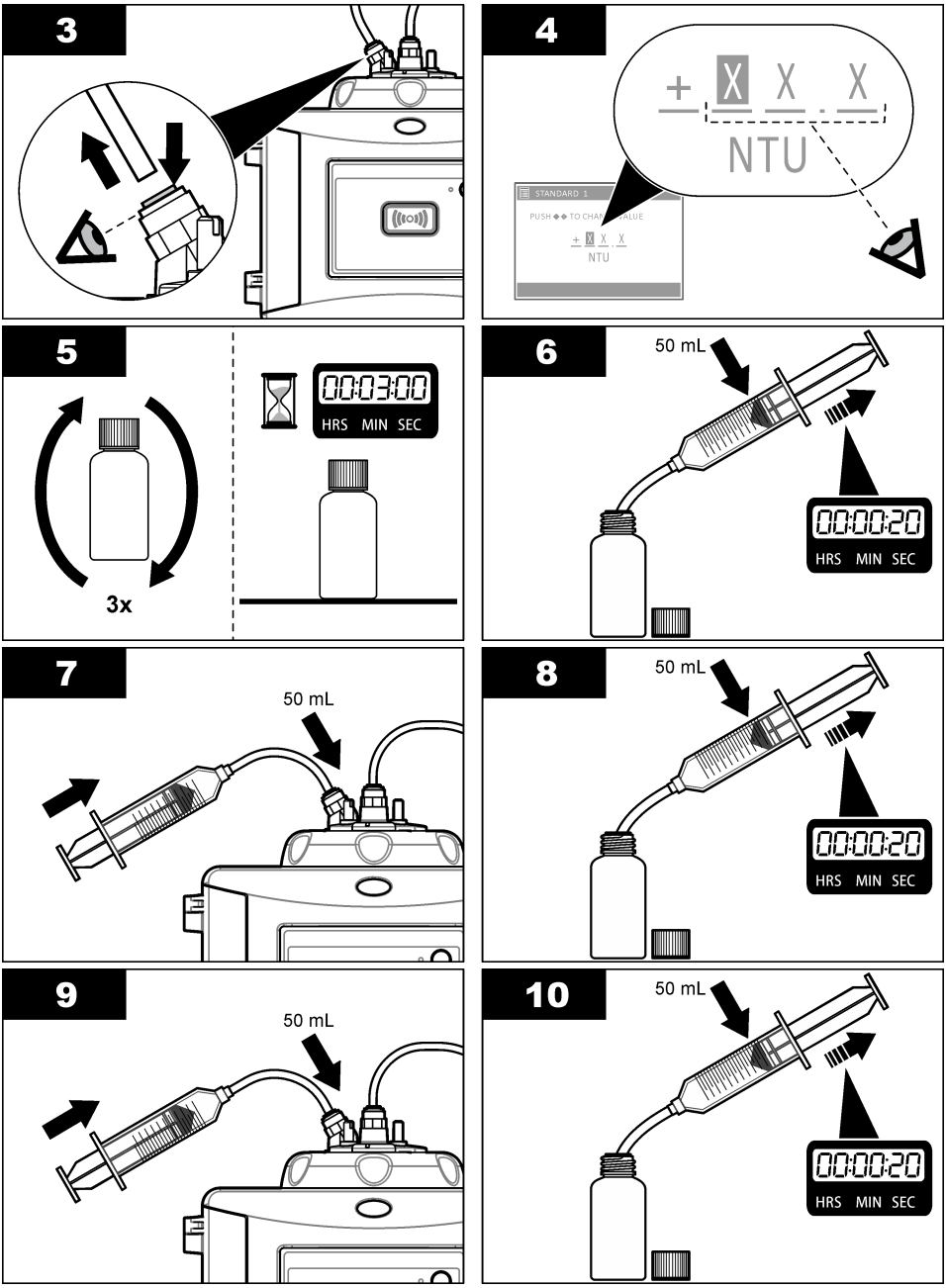
1. Push **menu**.
2. Select SENSOR SETUP>TU5x00 sc>VERIFICATION>SETUP>MENU GUIDED>SYRINGE.
3. Select SENSOR SETUP>TU5x00 sc>VERIFICATION>START.
4. Complete the steps shown on the display.
   Refer to the illustrated steps that follow to complete the steps shown on the display.

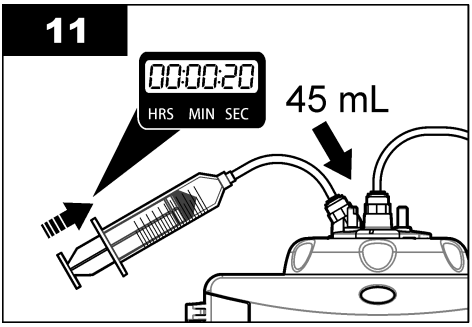
   At illustrated step 4, enter the measured turbidity value of the verification standard. If the verification standard value that shows on the display is correct, push confirm. The status indicator light changes to blue.

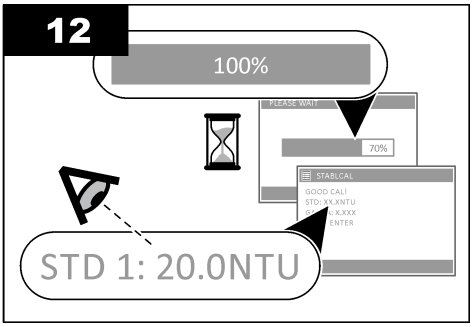
   At illustrated step 15, fully open the flow regulator. Then slowly close the flow regulator until the flow decreases by 20 to 30%.

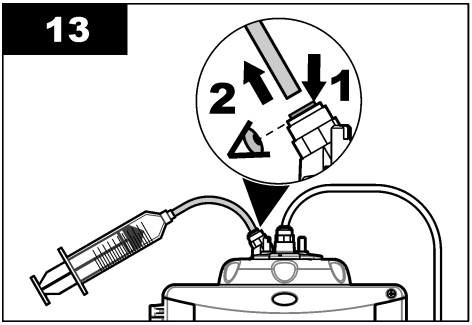


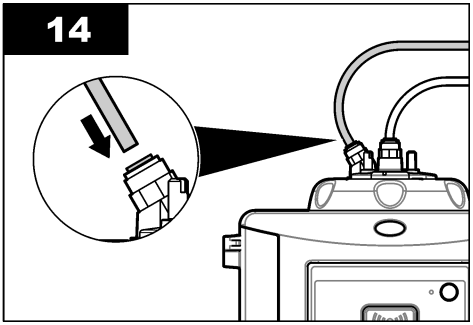


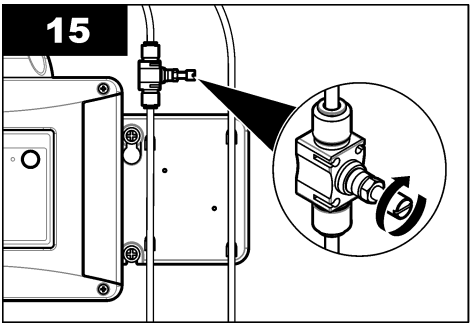

3
4
+ X X . X
NTU
STANDARD 1
PUSH ◆◆ TO CHA VALUE
+ X X . X
NTU
5
00:03:00
HRS MIN SEC
3x
6
50 mL
00:00:20
HRS MIN SEC
7
50 mL
8
50 mL
00:00:20
HRS MIN SEC
9
50 mL
10
50 mL
00:00:20
HRS MIN SEC

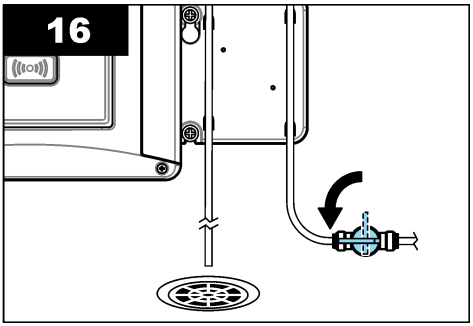

11
00:00:20
HRS MIN SEC
45 mL


12
100%
PLEASE WAIT
70%
STABLCAL
GOOD CAL!
ENTER
STD 1: 20.0NTU


13
2
1


14


15


16

Do a calibration verification with a sealed vial or glass rod

Use the optional calibration lid and a sealed-vial 10-NTU StablCal standard to do a primary calibration verification. As an alternative, use the optional calibration lid and the optional glass verification rod (< 0.1 NTU) to do a secondary calibration verification.



1. Push **menu**. Select SENSOR SETUP> TU5x00 sc> VERIFICATION> SETUP>MENU GUIDED> SEALED VIAL.



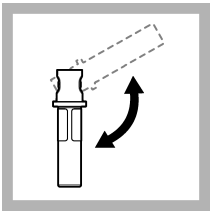
2. Select SENSOR SETUP> TU5x00 sc> VERIFICATION> START.



3. If the verification standard value that shows on the display is not correct, enter the accurate turbidity value of the verification standard from the certificate of analysis for the sealed-vial StablCal standard or from the last recorded value from the <0.1 NTU glass rod.

If the verification standard value that shows on the display is correct, push **confirm**.

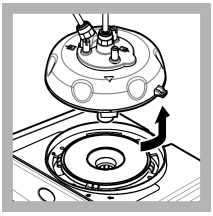
The status indicator light changes to blue.



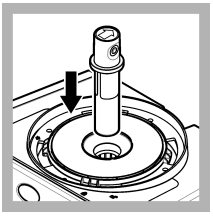
4. If the verification standard is a liquid standard, carefully invert the verification standard vial a minimum of three times.



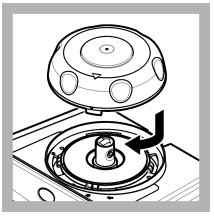
5. Clean and dry the verification standard vial with a no-lint cloth. Refer to Prevent vial contamination on page 32.



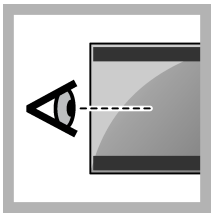
6. Remove the process head (or the automatic cleaning module).



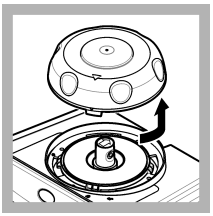
7. Put the vial in the vial compartment.



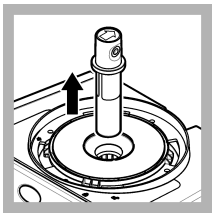
8. Install the calibration lid. Make sure that the calibration lid is in the closed position.



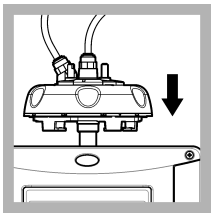
9. Complete the steps that show on the controller display.



10. When the status indicator light changes to green, remove the calibration lid.



11. Remove the vial.



12. Install the process head (or the automatic cleaning module).

Show the calibration or verification history

To show the historical data for the last four calibrations, push menu and select SENSOR SETUP>TU5x00 sc>CALIBRATION>CAL LOG.

To show the historical data for the last four verifications, push menu and select SENSOR SETUP>TU5x00 sc>VERIFICATION>VERIF LOG.

Maintenance

⚠ WARNING



Burn hazard. Obey safe handling protocols during contact with hot liquids.

⚠ CAUTION



Multiple hazards. Only qualified personnel must conduct the tasks described in this section of the document.

⚠ CAUTION



Personal injury hazard. Never remove covers from the instrument. This is a laser-based instrument and the user risks injury if exposed to the laser.

⚠ CAUTION



Personal injury hazard. Glass components can break. Handle with care to prevent cuts.

NOTICE

Do not disassemble the instrument for maintenance. If the internal components must be cleaned or repaired, contact the manufacturer.

NOTICE

Stop the sample flow to the instrument and let the instrument become cool before maintenance is done.

To set the output behavior during maintenance, push **menu** and select SENSOR SETUP>TU5x00 sc>DIAG/TEST>MAINTENANCE>OUTPUT MODE.

Maintenance schedule

Table 3 shows the recommended schedule of maintenance tasks. Facility requirements and operating conditions may increase the frequency of some tasks.

Table 3 Maintenance schedule

Task	1 to 3 months	1 to 2 years	As necessary
Clean the vial on page 42 ***Note:*** *The cleaning interval is dependent on the water quality.*	X		
Clean the vial compartment on page 44			X
Replace the vial on page 44		X	
Replace the desiccant cartridge on page 46 ***Note:*** *The replacement interval is dependent on the ambient humidity, ambient temperature and sample temperature.*		X[15]	
Replace the tubing on page 47			X

Clean spills

⚠ CAUTION



Chemical exposure hazard. Dispose of chemicals and wastes in accordance with local, regional and national regulations.

1. Obey all facility safety protocols for spill control.
2. Discard the waste according to applicable regulations.

Clean the instrument

Clean the exterior of the instrument with a moist cloth and a mild soap solution and then wipe the instrument dry as necessary.

Clean the vial

⚠ WARNING



Chemical exposure hazard. Obey laboratory safety procedures and wear all of the personal protective equipment appropriate to the chemicals that are handled. Refer to the current safety data sheets (MSDS/SDS) for safety protocols.

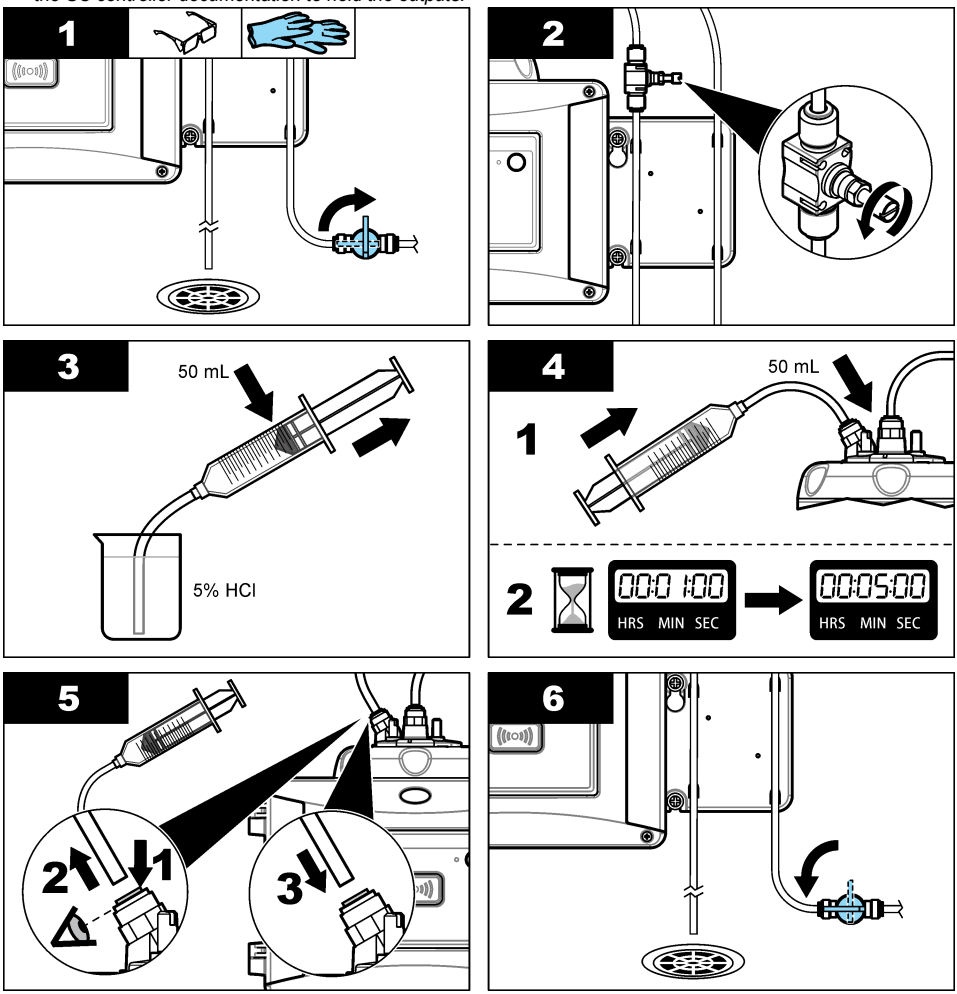
When the turbidity reading shows that there is contamination in the process vial or "VIAL CLARITY" shows on the controller display, clean the vial.

1. Push **menu**.
2. Select SENSOR SETUP>TU5x00 sc>DIAG/TEST>MAINTENANCE>VIAL CLEANING.
3. Complete the steps that show on the controller display. The date the vial was cleaned is automatically saved after the last screen shows.
4. If the optional automatic cleaning module is installed, push **menu** and select SETUP>TU5x00 sc>START WIPE to start the automatic cleaning process.
5. If the optional automatic cleaning module is not installed, clean the vial with the optional vial wiper if available. Refer to Clean the vial with the optional wiper on page 43.

[15] Two years or as identified by instrument notification.

6. If the turbidity readings do not go back to the original values, do the illustrated steps that follow to clean the vial.

   Note: *Hold the output values of the SC controller as necessary before the illustrated steps are done. Refer to the SC controller documentation to hold the outputs.*

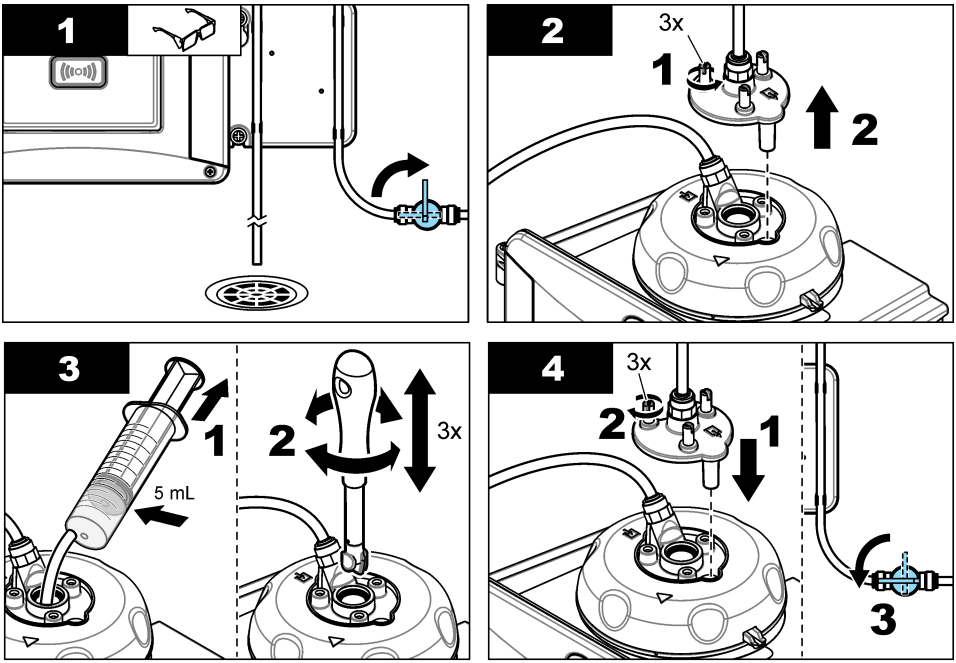


Clean the vial with the optional wiper

NOTICE

Carefully remove most of the water in the vial. Carefully put the vial wiper into the process vial so that no water spills out.

Clean the process vial with the optional vial wiper as shown in the illustrated steps that follow.



Clean the vial compartment

Clean the vial compartment only when the compartment has contamination. Make sure that the tool to clean the vial compartment has a soft surface and does not damage the instrument. Table 4 shows the options on how to clean the vial compartment.

Table 4 Cleaning options

Contaminant	Options
Dust	Vial compartment wiper, micro fiber cloth, lint-free cloth
Liquid, oil	Cloth, water and cleaning agent

Replace the vial

NOTICE

Keep water out of the vial compartment or instrument damage will occur. Before the automatic cleaning module is installed on the instrument, make sure that there are no water leaks. Make sure that all tubing is fully seated. Make sure that the vial nut is tight.

NOTICE

Hold the automatic cleaning module vertically when it is installed on the instrument or the vial can break. If the vial breaks, water will get in the vial compartment and instrument damage will occur.

NOTICE

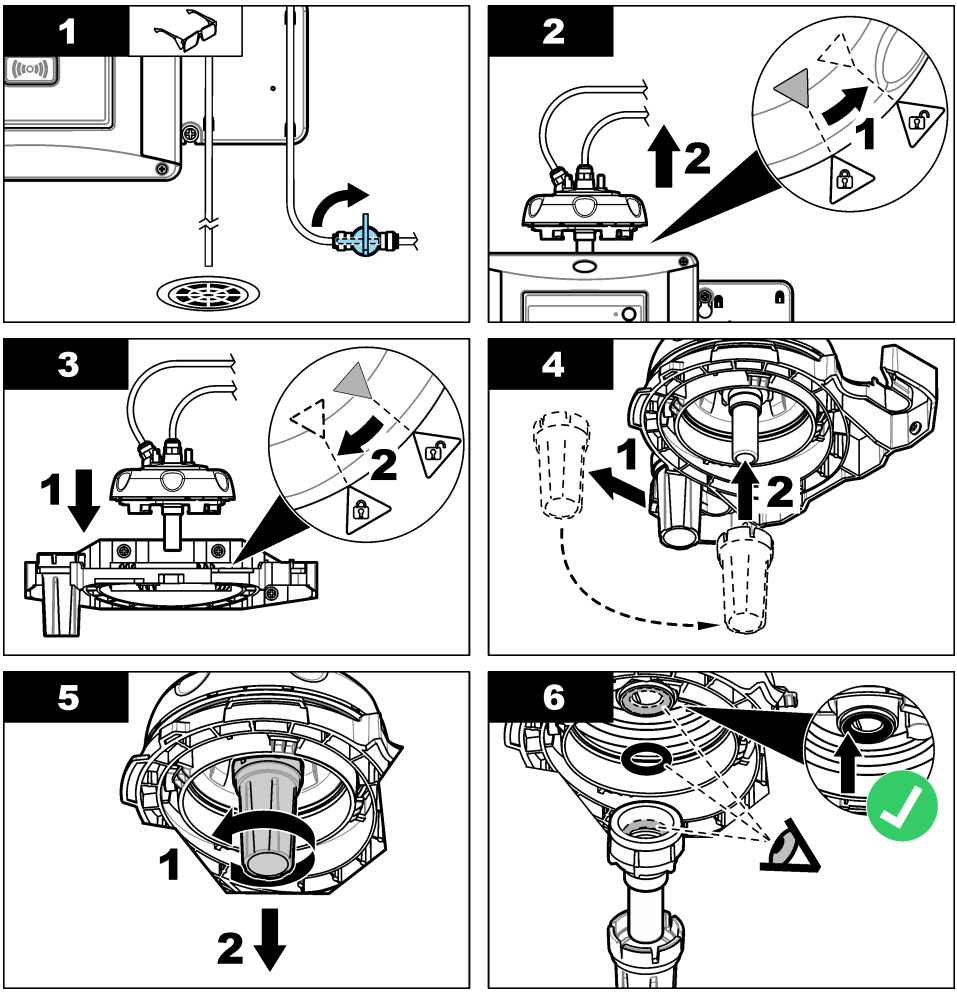
Do not to touch or scratch the glass of the process vial. Contamination or scratches on the glass can cause measurement errors.

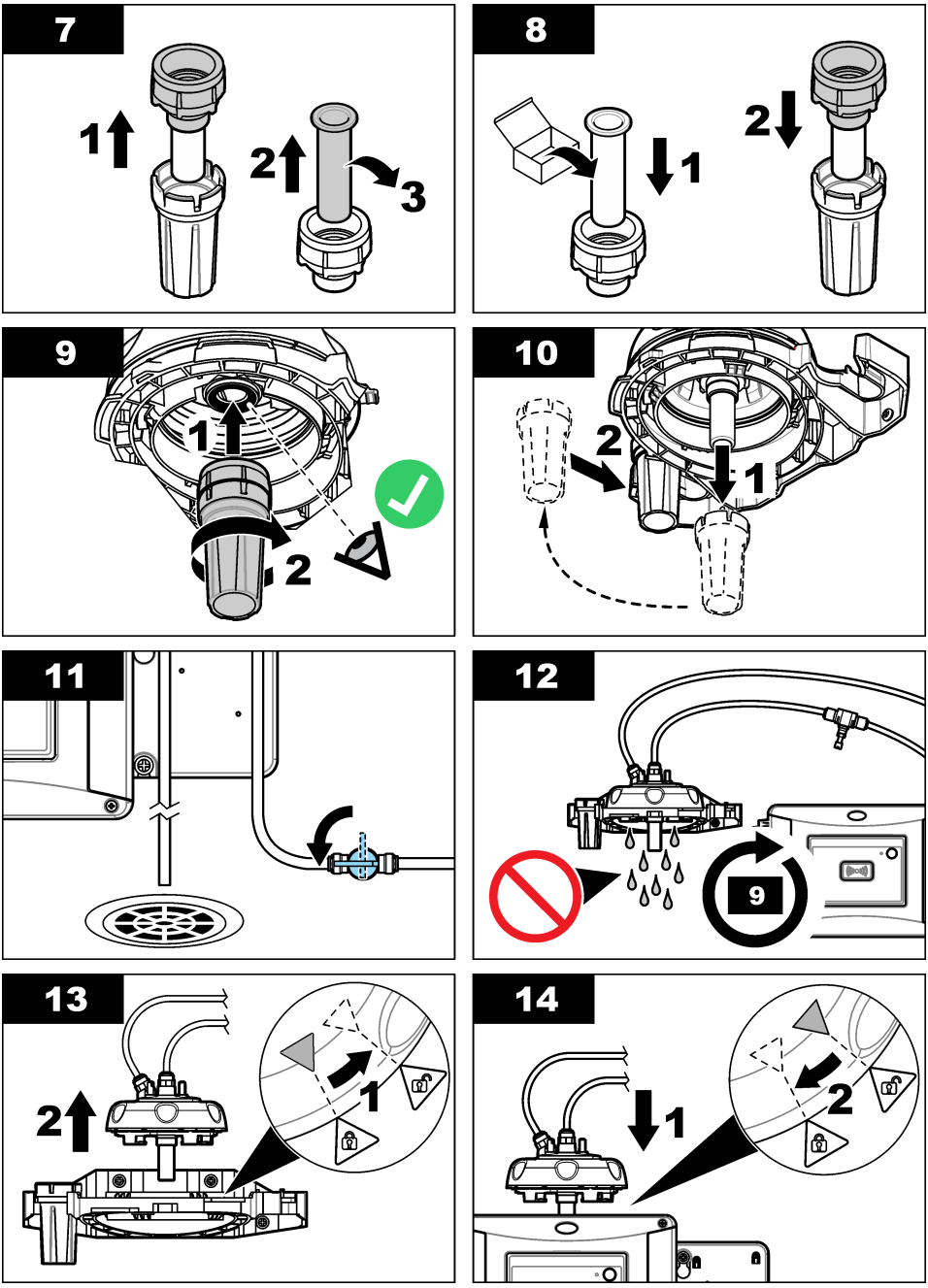
Note: *Make sure that no particles fall into the vial compartment.*

1. Push **menu**.
2. Select SENSOR SETUP>DIAG/TEST>MAINTENANCE>VIAL REPLACEMENT.
3. Complete the steps that show on the controller display. The date the vial was replaced is automatically saved after the last screen shows.

   Refer to the illustrated steps that follow to replace the vial. To protect the new vial from contamination, use the vial replacement tool to install the vial.

   At illustrated step 3, put the process head on its side on a flat surface if a service bracket is not installed near the instrument.





Replace the desiccant cartridge

The controller display will show when a desiccant cartridge replacement is due. Refer to the documentation included in the desiccant cartridge bag to replace the desiccant cartridge.

Replace the tubing

Replace the tubing when the tubing has a blockage or has damage.

Turn the flow shutoff valve to stop flow to the instrument. Then refer to Plumb the instrument on page 19 to replace the tubing.

Troubleshooting

More troubleshooting information is available online. Go to www.hach.com, then click Support to go to Hach Support Online.

Reminders

Reminders show on the controller display. To see all of the reminders, push **menu** then select DIAGNOSTICS>TU5x00 sc>REMINDER.

Message	Description	Solution
DRYER RANGE	The desiccant cartridge capacity is low.	Replace the desiccant cartridge. Refer to the documentation supplied with the desiccant cartridge.
PERFORM CAL	A calibration is due.	Do a calibration. Refer to Calibration on page 26.
PERFORM VER	A verification is due.	Do a verification. Refer to Verification on page 36.
WIPER REPLACE	A wiper replacement is due in the automatic cleaning module.	Replace the wiper in the automatic cleaning module. Refer to the documentation supplied with the automatic cleaning module to replace the wiper.

Warnings

Warnings show on the controller display. To see all of the active warnings, push **menu** then select DIAGNOSTICS>TU5x00 sc>WARNING LIST.

Warning	Description	Solution
DRYER	The drying circuit has a malfunction.	Contact technical support. Measurements with limited validity are still available.
CLEANING MODULE	The automatic cleaning module does not operate correctly.	Make sure that the wiper head is installed correctly and the wiper arm can move up and down.
DESICCANT OLD	The desiccant cartridge is more than 2 years old.	Replace the desiccant cartridge. Refer to the documentation supplied with the desiccant cartridge.
DRYER EXHAUS'D	The desiccant cartridge life is zero.	Replace the desiccant cartridge. Refer to the documentation supplied with the desiccant cartridge.
HIGH FLOW	The flow rate is higher than the limit (more than 1250 mL/min).	Adjust the flow regulator as necessary. Make sure that the flow regulator does not have a malfunction.
HUM PCB SC	There is humidity on the interior electronics of the instrument.	Contact technical support. Measurements with limited validity are still available.
LASER-TEMP HIGH	The laser temperature is higher than the limit.	Decrease the environmental temperature of the instrument.
LASER-TEMP SENS	The laser temperature sensor has a malfunction.	Contact technical support. Measurements with limited validity are still available.
LOW FLOW	The flow rate is lower than the limit (less than 75 mL/min).	Examine the tubing for blockages that decrease the flow rate. Remove the blockages. Adjust the flow regulator as necessary. Make sure that the flow regulator does not have a malfunction.

Warning	Description	Solution
NO FLOW	The flow rate is less than 10 mL/min.	Examine the tubing for blockages stop the flow. Remove the blockages.
NOT DRYING	The instrument cannot regulate the internal humidity.	Replace the desiccant cartridge. Refer to Replace the desiccant cartridge on page 46. If the error continues, contact technical support. Measurements with limited validity are still available.
PUMP	The air pump for the drying circuit has a malfunction.	Contact technical support. Measurements with limited validity are still available.
SENS.DRY: FUNC	The air system of the drying system has a malfunction.	Contact technical support. Measurements with limited validity are still available.
SENS.DRY: HUM	The humidity value from the air sensor is not correct.	Contact technical support. Measurements with limited validity are still available.
SENS.DRY: TEMP	The temperature value from the air sensor is not correct.	Contact technical support. Measurements with limited validity are still available.
TURB TOO HIGH	The turbidity reading is not within the calibration range.	Make sure that the calibration range selected is applicable to the turbidity value of the sample.
WIPER REPLACE	A wiper replacement is due in the automatic cleaning module.	Replace the wiper in the automatic cleaning module. Refer to the documentation supplied with the automatic cleaning module to replace the wiper.
VIAL CLARITY	The vial or vial compartment is dirty.	Clean or dry the vial and the vial compartment.

Errors

Errors show on the controller display. To see all of the active errors, push **menu** then select DIAGNOSTICS>TU5x00 sc>ERROR LIST.

Error	Description	Solution
AU COMM	An internal communication error occurred.	Set the controller power to off and then on again. Contact technical support.
AUTOCHK. NO FUNC	The automatic system check does not complete.	Contact technical support.
CLEANING MODULE	The automatic cleaning module has a malfunction.	Contact technical support.
EE RSRVD ERR	There is a problem with the internal memory.	Contact technical support.
FLASH FAIL	The internal calibration memory is corrupted.	Contact technical support.
HUMIDITY PCB	There is humidity or water in the instrument.	Contact technical support.
LASER TOO LOW	The laser has a malfunction.	Contact technical support.
MEAS ELECTRONIC	There is a measurement error. There is a problem in the electronics unit.	Contact technical support.
PROC HEAD OPEN	The process head is in the open position or the process head detector has a malfunction.	Turn the process head to the closed position.
TURB TOO HIGH	The turbidity reading is higher than the measurement range of the instrument (700 FNU maximum).	Make sure that the turbidity value of the sample is within the measurement range of the instrument.

Error	Description	Solution
VIAL PRESENT	There is no vial in the vial compartment.	Install a vial in the vial compartment.
VIAL CLARITY	The vial or vial compartment is dirty.	Clean or dry the vial and the vial compartment.
WATER INGRESS	There is water in the instrument.	Immediately stop flow to the instrument. Disconnect the sensor cable. Contact technical support. The desiccant cartridge can become hot. Only touch and remove the desiccant cartridge when it is at room temperature.

Replacement parts and accessories

⚠ WARNING

Personal injury hazard. Use of non-approved parts may cause personal injury, damage to the instrument or equipment malfunction. The replacement parts in this section are approved by the manufacturer.

Note: *Product and Article numbers may vary for some selling regions. Contact the appropriate distributor or refer to the company website for contact information.*

Recommended standards

Description	Quantity	Item no.
Verification standard, < 0.1 NTU, glass verification rod (solid secondary standard)	each	LZY901
StablCal 800 mNTU Standard	1 L	2788453
StablCal 10 NTU Standard	500 mL	2659949
StablCal 20 NTU Standard	1 L	2660153
StablCal 20-NTU sealed vial with RFID	each	LZY837
StablCal 20-NTU sealed vial without RFID	each	LZY899
StablCal kit, sealed vials with RFID, includes: 10, 20 and 600 NTU vials	each	LZY835
StablCal kit, sealed vials without RFID, includes: 10, 20 and 600 NTU vials	each	LZY898

Replacement parts

Description	Quantity	Item no.
Cleaning lid screws and washers, hot water, includes: Cleaning lid screws (3x) and washers (3x)	3	LZY905
Desiccant cartridge	each	LZY876
Mounting set, includes: Mounting screws (4x), tubing clip screws (2x) and tubing clips (2x)	each	LZY870
Nut, process vial	each	LZY917
Seal, automatic cleaning module	each	LZY914
Seal, process head	each	LZV969
Seal, process vial	each	LZY918

Replacement parts (continued)

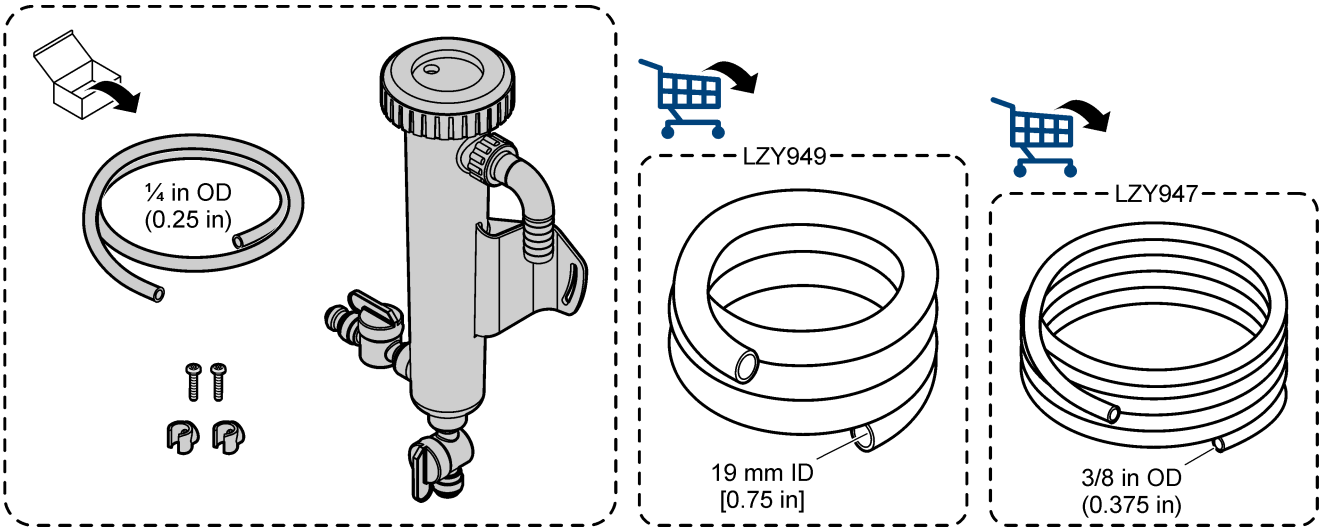
Description	Quantity	Item no.
Service bracket	each	LZY873
Flow regulator kit, includes: flow regulator and tube ¼-in. OD × 0.13 m (5.11 in.)	each	LZY963
Vial with no seal, process	each	LZY834
Vial replacement tool	each	LZY906
Wall mount bracket kit, includes: Wall mount bracket (two tubing clips on bracket), mounting screws (4x), tubing clips (2x) and tubing clip screws (2x)	each	LZY871

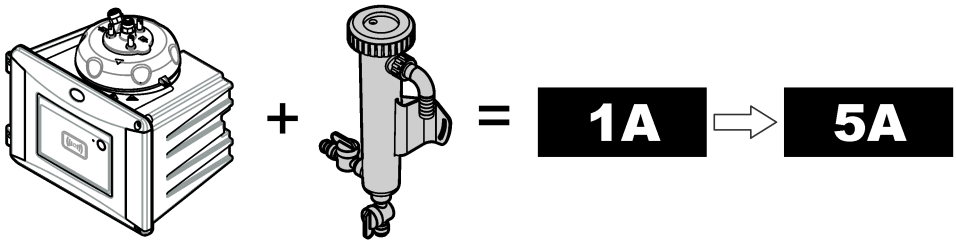
Accessories

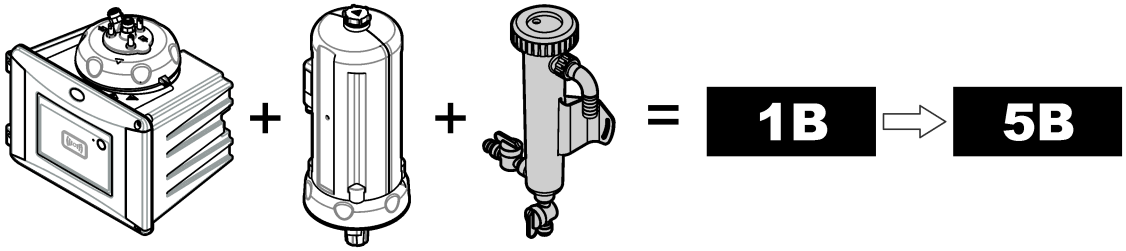
Description	Quantity	Item no.
Automatic cleaning module	each	LQV159.99.00002
Bubble trap	each	LZY828.99.00002
Calibration lid	each	LZY904.98.00002
Extension cable, sensor cable, 1 m (3.3 ft)	each	6122400
Extension cable, sensor cable, 5 m (16.40 ft)	each	LZX848
Extension cable, sensor cable, 10 m (32.81 ft)	each	LZX849
Flow sensor kit, includes: flow sensor, flow sensor cap, mounting screws and 1 m (3.3 ft) of ¼ in. OD tubing	each	LQV160.99.00002
Maintenance kit for post-filter applications, includes: Case, calibration lid, micro fiber cloth, 20 NTU StablCal sealed vial, verification glass rod, vial wiper, vial compartment wiper, mobile service bracket, glass verification rod (≤ 0.1 NTU) and vial replacement tool	each	LZY907
Micro fiber cloth, vial cleaning	each	LZY945
Process head holder	each	LZY946
RFID tags, operator	2/pkg	LZQ066
RFID stickers, black[16]	3/pkg	LZQ067
Syringe with tubing, calibration and verification	each	LZY953
Tubing adapter, ¼ in. to 6 mm	each	LZY954
Tubing, bubble trap to TU5x00 sc, ¼ in. OD	1 m	LZQ134
Tubing set, ULTRATURB replacement	each	LZY912
Tubing, inlet of bubble trap, 3/8 in. OD	4 m	LZY947
Tubing, inlet and outlet of TU5x00 sc, ¼ in. OD	4 m	LZY911
Vial wiper	each	LZY903
Vial compartment wiper	each	LZY910

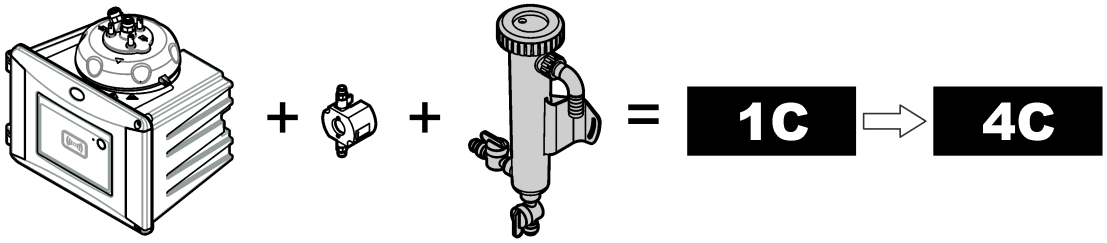
[16] Other colors are available.

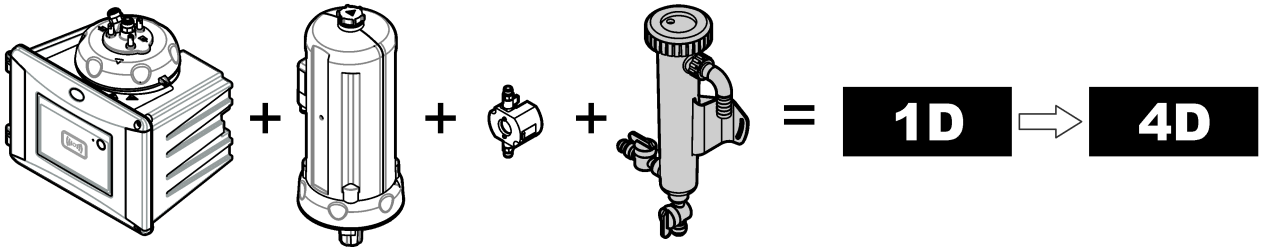
LZY828.99.00002

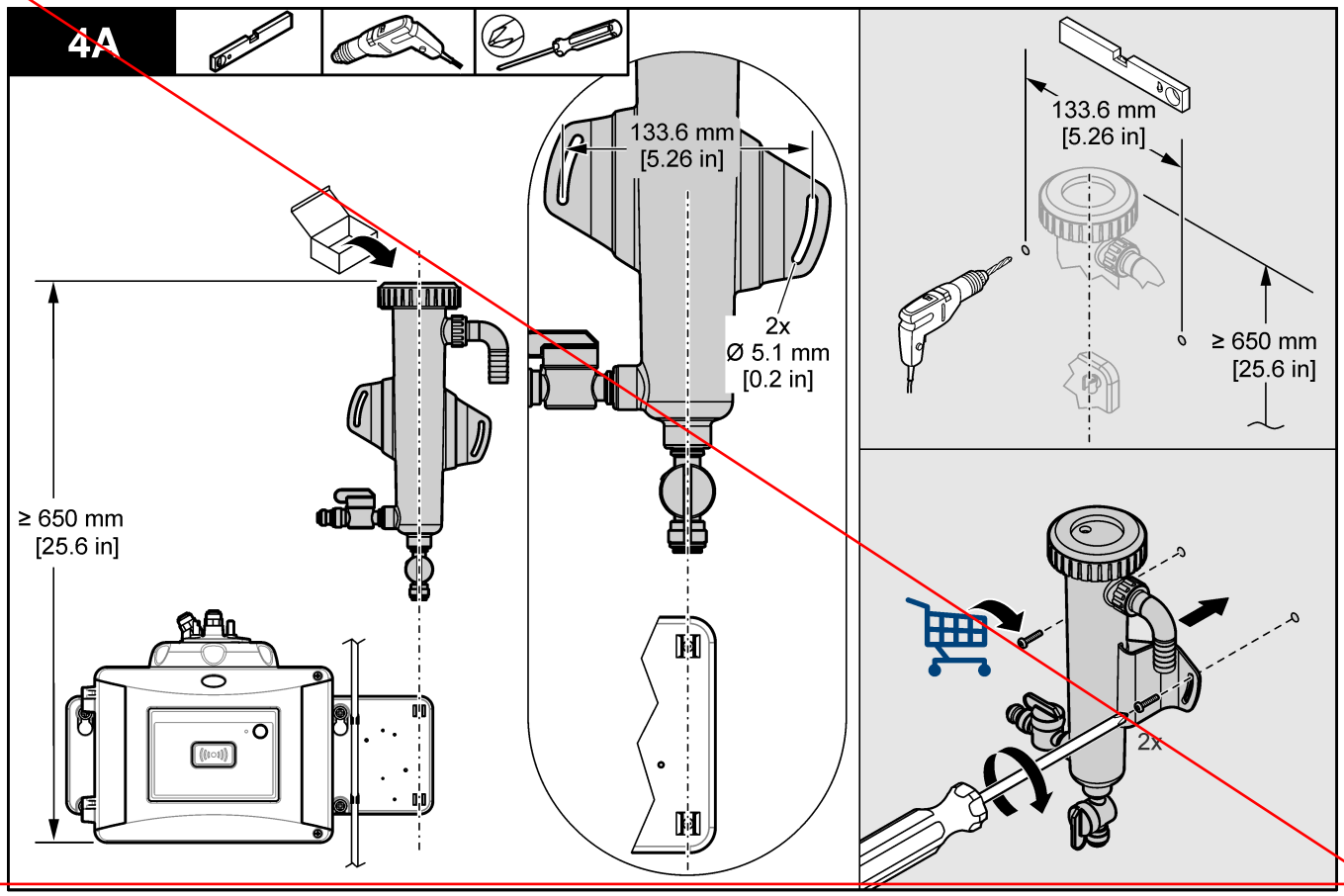


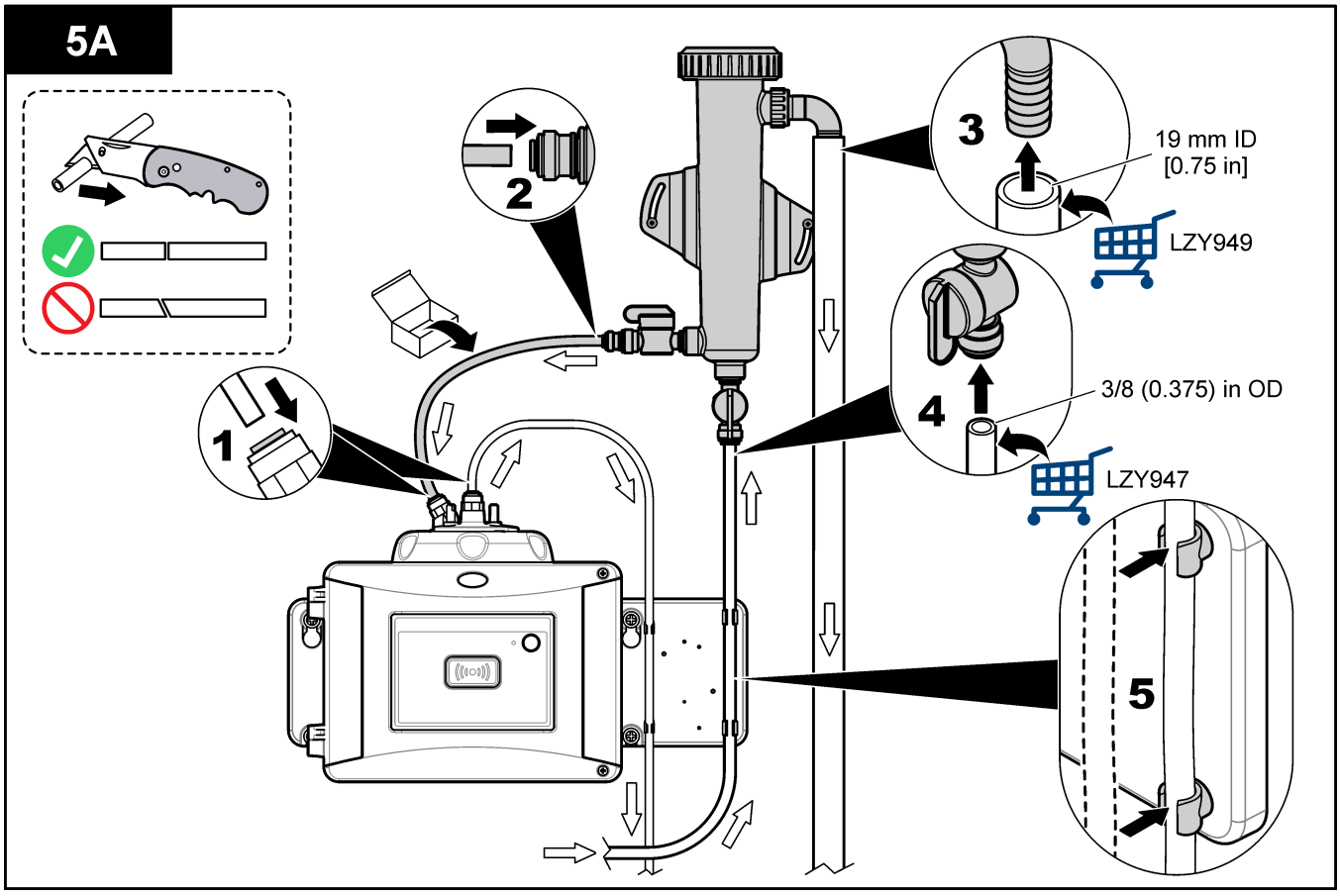









4A
133.6 mm
[5.26 in]
2x
Ø 5.1 mm
[0.2 in]
≥ 650 mm
[25.6 in]
133.6 mm
[5.26 in]
≥ 650 mm
[25.6 in]
2x


5A
1
2
3
19 mm ID
[0.75 in]
LZY949
4
3/8 (0.375) in OD
LZY947
5

VALVES

VLV-01

MANUAL VALVES

For Earth, For Life
Kubota

Submittal Transmittal

Manual Valves

Project Name	TAYLOR BAY BEACH CLUB WWTF UPGRADE
Project Site	8220 178TH AVENUE, LONGBRANCH, WA 98351
Engineer	Gray & Osborne, Inc 1130 RAINIER AVENUE SOUTH, SUITE 300
Submit to	Gray & Osborne, Inc
Prepared by	Shingo Kubo | Lead Project Manager KUBOTA Water and Environment U.S.A. Corporation 19910 N Creek Pkwy, Suite 100 Bothell, WA 98011
KMU Project #	KMU-OPID85
Issued Date	September 29, 2025
Package #	OPID85- VLV-01-C-Manual valves
Item	Tag # BFV280, BFV283, BFV286, BFV289 for 3” SMU Air Isolation Valve(inlet) qty=4 BFV282, BFV285, BFV288, BFV291 for 3” SMU Air Isolation Valve(outlet) qty=4 BFV281, BFV284, BFV287, BFV290 for 2” SMU PRMT Isolation Valve qty=4 BFV292, BFV293 for 3” SMU PRMT Header Isolation Valve qty=2 BFV160 – 167 for 3” MBR PRMT Pump Isolation Valve qty=8 CV160 - 162 for 3” MBR PRMT Pump discharge check valve qty=3 BFV101-104 for 3” Air Scour Blower Isolation Valves qty=4 BV282, BV283 for 1” CIP Injection Valves qty=2 BV281, BV284 for 1” CIP pressure relief qty=2

Clarifications;

1. Section1 contains Kubota scope list. The subjected item for this submittal is marked in red.

2. Section2 contains the manufacture submittal and datasheet for review.

3. Submittals for Manual valves for CIP Station are included in CIP Station submittal.

4. Material of the components are summarized in the table below

Tag#	Name	Type	Size	Body	Disc	Stem	Seal	Option
BFV280, BFV283, BFV286, BFV289	SMU Air Isolation Valve(inlet)	Manual Butterfly	3 inch	DI	Nylon 11 Coated	416SS	EPDM	Extended Stem
BFV282, BFV285, BFV288, BFV291	SMU Air Isolation Valve(outlet)	Manual Butterfly	3 inch	DI	Nylon 11 Coated	416SS	EPDM	
BFV281, BFV284, BFV287, BFV290	SMU PRMT Isolation Valve	Manual Butterfly	2 inch	DI	Nylon 11 Coated	416SS	EPDM	Extended Stem
BFV292, BFV293	SMU PRMT Header Isolation Valve	Manual Butterfly	3 inch	DI	Nylon 11 Coated	416SS	EPDM	Extended Stem
BFV160 - 167	MBR PRMT Pump isolation valve	Manual Butterfly	3 inch	DI	Nylon 11 Coated	416SS	EPDM	
CV160 - 162	MBR PRMT Pump discharge check valve	Ball check	3 inch	PVC	PVC	PVC	EPDM	
BFV101-104	Air Scour Blower Isolation Valves	Manual Butterfly	3 inch	DI	316SS	416SS	FKM	
BV282, BV283	CIP Injection Valve	Manual Ball	1 inch	PVC	PVC	PVC	EPDM	Extended Stem, vented
BV281, BV284	CIP Pressure Relief Valve	Manual Ball	1 inch	PVC	PVC	PVC	EPDM	vented

Response to 60% review comment;

1) General – Make Corrections Noted

a. Note that BABA certifications from manufacturers should be included in the final

Kubota Response: BABA certificate is included at the last page of section 2 for Bray DI valves. Please note that the certificate is subjected to be updated after the manufacturer receives the order.

ASAHI PVC valves do not comply with BABA requirement as shown in ATTACHMENT B.

ATTACHMENT B

SCOPE OF SUPPLY COMPONENTS THAT DO NOT COMPLY WITH BABA REQUIREMENTS

Part Identification (Name)	Equipment Description and Type	Manufacturer	Number of Units	Total Lump Sum Equipment Cost for Line Item
Kubota SMU Equipment	FS150 SMU Units + Associated Lifting Tool	Kubota	4 SMUs 1 Lifting Tool + Chains	$80,400.00
SMU Basin Associated Endress + Hauser Instrumentation	1. Air Pressure Transmitters 2. Blower Flow Meters 3. Permeate Flow Meter 4. Pump Pressure Transmitter 5. Level Transmitter	Endress + Hauser	Type 1 - QTY 3 Type 2 - QTY 2 Type 3 - QTY 1 Type 4 - QTY 2 Type 5 - QTY 2	$33,896.00
SMU Basin Hach Instrumentation	1. Air Pressure Transmitters 2. Blower Flow Meters 3. Permeate Flow Meters	Hach	Type 1 - QTY 1 Type 2 - QTY 1 Type 3 - QTY 1	$12,633.00
Kubota Standard CIP System	Kubota CIP system based around Mazzei injector, rotometer and flow control valve	Various	1 System of Supply	$18,500.00
PVC Isolation Valves + Check Valves	3 inch PVC Ball Valves 3 inch PVC Check Valves	Asahi	11 Ball Valves 3 Check Vavles	$11,072.00

b. Note that manufacturer services should be included in the final submittal.

Kubota Response: Manufacturer field service is not applicable to the products.

20) VLV-01-A-Manual Valves – No Exceptions Taken

a. Note that operator extensions should be provided for valves installed below the deck covers to allow manual operation from a cover hatch.

Kubota Response: Extended stem information has been included for Bray DI valves and Asahi PVC valves

Response to 100% review comment;

20) VLV-01-A-Manual Valves – Make Corrections Noted

a. We take no exceptions to the equipment submitted.

b. Equipment Tag Nos.: Add BFV 292 and BFV 293 (Permeate header Isolation). See attached latest P&ID drawings.

Kubota Response: The valves have been added in to Kubota scope list. See the updated scope list. Also the valves are added in the table in the clarification section (highlighted in yellow).

c. Equipment Tag Nos.: Add the following note below the table, or add all CIP valves Tag Nos.: "Note CIP System Valve Tag Numbers not included in this section. See Section EQ-05-B-CIP Station."

Kubota Response: The note added.

For Earth, For Life
Kubota

SECTION 1

KUBOTA Water and Environment U.S.A. Corporation
19910 N Creek Pkwy, Suite 100 Bothell, WA 98011| Phone: 425 898 2858 | Fax: 425-898-2853

No	Equipment Location	Tag	Category	Function	Name	Type	Chosen Size/Capacity	Unit	Material	Manufacturer	Model/ Specification	Motor HP	Voltage	FLA	QTY
	MBR Equipment	**x**													
1	MBR	02 MBR 01 02 MBR 02 02 MBR 03 02 MBR 04	SMU	Membrane Filtration	MBR SMU	Flat Plate			304SS	KUBOTA	FS150				4
2	MBR	n/a	SMU	SMU Maintenance	MBR SMU Lifting Tool	Lifting Tool			CS, SS	KUBOTA	TG150				1
3	MBR	n/a	SMU	SMU Maintenance	MBR SMU Lifting Chain	Lifting Tool			304SS	KUBOTA	CS30M				4
4	MBR	02 MOV 03 02 MOV 04	Auto Valve	Diffuser Cleaning	MBR Diffuser Cleaning Valve	ON/OFF Plug	4	inch	CI/DI	Auma/Pratt	SQ10.2/AC01.2/S651 w/2' extention stem	1/12	120 VAC	2.9	2
5	MBR	BFV280, BFV283, BFV286, BFV289	Other Valve	Isolation Valve	SMU Air Isolation Valve(inlet)	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S31				4
6	MBR	BFV282, BFV285, BFV288, BFV291	Other Valve	Isolation Valve	SMU Air Isolation Valve(outlet)	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S31				4
7	MBR	See Section VLV-01- C for Valve ID Tags	Other Valve	Isolation Valve	SMU PRMT Isolation Valve	Manual Butterfly	2	inch	DI, EPDM, Nylon Coat	Bray	S31				4
8	MBR	BFV 292, BFV 293	Other Valve	Isolation Valve	SMU PRMT Header Isolation Valve	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S31				2
9	MBR	BV282, BV283	Other Valve	Manual Valves	CIP injection	Manual Ball	1	inch	PVC, EPDM	ASAHI	Type21 True Union, extension stem				2
10	MBR	BV281, BV284	Other Valve	Manual Valves	CIP pressure relief	Manual Ball	1	inch	PVC, EPDM	ASAHI	Type21 True Union				2
11	MBR	02 LS 03 02 LS 04 02 LS 05 02 LS 06	Gauge, Switch	Level Measurement	MBR Level Switch	Float			PP, PU	Conery	2902-B8S1 w/ counter weight and brackets		Loop power		4
12	MBR	n/a	Fabrication	Fabrication	MBR SMU Guide & Stabilizer + Seismic Bracing				304SS	TBD					4
13	MBR	n/a	Fabrication	Fabrication	MBR SMU Fasteners				304SS	TBD					40
14	MBR	n/a	Fabrication	Fabrication	MBR In-Basin Pipe&Supports (Permeate Drop Pipe)				PVC	TBD					4
15	MBR	n/a	Fabrication	Fabrication	MBR In-Basin Pipe&Supports (Air Drop Pipe)				304SS	TBD					8
	Permeate (PRMT) Control Equipment	**x**													
16	PRMT	01 PMP 01 01 PMP 02 01 PMP 03	Permeate Pump	Permeate Extraction	PRMT Pump	Rotary Lobe	45	gpm		Boerger	AN 70 w/ piggyback mount	5	460 VAC	6.6	3
17	PRMT	PI169 PI170 PI171	Gauge	Pressure Gauge	PRMT Pump Pressuge Gauge(Inlet)		-15 - +15	psig	SS	Ashcroft or equivalent	1279 w/ grycelin filled				3
18	PRMT	PI172 PI173 PI174	Gauge	Pressure Gauge	PRMT Pump Pressuge Gauge (Inlet)		-15 - +15	psig	SS	Ashcroft or equivalent	1279 w/ grycelin filled				3
19	PRMT	01 PTR 01 01 PTR 02	Pressure Sensor	TMP Measurement	PRMT Pump Pressure Transmitter	Diaphragm	-15 - +15	psi	SS	Endress & Hauser	Cerabar PMCB51		Loop power		2
20	PRMT	01 MFM 01 01 MFM 02	Flow Sensor	Flow Measurement	PRMT Flow Meter	Electromagnetic	3	inch	PU	Endress & Hauser	Promag W 400		24VDC		2
21	MBR	BFV160 - 167	Other Valve	Isolation Valve	MBR PRMT Pump isolation valve	Manual Butterfly	3	inch	DI, EPDM, Nylon Coat	Bray	S31				8
22	MBR	See Section VLV-01- C for Valve ID Tags	Other Valve	Check valve	MBR PRMT Pump discharge check valve	Manual ball	3	inch	PVC, EPDM	ASAHI	True Union Ball Check				3
23	PRMT	01 TM 01	Other Instrument	Turbidity Measurement	PRMT Turbidity Meter	Laser	0-5	NTU		HACH	TU5300sc				1
24	PRMT	01 TM 01	Other Instrument	Turbidity Measurement	PRMT Turbidity Transmitter					HACH	SC4500		24VDC		1
25	PRMT	n/a	Other Instrument	Turbidity Measurement	Turbidity Meter Maintenance Kit					HACH					1
	Return Activated Sludge (RAS) Control	**x**													
26	RAS	Relocated from MBR 02 SLS02 02 SLS03	Other Instrument	Level Measurement	MBR Level Sensor	Hydrostatic	15	ft	SS	Endress & Hauser	Waterpilot FMX21 w/ brackets		Loop power		2

No	Equipment Location	Tag	Category	Function	Name	Type	Chosen Size/Capacity	Unit	Material	Manufacturer	Model/ Specification	Motor HP	Voltage	FLA	QTY
	MBR Blower	**x**													
27	MBR BLW	01 MSB 01 01 MSB 02 01 MSB 03	Blower	Blower	MBR Blower	Positive Displacement	114	scfm	CI	Aerzen	GM 4S DN 80	5	460 VAC	6.6	3
28	MBR BLW	n/a	Option	Noise Suppression	MBR Blower Sound Enclosure	With Blower									3
29	MBR BLW	n/a	Option	Blower Temperature	MBR Blower Temperature Gauge	With Blower									3
30	MBR BLW	n/a	Option	Blower Pressure	MBR Blower Pressure Gauge	With Blower									3
31	MBR BLW	n/a	Option	Blower Temperature	MBR Blower Temperature Switch	With Blower									3
32	MBR BLW	01 AFM 01 01 AFM 02	Flow Sensor	Air Flow Measurement	MBR Blower Flow Meter	Thermal Mass	3	inch	PU	Endress & Hauser	t-mass I 300, w/ flow conditioner plate		24VDC		2
33	MBR BLW	BFV101-104	Other Valve	Manual Valves	Air Scour Blower Isolation Valves	Manual Butterfly	3	inch	DI, FKM, SS Disk	Bray	S31				4
	Clean-In-Place Equipment	**x**													
34	CIP Station	n/a	Chemical Injection	Chemical Injection	SMU CIP System PVC pipes		1	inch	PVC	KUBOTA	Loose ship parts shown on xxx				1
35	CIP Station	n/a	Flow Sensor	Flow Measurement	CIP solution Flow Meter	Electromagnetic	1	inch	PU				24 VDC		1
36	CIP Station	n/a	Flow Sensor	Flow Measurement	CIP shelf chenical Flow Meter	Electromagnetic	3/8	inch	PU	Keyence	FD-Q10C		24VDC		1
37	CIP Station	*1	Auto Valve	Flow Control	CIP Flow Control Valve	ON/OFF Ball	1	inch	DI	ASAHI	S19-120VAC--1"-C20/S20		120VAC	0.18	1
38	CIP Station	*1	Other Valve	Manual Valves	Isolation Valves on CIP Station	Manual Ball	1, 0.5	inch	PVC	ASAHI	Type21 True Union				1
39	CIP Station	*1	Other Valve	Manual Valves	Pressure reducing valve	Pressure Reducing	1.5	inch	CI	Zurn	ZW209				1
	System Control Equipment	**x**													
40	CONTROL	n/a	Control Panel	Control Panel	Control Panel	OIT, PLC					NEMA 4/12, 72" x 72" x 18" floor mount enclosure (estimated size) , Allen Bradley 1756-L81E PLC (BABA-Version), FactoryTalk View SE		120VAC	TBD	1
41	D. SERVICE	n/a	D. Service	Direct Service	Direct Service						Design support, start-up, field service, remote service				1

***1; Note CIP System Valve Tag Numbers not included in this section. See Section EQ-05-B-CIP Station.**

SECTION 2

The Bray Series 30/31 features a high strength one piece stem design utilizing an efficient internal disc to stem connection. This resilient seated butterfly valve provides a primary and secondary seal between the disc and seat as well as the stem and seat which ensures the total encapsulation of the line media and zero external leakage.

PRESSURE RATINGS

BIDIRECTIONAL BUBBLE TIGHT SHUT OFF – Standard Disc* Downstream flanges and disc in closed position		
Series 30/31 Standard Disc*	2"-12" (50-300mm)	175 psi (12 bar)
	14"-20" (350-500mm)	150 psi (10.3 bar)
DEAD END SERVICE – Lug Bodies and Standard Disc* No downstream flanges and disc in closed position		
Series 31	2"-12" (50-300mm)	75 psi (5.2 bar)
	14"-20" (350-500mm)	50 psi (3.4 bar)
BODY: 250 psi (17.2 bar)		

*For low pressure (50 psi) applications, Bray offers a standard reduced disc diameter to decrease seating torques and extend seat life, thus increasing the valve's performance and reducing actuator costs.

VELOCITY LIMITS FOR ON/OFF SERVICES

FLUIDS: 30 ft/sec (9 m/s)	**GASES:** 175 ft/sec (54 m/s)



1 – **STEM RETAINING ASSEMBLY:** The stem is retained in the body by means of a unique stainless steel Spirolox® retaining ring, a thrust washer and two C-rings, manufactured from brass as standard, stainless steel upon request.

2 – **STEM BUSHING:** Non-corrosive, heavy duty acetal bushing absorbs actuator side thrust.

3 – **STEM SEAL:** Double "U" cup seal design is self-adjusting and gives positive sealing in both directions.

4 – **PRIMARY AND SECONDARY SEALS:** These seals prevent line media from coming in contact with the stem or body. The primary seal is an interference fit of the molded seat flat with the disc hub. The secondary seal is created because the stem diameter is greater than the diameter of the seat stem hole.

5 – **BODY:** One piece wafer or lug style. Polyester coating for excellent corrosion resistance. Nylon 11 coating is available as an option.

6 – **SEAT:** Bray's tongue and groove seat design provides complete isolation of flowing media from the body. The seat also features a molded o-ring which eliminates the use of flange gaskets.

7 – **DISC:** Casting is spherically machined and hand polished to provide a bubble tight shutoff, minimum torque, and longer seat life. Bray's resilient Nylon 11 coating comes as standard.

8 – **STEM:** Precision double "D" disc to stem connection drives the disc without the need for screws or pins. The close tolerance, double "D" connection that drives the valve disc is an exclusive feature of the Bray valve. Disassembly of the Bray stem is just a matter of pulling the stem out of the disc.



MATERIAL SELECTION OPTIONS

BODY	DISC	STEM	SEAT
Cast Iron✦	Nylon 11 Coated Ductile Iron✦	416 Stainless Steel✦	BUNA-N Food Grade✦
Ductile Iron✦	316 Stainless Steel✦	304 Stainless Steel	EPDM Food Grade✦
Carbon Steel	Nickel Aluminum Bronze	316 Stainless Steel	FKM*
Aluminum	Coated Ductile Iron	Monel® K500	White BUNA-N Food Grade
	Halar® Coated Ductile Iron		Bonded EPDM
	304 Stainless Steel		Bonded BUNA-N
	Duplex Stainless Steel		
	Super Duplex Stainless Steel		
	Hastelloy®		

✦Standard Option

*FKM is the ASTM D1418 designation for fluorinated hydrocarbon elastomers (also called fluoroelastomers).

Monel® is a registered trademark of The International Nickel Company, Inc.

Halar® is a registered trademark of Solvay Solexis, Inc.

Hastelloy® is a registered trademark of Haynes International, Inc.



SERIES 31H

2"-20" (50mm-500mm)

Series 31H Lug valves are drilled and tapped to meet ASME Class 125/150 and PN16 flanges. Series 31H valves are designed for manual operation only.

PRESSURE RATINGS

BIDIRECTIONAL BUBBLE TIGHT SHUT OFF AND DEAD END SERVICE	
2"-20" (50-500mm)	250 psi (17.2 bar)
BODY: 250 psi (17.2 bar)	

VELOCITY LIMITS FOR ON/OFF SERVICES

FLUIDS: 30 ft/sec (9 m/s)	**GASES:** 175 ft/sec (54 m/s)

STANDARD MATERIAL SELECTIONS

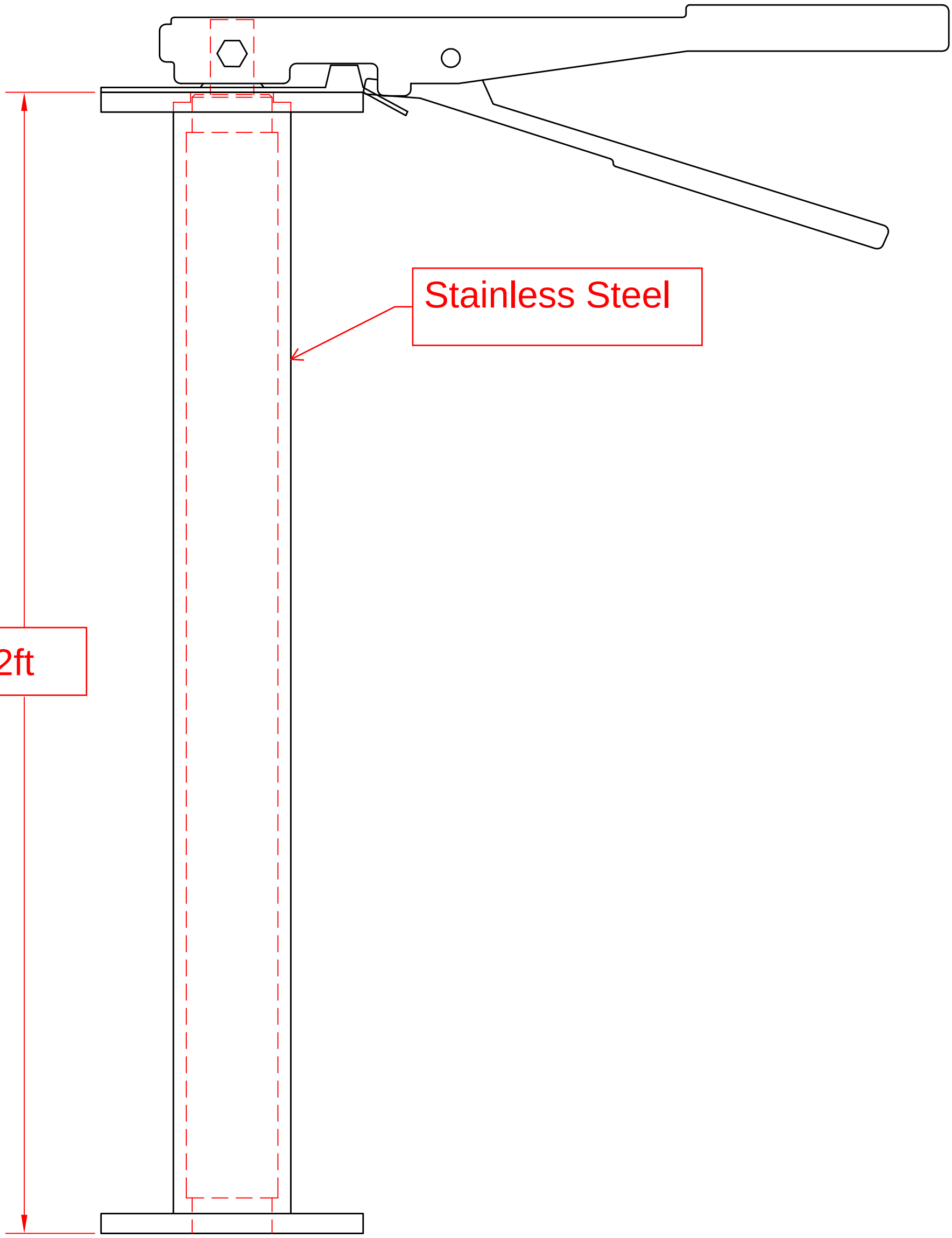
Body	Cast Iron Ductile Iron
Disc	Nickel Aluminum Bronze Nylon 11 Coated Ductile Iron 316 Stainless Steel
Stem	416 Stainless Steel
Seat	Bonded EPDM Bonded BUNA-N

Material availability depends on valve size and series. Other materials are available. Please consult your local Bray representative for your specific application.

DWG NO.

BFV280, BFV283, BFV286, BFV289 SMU Air Isolation Valve(inlet) will have 2ft extension stem

BFV281, BFV284, BFV287, BFV290SMU PRMT Isolation Valve will have 2ft extension stem



REV	DESCRIPTION	DATE	APPRVD

NVH Nitz Valve Hardware Inc.

THIS DOCUMENT AND THE DATA DISCLOSED HEREIN OR HEREWITH IS NOT TO BE REPRODUCED, USED, OR DISCLOSED IN WHOLE OR IN PART WITHOUT THE WRITTEN CONSENT OF NITZ VALVE HARDWARE, INC.

EXTENSION EXAMPLE WITH HANDLE & 10 POS. PLATE

DRAWN BY:

APPROVED BY:

PART NO.

REV -

SCALE 1:1

SHEET 1 OF 1



Type-21/21A Ball Valve

Specifications

Sizes: 1/2" – 6"
Models: PVC & CPVC: Socket, Threaded and Flanged (ANSI)
PP & PVDF: IPS and Metric (DIN) Socket, Threaded, Butt and Flanged (ANSI)
Bodies: PVC, CPVC, PP and PVDF
Seats: PTFE backed with EPDM or FKM
Seals: EPDM or FKM or AFLAS®‡

Sizes 1/2" - 4" PVC/EPDM/FKM Models
1/2"- 4" CPVC/EPDM/FKM Models
NSF-61 Certified

‡ Trademark of Asahi Glass Co., Ltd.

Standard Features (Sizes 1/2" – 6")

- Pressure rated up to 230psi (PVC, CPVC, PVDF)
- Double O-ring seals on stem for added protection
- Full bore, sizes 1/2" – 2"
- Full vacuum rated, all sizes
- Blocks in two directions, upstream and downstream, leaving full pressure on the opposite end of the valve
- Integrally molded ISO mounting pad for both manual and actuated operations
- Integrally molded base pad to mount valves securely or panel mounting
- PTFE seats with elastomeric backing cushions ensure bubble tight shut-off and a low fixed torque, while at the same time compensating for wear
- True union design for easier installation or repairs without expanding the pipe system
- Built-in spanner wrench on the handle for valve disassembly and assembly
- Two sets of end connectors (socket and threaded) included with all PVC and CPVC valves in sizes 1/2"– 2"
- CPVC threaded end connectors on sizes 1/2" – 1" come with stainless steel reinforcing rings
- New PTFE seat design – Facilitates easier field maintenance if required
- Tapered O-ring groove – Helps to keep the end connector O-rings on the valve body during installation
- Body flats – Flats have been added to either side of the valve body where a wrench can be applied to prevent the valve body from turning when the union nuts are tightened
- 1/2 - 2 " PVC and CPVC T-21A design

Options

- Pneumatic and electric actuators and accessories
- Stem extensions
- 2" square operating nut or "T" nut
- Locking handles
- Limit switches
- Vented ball

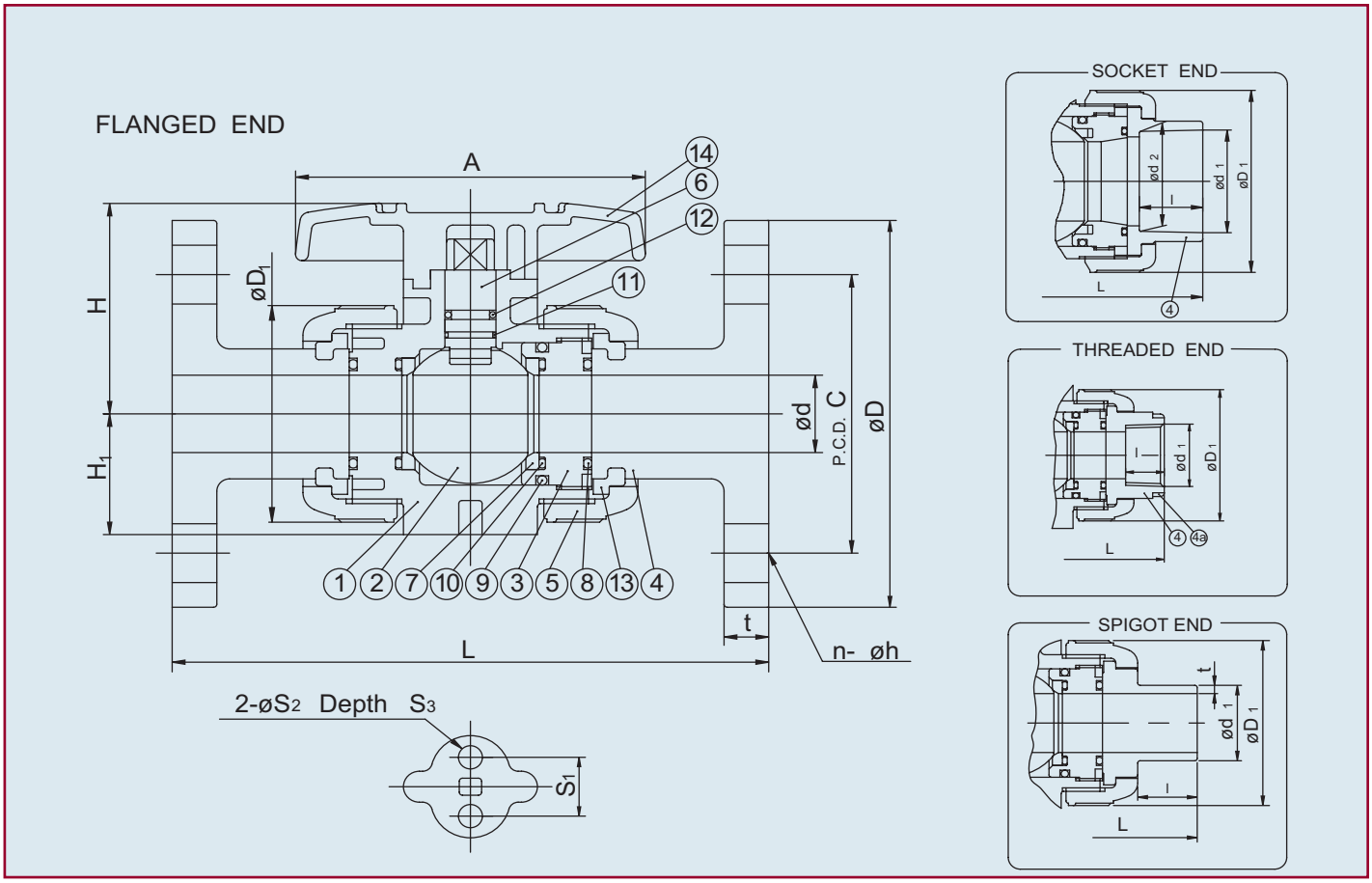
Parts List (Sizes 1/2" – 2")

PARTS			
NO.	DESCRIPTION	PCS.	MATERIAL
1	Body	1	PVC, CPVC, PP, PVDF
2	Ball	1	PVC, CPVC, PP, PVDF
3	Carrier	1	PVC, CPVC, PP, PVDF
4	End Connector	2	PVC, CPVC, PP, PVDF
5	Union Nut	2	PVC, CPVC, PP, PVDF
6	Stem	1	PVC, CPVC, PP, PVDF
7	Seat	2	PTFE
8	O-Ring (A)	2	EPDM, FKM, Others
9	O-Ring (B)	1	EPDM, FKM, Others
10	O-Ring (C)	2	EPDM, FKM, Others
11	O-Ring (D)	1	EPDM, FKM, Others
12	O-Ring (E)	1	EPDM, FKM, Others
~~13~~	~~Stop Ring*~~	~~2~~	~~PVDF~~
14	Handle	1	ABS
~~4a~~	~~Ring**~~	~~2~~	~~304 Stainless Steel~~

* Used for flanged end.
**Used for CPVC body, threaded end, 1/2"–1".



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Dimensions (Sizes 1/2" – 2") (in.)

NOMINAL SIZE			FLANGED						SOCKET										
			ANSI CLASS 150						PVC, CPVC				PP, PVDF (DIN)				PP, PVDF (IPS)		
									ASTM SCH 80				DIN 16962						
INCHES	mm	d	D	C	n	h	L	t	d1	d2	l	L	d1	d2	l	L	d1	l	L
1/2	15	0.59	3.50	2.38	4	0.62	5.63	0.47	0.848	0.836	0.875	4.45	0.768	0.760	0.57	3.90	0.83	0.87	4.45
3/4	20	0.79	3.88	2.75	4	0.62	6.77	0.55	1.058	1.046	1.000	5.08	0.965	0.957	0.63	4.45	1.03	1.00	5.08
1	25	0.98	4.25	3.12	4	0.62	7.36	0.55	1.325	1.310	1.125	5.75	1.240	1.232	0.71	4.84	1.30	1.13	5.75
1-1/4	32	1.26	4.62	3.50	4	0.62	7.48	0.63	1.670	1.655	1.250	6.46	1.553	1.543	0.81	5.47	1.65	1.25	6.46
1-1/2	40	1.57	5.00	3.88	4	0.62	8.35	0.63	1.912	1.894	1.375	7.24	1.947	1.937	0.93	5.87	1.89	1.37	7.24
2	50	2.01	6.00	4.75	4	0.75	9.21	0.63	2.387	2.369	1.500	8.23	2.461	2.445	1.08	6.93	2.36	1.50	8.23

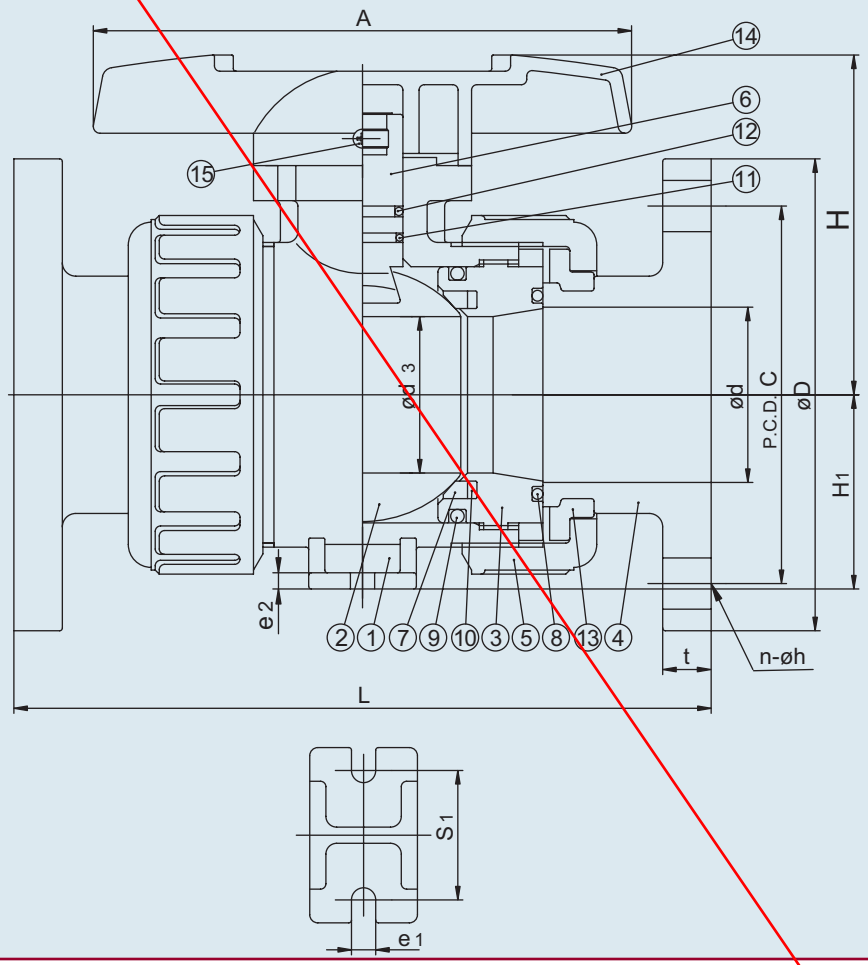
NOMINAL SIZE		THREADED			SPIGOT (BUTT END)											
					PP,PVDF											
					DIN 3442		PP	PVDF								
INCHES	mm	d1	l	L	d1	l	t	t	L	D1	H	H1	A	S1	S2	S3
1/2	15	1/2 - 14 NPT	0.59	4.02	0.787	0.728	0.098	0.075	4.882	1.89	2.03	1.14	3.62	0.75	0.29	0.43
3/4	20	3/4 - 14 NPT	0.67	4.72	0.984	0.866	0.106	0.075	5.669	2.36	2.34	1.38	3.94	0.75	0.29	0.43
1	25	1 - 11-1/2 NPT	0.79	5.16	1.260	0.886	0.118	0.094	6.063	2.76	2.68	1.54	4.33	0.75	0.29	0.43
1-1/4	32	1-1/4 - 11-1/2 NPT	0.87	5.91	1.575	1.024	0.146	0.094	6.850	3.23	3.17	1.85	4.76	1.18	0.35	0.59
1-1/2	40	1-1/2 - 11-1/2 NPT	0.98	6.42	1.968	1.260	0.181	0.118	7.638	3.94	3.50	2.17	5.16	1.18	0.35	0.59
2	50	2 - 11-1/2 NPT	1.10	7.76	2.480	1.417	0.228	0.118	8.819	4.96	4.04	2.60	6.26	1.18	0.35	0.59

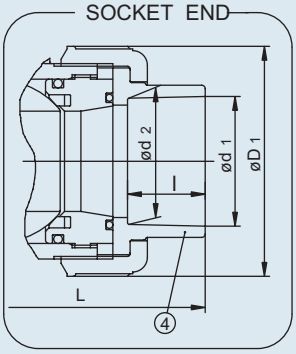
Note: The shape and appearance of assembly differ a little with nominal size compared to this drawing.

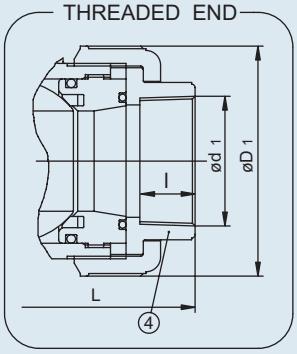
PARTS (Different Numbers from 1/2"-2")			
NO.	Description	PCS	MATERIAL
10	Cushion	2	EPDM, FKM, Others
15	Screw	1	304 Stainless Steel

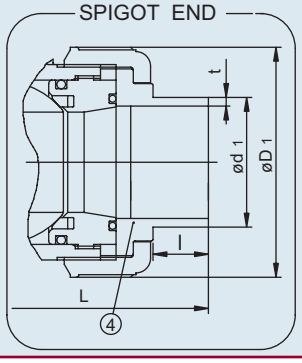
NOTE: Quantity on Nos. 3 and 9 (see p. 6) is 2.

FLANGED END









Dimensions (Sizes 2-1/2" – 4") (in.) For 6" size consult factory.

NOMINAL SIZE			FLANGED									SOCKET												
			ANSI CLASS 150									PVC, CPVC				PP, PVDF (DIN)					PP, PVDF (IPS)			
							L					ASTM SCH 80				DIN 16962			PP	PVDF			PP	PVDF
INCHES	mm	d	D	C	n	h	PVC CPVC	PP	PVDF	t	d1	d2	l	L	d1	d2	l	L	L	d1	l	L	L
2-1/2	65	2.56	7.0	5.5	4	0.75	10.20	10.12	10.08	0.71	2.889	2.868	1.750	9.45	2.923	2.911	1.22	8.07	8.03	2.88	1.752	9.37	9.33
3	80	3.07	7.5	6.0	4	0.75	12.05	12.07	11.89	0.71	3.516	3.492	1.875	11.14	3.512	3.498	1.40	9.92	9.80	3.48	1.874	11.10	10.28
4	100	3.94	9.0	7.5	8	0.75	14.72	14.72	14.53	0.71	4.518	4.491	2.000	13.89	4.293	4.278	1.63	12.28	12.09	4.48	2.252	14.37	14.13

NOMINAL SIZE		THREADED					SPIGOT (BUTT END)														
				L			PP,PVDF														
				PVC CPVC	PP	PVDF	DIN 3442		PP	PVDF	PP	PVDF									
INCHES	mm	d1	l				d1	l	t	t	L	L	d3	D1	H	H1	A	e1	e2	S1
2-1/2	65	2-1/2 - 8NPT	1.26	8.46	8.39	8.35	2.953	1.496	0.272	0.142	9.648	9.606	2.28	5,24	4.96	2.83	7.87	0.35	0.24	1.89
3	80	3 - 8NPT	1.38	10.43	10.39	10.28	3.543	1.496	0.323	0.169	11.654	11.535	2.70	5.98	5.51	3.35	9.45	0.43	0.28	2.17
4	100	4 - 8NPT	1.77	14.25	14.25	14.06	4.331	1.752	0.394	0.209	13.978	13.779	3.54	8.27	7.01	4.33	11.81	0.43	0.31	2.56

Note: The shape and appearance of assembly differ a little with nominal size compared to this drawing.

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Pressure vs. Temperature (psi, water, non-shock)

NOMINAL SIZE		PVC				CPVC						PP				PVDF				
INCHES	mm	30° F 70° F	71° F 105° F	106° F 120° F	121° F 140° F	30° F 70° F	71° F 105° F	106° F 120° F	121° F 140° F	141° F 175° F	176° F 195° F	- 5° F 85° F	86° F 120° F	121° F 140° F	141° F 175° F	- 5° F 70° F	71° F 105° F	106° F 140° F	141° F 175° F	176° F 210° F
1/2-2	15-50	230	170	150	30	230	170	150	120	75	55	150	110	90	55	230	185	150	115	85
2-1/2	65	230	170	150	NA	230	170	150	120	75	55	150	95	70	40	230	185	150	115	85
3	80	230	170	150	NA	230	170	150	85	55	40	150	95	70	40	230	185	150	100	70
4-6	100-150	150	150	150	NA	150	150	150	85	55	40	150	95	70	40	150	150	150	100	70

Sample Specification

All Type-21/21A ball valves, sizes 1/2" to 4", shall be of true union design with two-way blocking capability. All O-rings shall be EPDM or FKM with PTFE seats. PTFE seats shall have elastomeric backing cushion of the same material as the valve seals. Stem shall have double O-rings and be of blowout-proof design. The valve handle shall double as carrier removal and/or tightening tool. ISO mounting pad shall be integrally molded to valve body for actuation. PVC conforming to ASTM D1784 Cell Classification 12454A, CPVC conforming to ASTM D1784 Cell Classification 23567-A, PP conforming to ASTM D4101 Cell Classification PP0210B67272 and PVDF conforming to ASTM D3222 Cell Classification Type II. The ball valves, except PP, shall have a pressure rating of 230psi for sizes 1/2" to 3" and 150psi for 4" (150psi for PP, all sizes) at 70º F. Type-21/21A ball valves must carry a two year guarantee, as manufactured by Asahi/America, Inc.

Cv Values

NOMINAL SIZE		Cv
INCHES	mm	
1/2	15	14
3/4	20	29
1	25	47
1-1/4	32	72
1-1/2	40	155
2	50	190
2-1/2	65	365
3	80	410
4	100	680

Weight (lbs.)

NOMINAL SIZE		SOCKET	FLANGED
INCHES	mm	THREADED	
1/2	15	0.44	1.10
3/4	20	0.66	1.54
1	25	1.1	2.70
1-1/4	32	1.54	3.30
1-1/2	40	2.64	4.40
2	50	4.4	8.15
2-1/2	65	6.17	8.80
3	80	9.7	13.00
4	100	24.00	26.67

Caution

- Never remove valve from pipeline under pressure.
- Always wear protective gloves and goggles.
- Watch out for trapped fluid in valve. It is safe to close valve before removing it from the pipeline.

Caution

- Do not use ball valves where media has suspended particles. Use the following valves:
  - Butterfly valves – PVDF disc is most abrasion resistant. Make sure of chemical compatibility.
  - Diaphragm valves – Elastomeric diaphragm is designed for handling suspended particles.
- Volatile fluids such as sodium hypochlorite (NaClO) and hydrogen peroxide (H_2O_2) could be trapped and gasified within the valve. We can provide you with a Type-21 ball valve with a vented ball to relieve pressure build-up inside the valve.

Troubleshooting

What if the fluid still flows when valve is closed?

1. Carrier is not properly tightened. Tighten it.
2. PTFE seat is damaged or worn. Replace seat.
3. Foreign material is caught between ball and PTFE seat. Remove material and clean.
4. Ball is damaged or worn. Change ball.

What if fluid leaks outside of valve?

1. Union nut not properly tightened. Retighten.
2. Carrier is not properly tightened. Thread it in firmly.
3. Carrier or face O-ring is damaged, worn, or missing. Replace O-ring.

What if handle does not rotate smoothly?

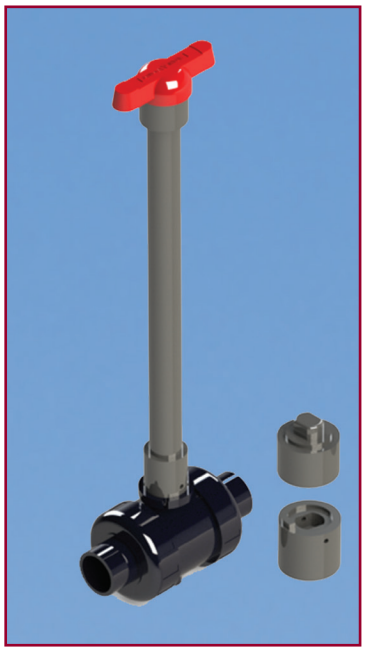
1. Foreign material has formed on the ball or seat. Clean both.
2. Internal part(s) chemically attacked or swollen. Refer to Asahi/America Chemical Resistance Chart for compatibility. Replace part(s) as required.
3. Carrier overtightened. Retighten properly.

What if handle rotates too freely?

1. Stem is damaged. Replace stem.
2. Handle is not engaged with stem. Disassemble and reengage. Inspect.
3. Engaging part of stem and/or ball is damaged. Change stem and/or ball.

BV282, BV283 CIP Injection Valve will have 2.5ft Extension

Type-21 Ball Valve Stem Extension Kit



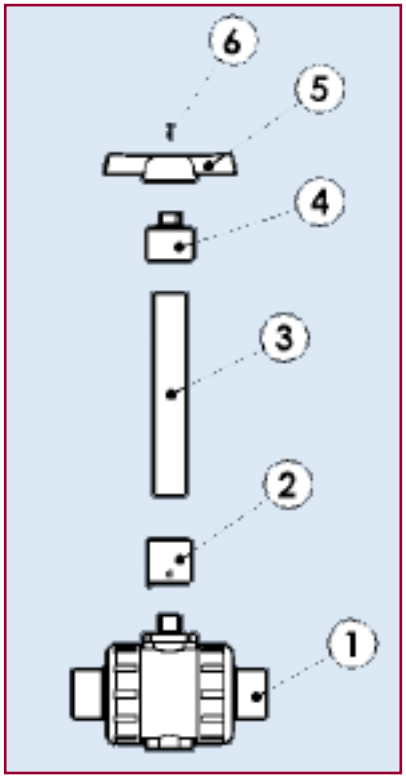
The Type-21 ball valve stem extension kits are the ideal solution for accessing valves that are installed in out of reach locations. Machined from PVC bar stock to exact specifications, for a factory fit and finish. Available for valves ½" – 2", extension kits are supplied ready to be assembled and installed using your existing or a new Type-21 ball valve, and Schedule 40/80 PVC pipe. Cut your pipe to the desired length, solvent cement to the extension couplings, and install on the valve for a simple and effective stem extension.

Standard Features (Sizes 1/2" – 2")

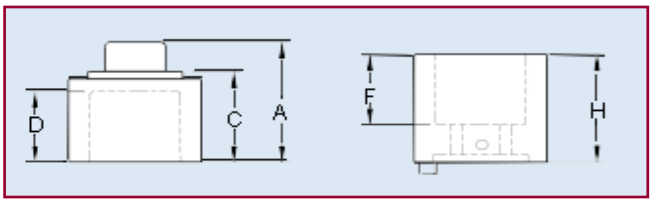
- Designed to fit PVC, CPVC, PP & PVDF T-21 manual valves
- Machined from solid PVC stock - ASTM D1784 Cell Class 12454
- For use with Schedule 40/80 PVC pipe
- 2-piece kits for field assembly using PVC solvent cement
- 4 unique kits cover ½" thru 2" size range
- Tight tolerances provides factory fit and finish
- Torque tested & approved for handle extensions up to 6' long
- Not intended for actuator use

Parts List (Sizes 1/2" – 2")

PARTS			
NO.	DESCRIPTION	PCS.	MATERIAL
1	Type-21 Ball valve	1	PVC,CPVC,PP,PVDF
2	Lower Coupling	1	PVC
3	Schedule 40/80 PVC Pipe	1	PVC (not supplied)
4	Upper Coupling	1	PVC
5	Type-21 Handle	1	ABS
6	SS Cap Screw	1	304SS

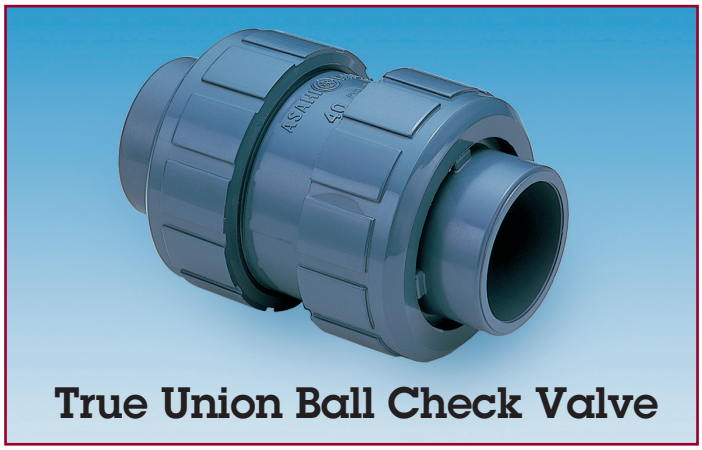


Dimensions (in.)



NOMINAL SIZE		Pipe Size*	A	H	C	D	F
INCHES	mm						
1/2	15	1" Sch 40/80	1.895	1.760	1.330	1.125	1.125
3/4-1	20-25	1" Sch 40/80	1.970	1.760	1.330	1.125	1.125
1-1/4	32	1" Sch 40/80	2.010	1.760	1.330	1.125	1.125
1-1/2-2	40-50	1" Sch 40/80	2.150	1.760	1.330	1.125	1.125

*Schedule 40 or 80 PVC pipe can be used, for maximum strength Schedule 80 is recommended.



True Union Ball Check Valve

Specifications

Sizes: True Union : 1 /2" – 2"
Single Union: 3" – 4"
Models: Socket, Threaded, Flanged (ANSI), Butt End
Bodies: PVC, CPVC, PP and PVDF
Seats: EPDM, FKM, PTFE
Seals: EPDM, FKM, PTFE
Option: Foot Valve

Sizes 1/2" - 4" PVC/EPDM/FKM Models
1/2" - 4" CPVC/EPDM/FKM Models
NSF-61 Certified

Standard Features (Sizes 1/2" - 2")

- Uniseat/seal of EPDM or FKM
- Ball is the only moving part. It unseats to permit flow in one direction but seals against seat to prevent back flow
- May be used vertically or horizontally
- Minimum shut-off of 5psi
- All sizes rated for full vacuum service
- Solid thermoplastic ball

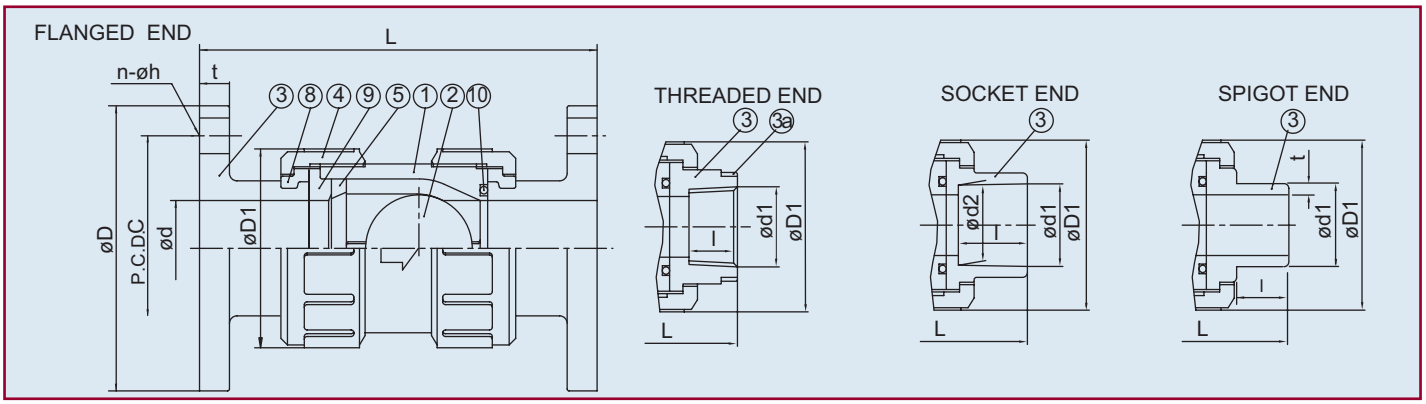
Options:

- PTFE coated FKM uniseat/seal
- Spring-loaded ball to assist ball in seating faster

Parts List – True Union (Sizes 1/2" - 2")

PARTS			
NO.	DESCRIPTION	PCS.	MATERIAL
1	Body	1	PVC, CPVC, PP, PVDF
2	Ball	1	PVC, CPVC, PP, PVDF
3	End Connector	2	PVC, CPVC, PP, PVDF
4	Union Nut	2	PVC, CPVC, PP, PVDF
5	Stop Ring (A)	1	PVC, CPVC, PP, PVDF
8	Stop Ring (B)*	1	PVDF
9	Seat	1	EPDM, FKM, PTFE
10	O-Ring	1	EPDM, FKM, PTFE
3a	Ring**	1	Stainless Steel 304

* Used for flanged end.
** Used for CPVC body, threaded end; 1/2" - 1".



Dimensions (Sizes 1/2" – 2") (in.)

NOMINAL SIZE		FLANGED						THREADED					SOCKET											SPIGOT (BUTT END)				
		ANSI CLASS 150											PVC, CPVC				PP, PVDF (DIN)				PP, PVDF (IPS)			PP, PVDF				
													ASTM SCH 80				DIN 16962							DIN 3442		PP	PVDF	
INCHES	mm	D	C	n	h	L	t	d1	l	L	d	D1	d1	d2	l	L	d1	d2	l	L	d1	l	L	d1	l	t	t	L
1/2	15	3.50	2.38	4	0.62	5.12	0.47	1/2 - 14NPT	0.59	3.39	0.59	1.89	0.848	0.836	0.688	3.43	0.768	0.760	0.57	3.19	0.83	0.87	3.31	0.787	0.728	0.098	0.075	4.00
3/4	20	3.88	2.75	4	0.62	6.10	0.55	3/4 - 14NPT	0.67	4.06	0.79	2.36	1.058	1.046	0.719	3.86	0.965	0.957	0.63	3.70	1.03	1.00	4.43	0.984	0.866	0.106	0.075	4.35
1	25	4.25	3.12	4	0.62	6.50	0.55	1 - 11-1/2NPT	0.79	4.45	0.98	2.76	1.325	1.310	0.875	4.37	1.240	1.232	0.71	4.13	1.30	1.13	4.35	1.260	0.866	0.118	0.094	4.75
1-1/4	32	-	-	-	-	-	-	1-1/4 - 11-1/2NPT	0.87	5.00	1.22	3.78	1.670	1.655	0.938	4.92	-	-	-	-	-	-	-	-	-	-	-	-
1-1/2	40	5.00	3.88	4	0.62	7.56	0.63	1-1/2 - 11-1/2NPT	0.98	5.94	1.57	3.78	1.912	1.894	1.094	5.94	1.947	1.937	0.93	5.62	1.89	1.37	5.57	1.969	1.260	0.181	0.118	5.75
2	50	6.00	4.75	4	0.75	8.43	0.63	2 - 11-1/2NPT	1.10	6.97	2.01	4.17	2.387	2.369	1.156	6.77	2.461	2.445	1.08	6.69	2.36	1.50	6.49	2.480	1.417	0.228	0.118	6.50

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Ball Check Single Union



Parts List – Single Union (Sizes 3" – 4")

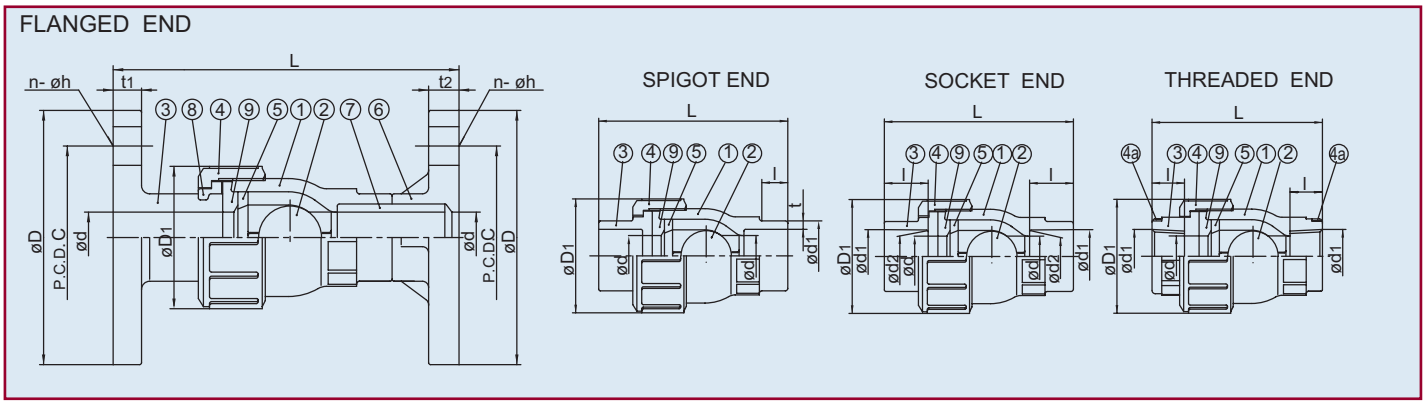
PARTS			
NO.	DESCRIPTION	PCS.	MATERIAL
1	Body	1	PVC, CPVC, PP, PVDF
2	Ball	1	PVC, CPVC, PP, PVDF
3	End Connector	1	PVC, CPVC, PP, PVDF
4	Union Nut	1	PVC, CPVC, PP, PVDF
5	Stop Ring (A)	1	PVC, CPVC, PP, PVDF
8	Flange	1	PVC, CPVC, PVDF
9	Stub	1	PVC, CPVC, PVDF
10	Stop Ring (B)*	1	PVDF
3a	Seat	1	EPDM, FKM, PTFE

* Used for flanged end

Single Union Ball Check Valves

Dimensions (Sizes 3" – 4") (in.)

NOMINAL SIZE				FLANGED							SOCKET												THREADED			SPIGOT (BUTT END)				
				ANSI CLASS 150							PVC, CPVC				PP, PVDF (DIN)				PP, PVDF (IPS)							PP, PVDF				
											ASTM SCH40				DIN 16962											DIN 3442		PP	PVDF	
INCHES	mm	d	D1	D	C	n	h	l	t1	t2	d1	d2	l	l	d1	d2	l	l	d1	l	l	d1	l	l	d1	l	t	t	l
3	80	3.07	5.98	7.50	6.00	4	0.75	12.2	0.71	0.87	3.516	3.492	1.875	9.57	3.51	3.50	1.40	8.46	3.480	1.874	9.55	4-8 NPT	1.38	8.74	3.54	1.49	0.32	0.17	11.67
4	100	3.94	8.27	9.00	7.50	8	0.75	15.63	0.71	0.87	4.518	4.491	2.000	12.20	4.29	4.28	1.63	11.46	4.480	2.252	12.60	3-8 NPT	1.77	12.09	4.33	1.75	0.39	0.21	13.93



True Union, Single Union, and Foot Valve Weight (lbs.)

NOMINAL SIZE		SOCKET	FLANGED
INCHES	mm		
1/2	15	0.22	0.66
3/4	20	0.44	1.10
1	25	0.66	1.54
1-1/2	40	1.54	2.20
2	50	2.20	3.31
3	80	6.17	9.92
4	100	14.99	24.25

Cv Values

NOMINAL SIZE		Cv
INCHES	mm	
1/2	15	6.5
3/4	20	17
1	25	25
1-1/2	40	86
2	50	130
3	80	280
4	100	500

Sample Specification

All ball check valves and foot valves shall be of solid thermoplastic construction, and shall be designed with an elastomeric uniseat/seal for tight shut-off under pressure. Sizes 1/2" through 2" shall be of true union design, while 3" & 4" shall be single union design. The same seal shall function as both the ball seat and the union seal. PVC shall conform to ASTM D1784 Cell Classification 12454A, CPVC shall conform to ASTM D1784 Cell Classification 23567A, PP shall conform to ASTM D4101 Cell Classification PP0210B67272 and PVDF shall conform to ASTM D3222 Cell Classification Type II. Ball check valves and foot valves sizes 1/2"- 2" shall be rated 150psi at 70º F, 3" and 4" rated 100psi at 70º F, as manufactured by Asahi/America, Inc.

Bray International, Inc.
13333 Westland East Blvd. Tel: 281.894/5454
Houston, Texas 77041 www.bray.com

BUY AMERICAN ACT COMPLIANCE STATEMENT
COMMERCIAL OFF THE SHELF ITEM MANUFACTURED IN THE UNITED-STATES

Purchase Order No.: [redacted]
Sales Order No.: [redacted]
Government Contract Date: N/A
Date Certificate Issued: September 1, 2021

This Product is a domestic construction material within the meaning of the Buy American Act as a Commercial-Off- the Shelf (COTS)[1] Product manufactured[2] in the United States within the meaning of the BAA, even if the country of origin marking remains on the product to comply with U.S. Customs requirements.

[1] Any item of supply (including construction material) that is . . . [a] commercial item, sold in substantial quantities in the commercial market place; and offered to the Government, under a contract or subcontract at any tier, without modification, in the same form in which it is sold in the commercial marketplace." BAA 52.225-11 (WTO or Free Trade Agreement Country). Bray International, Inc. maintains about twenty-five (25) U.S. locations. Each region maintains a factory certified sales and service network for all Bray International, Inc. products where the products covered by this contract are available for sale to the general public. Accordingly, the products on this contract are COTS because (1) commercially available for sale or lease in the market place, and (2) offered to the Government under a contract in the same form.

[2] Courts and administrative tribunals have interpreted the term manufacturing to mean completion of the article in the form required for use by the government. Moreover, manufacturing in the United States does not necessarily preclude all overseas processing. To that effect, the process performed in the United States does not have to result in a substantial or fundamental change to the physical character of an imported product in order for it to constitute manufacture. Instead, mere assembly may sometimes be sufficient.

Naomi Pruitt
Contracts Review Specialist
Bray International, Inc.

Naomi Pruitt

APPENDIX C

DOCUMENTATION OF HAZARDOUS (CLASSIFIED) AREAS

Gray & Osborne, Inc.
CONSULTING ENGINEERS

February 12, 2026

Mr. Ken Rice
Fire Marshal
Pierce County
2401 South 35th Street
Tacoma, Washington 98409

SUBJECT: HAZARDOUS AREAS CLASSIFICATIONS – WASTEWATER TREATMENT FACILITIES
TAYLOR BAY BEACH CLUB HOMEOWNER'S ASSOCIATION, PIERCE COUNTY, WASHINGTON
G&O #22848.01

Dear Mr. Rice:

In accordance with the requirements of National Electrical Code (NEC) 500-3(b), this letter provides documentation of Hazardous (Classified) Areas at the Taylor Bay Beach Club Homeowner's Association's (Taylor Bay Beach Club) Wastewater Treatment Facility (WWTF) that will be modified or constructed during the upcoming upgrade project. In preparing this document, consideration has been given to the information contained in National Fire Protection Association (NFPA) 820 *Standard for Fire Protection in Wastewater Treatment and Collection Facilities*, 2024 Edition, as well as the actual treatment process, physical layout, ventilation, and similar factors at the Taylor Bay Beach Club WWTF.

This letter is to be made available to, and used by, those individuals authorized to design, install, inspect, maintain, or operate electrical equipment at the Taylor Bay Beach Club WWTF.

It is important to note that this letter relates only to Hazardous (Classified) Areas as defined in NEC Article 500. The scope of that article is limited to requirements for "electrical and electronic equipment and wiring" in locations where "fire or explosion hazards may exist due to flammable gases or vapors, flammable liquids, combustible dusts, or ignitable fibers or filings." There may be other areas at the Taylor Bay Beach Club WWTF that are considered hazardous as a result of hazards other than those in the scope of NEC Article 500. These may include, but are not limited to, hazards to life, limb, and/or property due to electromagnetic radiation, biological, chemical, radiological, or other agents or dangers.

This letter presents our determination of possible hazards in the areas that will be constructed or modified as a part of this project and the corresponding electrical classifications, as well as the most appropriate NFPA 820 (2024 Edition) descriptions for each area. Please see the attached figures for visual representations of the classified areas.

AREA 1 – OPERATIONS BUILDING

Process Equipment Room

Closest NFPA 820 Description

Table	Row	Line	Location and Function	Fire and Explosion Hazard	Ventilation	Extent of Classified Location	NEC – Location Electrical Classification	Fire Protection Measures
5.2.2	21		Intermediate or Final Pumping Stations and Other Unit Processes and Structures not Specifically Addressed in this Table – Preceded by primary treatment.	Not applicable	No requirement	Not applicable	Unclassified	H (Hydrant Protection
5.2.2	26		Ultraviolet Disinfection Unit – Disinfection of wastewater effluent by ultraviolet radiation.	Not applicable	No requirement	Not applicable	Unclassified	H (Hydrant Protection)
5.2.2	27		Effluent Structures – Various structures conveying treated wastewater away from treatment processes.	Not applicable	No requirement	Not applicable	Unclassified	H (Hydrant Protection)

Our Determination

Possible Hazards: None.

Classification: Unclassified.

Conclusion: There are no restrictions on the electrical system.

Fire Protection: Non-potable water supply will be available inside the electrical room.

Non-Potable Water Tank

Closest NFPA 820 Description

Table	Row	Line	Location and Function	Fire and Explosion Hazard	Ventilation	Extent of Classified Location	NEC – Location Electrical Classification	Fire Protection Measures
5.2.2	27		Effluent Structures – Various structures conveying treated wastewater away from treatment processes.	Not applicable	No requirement	Not applicable	Unclassified	H (Hydrant Protection)

Our Determination

Possible Hazards: None.

Classification: Unclassified.

Conclusion: There are no restrictions on the electrical system.

Fire Protection: Non-potable water supply will be available within the vicinity of the non-potable water tank.

AREA 2 – PROCESS TANKS AND HEADWORKS

Influent Pump Station and Equalization Basin

Closest NFPA 820 Description

Table	Row	Line	Location and Function	Fire and Explosion Hazard	Ventilation	Extent of Classified Location	NEC – Location Electrical Classification	Fire Protection Measures
4.2.2	14	a	Wastewater Pumping Station Wet Wells – Liquid side of a pumping station serving a sanitary sewer or combined system.	Possible ignition of flammable gases and floating Class I liquids (flash point less than 37.8 degrees Celsius) (100 degrees Fahrenheit).	A (No ventilation or less than 12 air changes per hour.)*	Entire room or space plus an envelope of 0.9 meters (3 feet) around vents.	Division 1	CGD (Combustible Gas Detection System) required if mechanically ventilated or if it opens into a building interior.

Table	Row	Line	Location and Function	Fire and Explosion Hazard	Ventilation	Extent of Classified Location	NEC – Location Electrical Classification	Fire Protection Measures
		b			A (No ventilation or less than 12 air changes per hour.)*	1.5 Meters (5 feet) beyond vent plus an envelope of 0.46 meters (18 inches) extending 0.9 meters (3 feet) around openings (hatches or doors).	Division 2	CGD (Combustible Gas Detection System) required if mechanically ventilated or it opens into a building interior.
4.2.2	32	a	Wastewater Holding Basins – Enclosed structures temporarily holding untreated or partially-treated wastewater.	Possible ignition of flammable gases and floating Class I liquids (flash point less than 37.8 degrees Celsius) (100 degrees Fahrenheit).	A (No ventilation or less than 12 air changes per hour) or NNV (not normally ventilated).*	Enclosed space plus an envelope of 0.9 meters (3 feet) around vents.	Division 1	No requirement
		b			A (No ventilation or less than 12 air changes per hour) or NNV (not normally ventilated).*	1.5 Meters (5 feet) beyond Division 1 vents plus an envelope of 0.48 meters (18 inches) extending 0.9 meters (3 feet) around openings (hatches or doors).	Division 2	No requirement

Table	Row	Line	Location and Function	Fire and Explosion Hazard	Ventilation	Extent of Classified Location	NEC – Location Electrical Classification	Fire Protection Measures
5.2.2	4	a	Flow Equalization Tanks – Storage of raw or partially-treated wastewater.	Possible ignition of flammable gases and floating Class I liquids (flash point less than 37.8 degrees Celsius) (100 degrees Celsius).	A (No ventilation or less than 12 air changes per hour.)*	Enclosed – entire space.	Division 1	FE (Portable Extinguisher), H (Hydrant Protection) or CGD (Combustible Gas Detection System) if enclosed in a building.

* Tank headspace will be ventilated by the odor control-fan, but the ventilation systems will not meet the requirements of NFPA 820 at all times.

Our Determination

Possible Hazards: Possible ignition of flammable gases and floating Class I liquids in raw wastewater.

Classification: The NFPA 820 area classifications for the influent pump station wet well and equalization basin are Class I, Division 1 within the wet well and equalization basin, Class I, Division 1 in an envelope extending in a 3-foot radius from any wet well and equalization basin vent openings, and Class I, Division 2 in an envelope extending 5 feet from the wet well vent opening plus 3 feet around openings, such as hatches or doors.

Conclusion: All new electrical systems in classified areas should be designed in accordance with the requirements of the appropriate NEC classifications.

Fire Protection: The influent pump station wet well and equalization basin do not open into a building interior. Both the influent pump station wet well and equalization basin will be ventilated through the odor-control system. Therefore, no fire protection measures are required. However, the fire extinguisher and yard hydrant for the headworks and odor-control will be in the vicinity.

Valve Vault

Closest NFPA 820 Description

Table	Row	Line	Location and Function	Fire and Explosion Hazard	Ventilation	Extent of Classified Location	NEC – Location Electrical Classification	Fire Protection Measures
4.2.2	29	a	Below Grade or Partially Below Grade Valve Vault – Physically separated from the wet well and with closed piping system.	Buildup of vapors from ignitable (flammable or combustible) liquids.	NNV (not normally ventilated)	Entire room or space plus an envelope of 0.9 meters (3 feet) around vents.	Division 2	No requirement

Our Determination

Possible Hazards: Buildup of vapors from flammable or combustible liquids.

Classification: The piping in the valve vault will be closed and the access hatches to the vaults will be outside the Hazardous Area envelope of the other components; therefore, the risk of buildup of flammable or combustible liquids is minimized. The valve vault is classified as Class 1, Division 2, in accordance with NFPA 820 standards.

Conclusion: All new electrical systems in classified areas should be designed in accordance with the requirements of the appropriate NEC classifications.

Fire Protection: None required.

Influent Fine Screening Facilities

Closest NFPA 820 Description

Table	Row	Line	Location and Function	Fire and Explosion Hazard	Ventilation	Extent of Classified Location	NEC – Hazardous Location Classification	Fire Protection Measures
5.2.2	2	a	Coarse and Fine Screen Facilities – Removal of screenings from raw wastewater.	Possible ignition of flammable gases and floating Class I liquids (flash point less than 37.8 degrees Celsius (100 degrees Fahrenheit).	B (Continuously ventilated at 12 air changes per hour in accordance with Chapter 9.)	Enclosed – entire space.	Division 2	FE (Portable Fire Extinguishers Installed, Located and Maintained in Accordance with NFPA 10), H (Hydrant Protection), and CGD (Combustible Gas Detection System).

Our Determination

Possible Hazards: Flammable gases could be generated by the influent wastewater and/or floating flammable liquids could enter the headworks from the influent wastewater.

Classification: The headworks fine screens are self-contained rotary drum screen units, which are closed to the atmosphere with ventilation provided by the odor-control system at equal to or greater than 12 air exchanges an hour; therefore, the NFPA 820 classification for this area is Class I, Division 2. The classification envelope is limited to the interior of the system.

Conclusion: All new electrical systems in the classified area envelope should be designed and installed in accordance with the aforementioned NEC classification requirements.

Fire Protection: The headworks channels are enclosed and not intended for ingress; therefore, a combustible gas detection system will not be installed. A fire extinguisher will, however, be installed and maintained in the headworks area for the headworks and odor-control system. A yard hydrant with non-potable water supply will be installed within the vicinity of headworks as well.

Odor-Control System

Closest NFPA 820 Description

Table	Row	Line	Location and Function	Fire and Explosion Hazard	Ventilation	Extent of Classified Location	NEC – Location Electrical Classification	Fire Protection Measures
4.2.2	18	e	Odor-Control and Ventilation Systems Serving Classified Locations	Leakage and ignition of flammable gases and vapors.	Not enclosed, open to the atmosphere.	Areas within 0.9 meters (3 feet) of leakage sources such as vents, fans, dampers, flexible connections, flanges, pressurized unwelded ductwork, and odor-control vessels plus envelope 0.9 meters (3 feet) around vents from Division 2 gas.	Division 2	FE (fire extinguisher)
		f			Not enclosed, open to the atmosphere.	Areas beyond 0.9 meters (3 feet).	Unclassified	FE (Fire extinguisher)

Our Determination

Possible Hazards: Flammable gases could leak from the odor-control equipment and piping.

Classification: The NFPA 820 classification is Class I, Division 2 within 3 feet of leakage sources such as fans, dampers, flexible connections, flanges, pressurized unwelded ductwork, and odor-control vessels.

Conclusion: All the electrical systems in classified areas should be designed in accordance with the requirements of the appropriate NEC classifications.

Fire Protection: A fire extinguisher will be installed in the headworks area for the headworks and odor-control system.

Anoxic Basin, Aeration Basin, Membrane Bioreactor Basins

Closest NFPA 820 Description

Table	Row	Line	Location and Function	Fire and Explosion Hazard	Ventilation	Extent of Classified Location	NEC – Location Electrical Classification	Fire Protection Measures
5.2.2	6	A	Preaeration Tanks – Conditioning of wastewater prior to further treatment.	Possible ignition of flammable gases and floating Class I liquids (flash point less than 37.8 degrees°Celsius) (100 degrees Fahrenheit).	A (No ventilation or ventilated at less than 12 air changes per hour).*	Enclosed – entire space.	Division 1	H (Hydrant Protection) or CGD (Combustible Gas Detection System) if enclosed in a building.
5.2.2	9	b1	Enclosed Aeration Basin, Aerobic or Suspended Growth Systems, and Membrane Biological Reactors – Aerobic treatment not preceded by primary treatment with skimming.	Possible ignition of flammable gases and floating Class I liquids (flash point less than 37.8 degrees Celsius) (100 degrees Fahrenheit).	B (Interior of tank maintained at negative pressure.)*	Entire enclosed space or tank of system.	Division 2	No requirement
		b2			B (Interior of tank maintained at negative pressure.)*	Exterior of enclosed space or tank, installed outdoors.	Unclassified	No requirement

* Tank headspace will be ventilated by the odor-control fan, but the ventilation systems will not meet the requirements of NFPA 820 at all times.

Our Determination

Possible Hazards: Possible ignition of flammable gases and floating Class I liquids.

Classification: A concrete or fiberglass-reinforced plastic (FRP) cover will be provided over the common walled process tanks (anoxic basin, aeration basin, and membrane filtration basins). The NFPA 820 area classifications for the anoxic basin is Class I, Division 1 under the cover, Class I, Division 2 under the cover of the aeration basin and membrane bioreactor basins, and unclassified outside all the basins.

Conclusion: All new electrical systems in classified areas should be designed in accordance with the requirements of the appropriate NEC classifications.

Fire Protection: A yard hydrant with non-potable water supply will be installed within the vicinity of the tanks.

Return-Activated Sludge (RAS) Pump Station and Waste-Activated Sludge (WAS) Holding Tank

Closest NFPA 820 Description

Table	Row	Line	Location and Function	Fire and Explosion Hazard	Ventilation	Extent of Classified Location	NEC – Hazardous Location Classification	Fire Protection Measures
6.2.2	10	a	Sludge Storage Wet Wells, Pits, and Holding Tanks – Retaining of sludge.	Possible generation of methane gas in explosive concentrations and carryover of floating Class I liquids (flash point less than 37.8 degrees Celsius) (100 degrees Fahrenheit).	A (No ventilation or ventilated at less than 12 air changes per hour.)*	Enclosed – entire space.	Division 1	CGD (Combustible Gas Detection System), H (Hydrant Protection), and FE (Portable Fire Extinguishers) if the tank is enclosed in the building.

* Tank headspace will be ventilated by the odor-control fan, but the ventilation systems will not meet the requirements of NFPA 820 at all times.

Our Determination

Possible Hazards: Flammable gases could be generated by the influent wastewater and/or floating flammable liquids could enter the headworks from the influent wastewater.

Classification: The closest description in NFPA 820 for the RAS pump station is the sludge storage wet well since this is a submersible pump station. The WAS holding tank will be ventilated but may not meet ventilation requirements in the NFPA 820 at all times. Therefore, the NEC hazardous location classification for the RAS pump station and WAS holding tank is Class I Division 1 for enclosed spaces.

Conclusion: All new electrical systems in the classified area envelope should be designed and installed in accordance with the aforementioned NEC classification requirements.

Fire Protection: Because the WAS storage tank will be installed outdoors, no fire protection measures are required. The RAS pump station will be enclosed. Yard hydrants with non-potable water supply will be available within the vicinity.

AREA 3 – BLUFF LIFT STATION

Bluff Lift Station

Closest NFPA 820 Description

Table	Row	Line	Location and Function	Fire and Explosion Hazard	Ventilation	Extent of Classified Location	NEC – Area Electrical Classification	Fire Protection Measures
4.2.2	9		Individual Residential Pumping Units – Pumping units serving one or more individual residences with a total flow of not more than 5,678 liters per day (1,500 gallons per day (gpd)) (e.g., grinder pumps, septic tank effluent pumps, ejector pumps).	Not applicable	NNV (not normally ventilated)	Within enclosed space.	Unclassified	No requirement

Our Determination

Possible Hazards: None.

Classification: Unclassified.

Conclusion: There are no restrictions on the electrical equipment within the scope of NFPA 820 standards.

Fire Protection: None required.

We understand that Washington State Department of Labor & Industries Electrical Inspectors will rely on your agreement with the Hazardous Area classifications as described in this letter. We will be contacting you in the near future to discuss these Hazardous Areas at the wastewater treatment facilities and to reach a mutual agreement on their classifications.

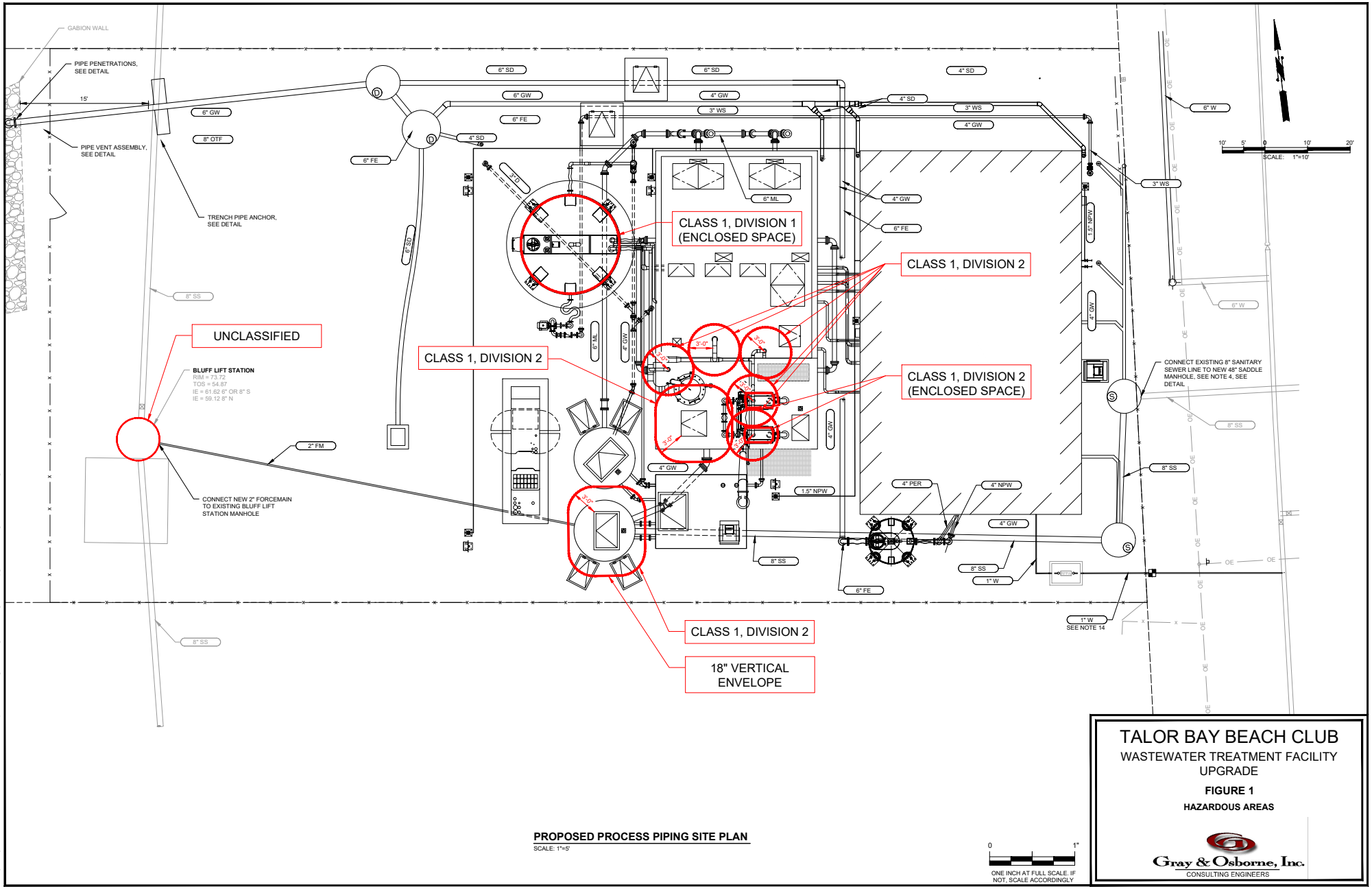
Please contact the undersigned at (206) 284-0860 if you have any questions or if you require any additional information.

Sincerely,

GRAY & OSBORNE, INC.

Eric Nutting, P.E.

EN/sr



PROPOSED PROCESS PIPING SITE PLAN

SCALE: 1"=5'

ONE INCH AT FULL SCALE. IF NOT, SCALE ACCORDINGLY

TALOR BAY BEACH CLUB

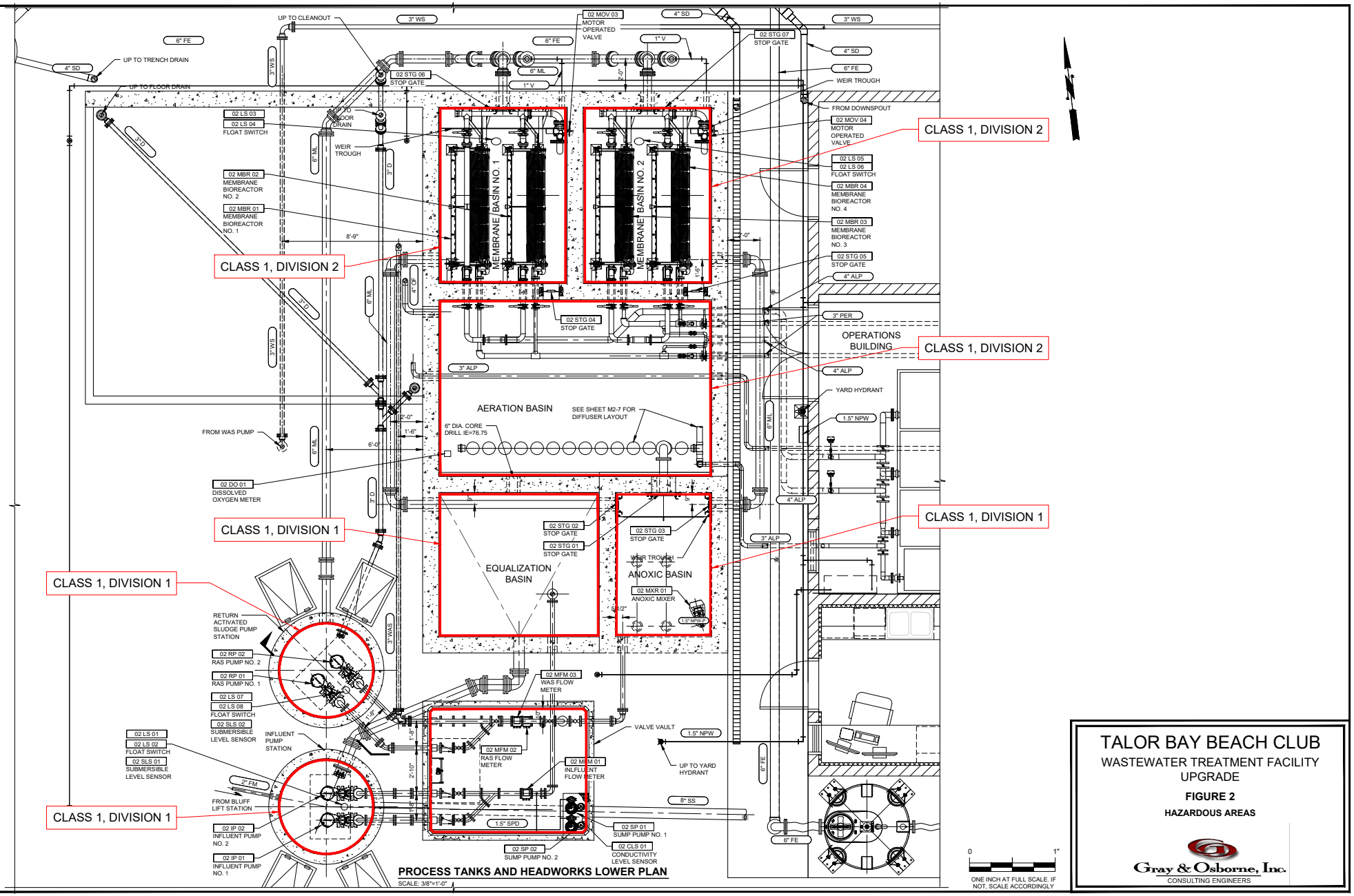
WASTEWATER TREATMENT FACILITY UPGRADE

FIGURE 1

HAZARDOUS AREAS

Gray & Osborne, Inc.
CONSULTING ENGINEERS

M:\Taylor Bay Beach Club\HOA22845.01 Construction Plans, Spec, & Permitting WA DOH grant\01 Design\WWTF Upgrade\Planset\Figures\FIGURE 1.dwg, 12/7/2026 2:19 PM, PHILIP MARSHALL



TALOR BAY BEACH CLUB

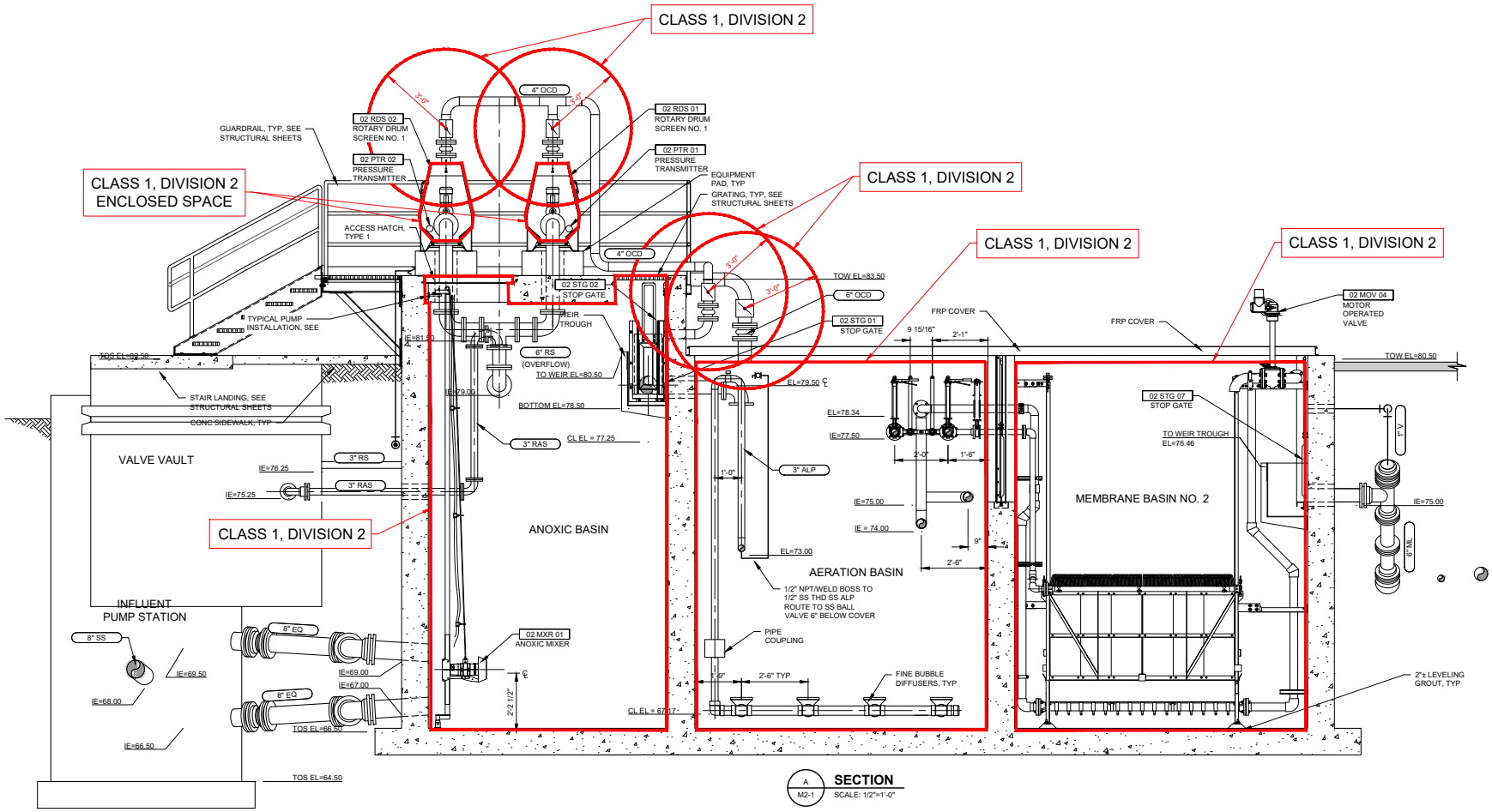
WASTEWATER TREATMENT FACILITY UPGRADE

FIGURE 2

HAZARDOUS AREAS

Gray & Osborne, Inc.
CONSULTING ENGINEERS

M:\Taylor Bay Beach Club HOA\22848.01 Construction Plans, Spec, & Permitting WA DOH gron\01 Design\WWTF Upgrade\Pionset\Figures\FIGURE 2.dwg, 1/27/2026 2:18 PM, PHILIP MARSHALL



0 1"

ONE INCH AT FULL SCALE. IF NOT, SCALE ACCORDINGLY

TALOR BAY BEACH CLUB

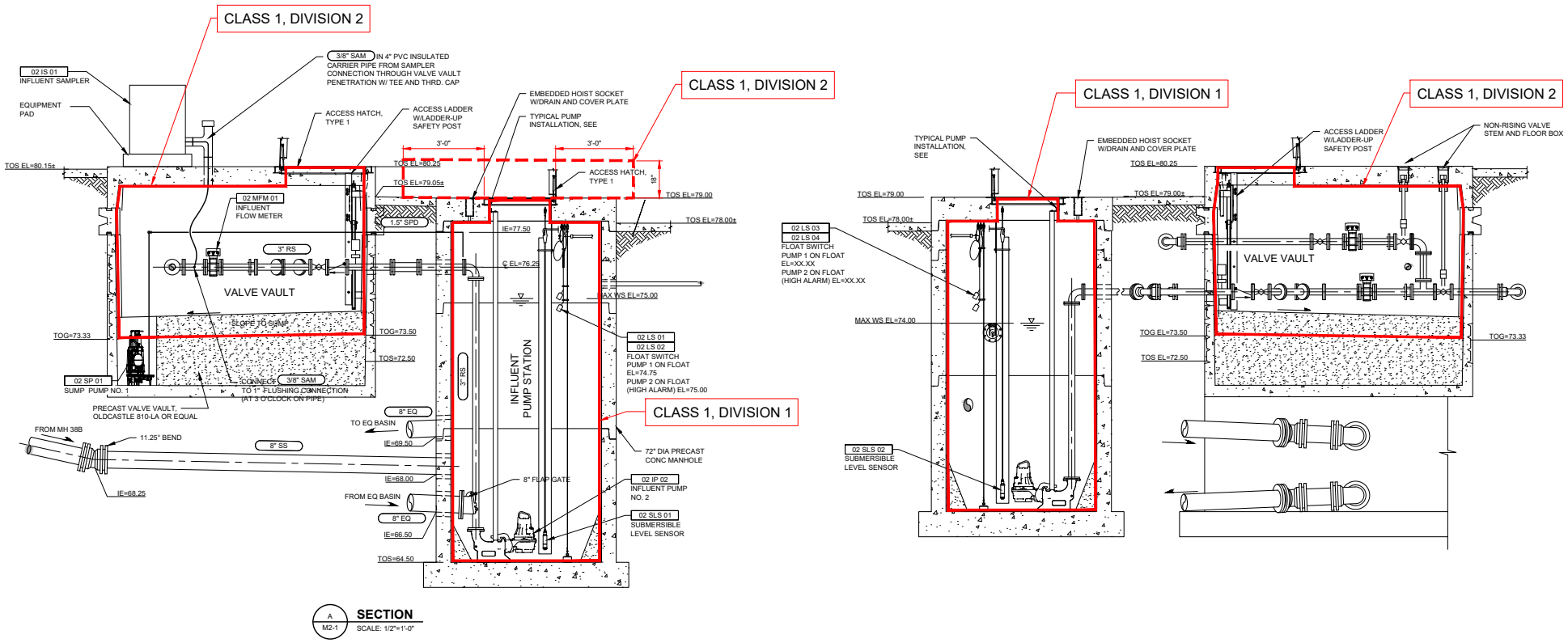
WASTEWATER TREATMENT FACILITY UPGRADE

FIGURE 3

HAZARDOUS AREAS

Gray & Osborne, Inc.
CONSULTING ENGINEERS

M:\Taylor Bay Beach Club HOA\22848.01 Construction Plans, Spec, & Permitting WA DOH grant\01 Design\WWTF Upgrade\Plansets\Figures\FIGURE 3.dwg, 1/27/2026 2:16 PM, PHILIP MARSHALL



A
M2-1
SECTION
SCALE: 1/2"=1'-0"

0 1"
ONE INCH AT FULL SCALE. IF NOT, SCALE ACCORDINGLY

TALOR BAY BEACH CLUB

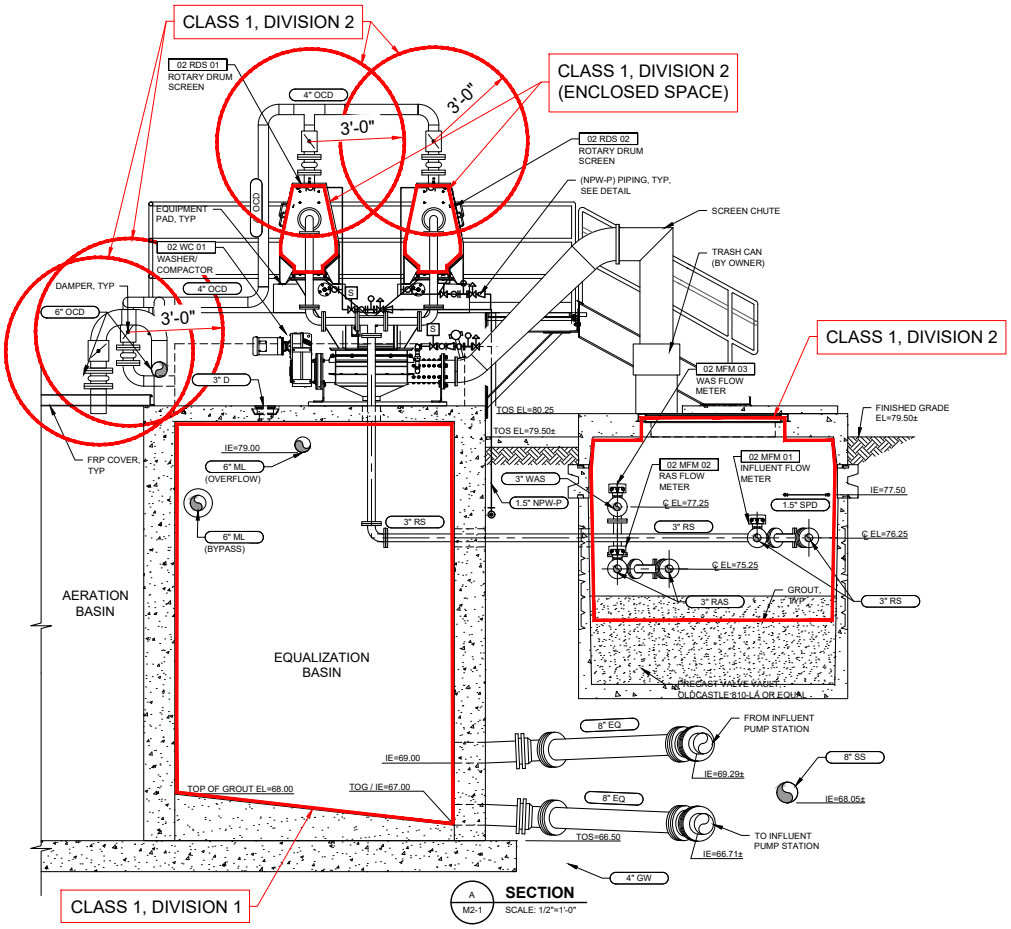
WASTEWATER TREATMENT FACILITY UPGRADE

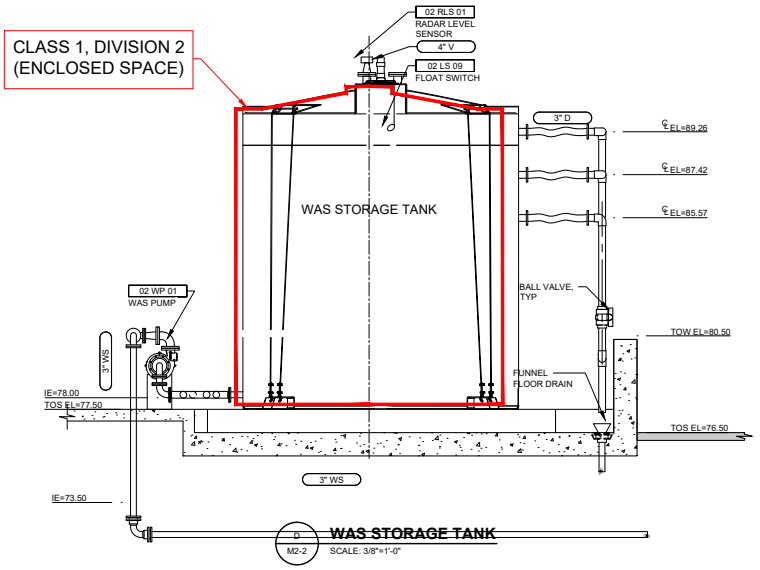
FIGURE 4

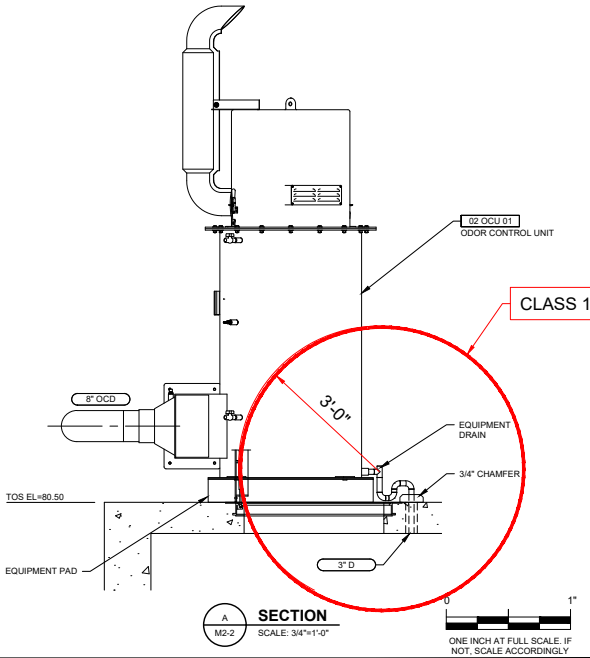
HAZARDOUS AREAS

Gray & Osborne, Inc.
CONSULTING ENGINEERS

M:\Taylor Bay Beach Club HOA\22848.01 Construction Plans, Spec, & Permitting WA DOH grant\01 Design\WWTF Upgrade\Plonset\Figures\FIGURE 4.dwg, 2/11/2026 9:04 AM, PHILIP MARSHALL







TALOR BAY BEACH CLUB

WASTEWATER TREATMENT FACILITY UPGRADE

FIGURE 5

HAZARDOUS AREAS

Gray & Osborne, Inc.
CONSULTING ENGINEERS

M:\Taylor Bay Beach Club HOA\22848.01 Construction Plans, Spec, & Permitting WA DOH grant\01 Design\WWTF Upgrade\Plonset\Figures\FIGURE 5.dwg, 1/27/2026 2:13 PM, PHILIP MARSHALL

APPENDIX D

GEOTECHNICAL REPORTS
(FOR INFORMATION ONLY)

SUBSURFACE EXPLORATION, GEOLOGIC HAZARD, AND GEOTECHNICAL ENGINEERING REPORT

associated
earth sciences
incorporated



Subsurface Exploration, Geologic Hazard, and Geotechnical Engineering Report

TAYLOR BAY SEWAGE TREATMENT PLANT

Longbranch, Washington

Prepared For:

GRAY AND OSBORNE, INC.

Project No. 20200440E001
May 20, 2024

This report identifies potential erosion(landslide) hazards and possible seismic susceptibility. It is recommended that the HOA keep a visual inspection on the site and identify and cracks in structures or land movement that may take place. Relocation of the facilities or site stabilization may be required if problems develop.

REVIEWED AND ACCEPTED
Pierce County Single Family Technical Review
Jeff Roscoe 07/10/2024
8:53:34 AM



Associated Earth Sciences, Inc.

www.aesgeo.com

Kirkland | Mount Vernon | Tacoma

associated earth sciences incorporated

June 22, 2023
Revised May 20, 2024
Project No. 20200440E001

Gray and Osborne, Inc.
11 Spokane Street, Suite 211
Wenatchee, Washington 98801

Attention: Mr. Peter Burgoon

Subject: Subsurface Exploration, Geologic Hazard, and Geotechnical Engineering Report
Taylor Bay Sewage Treatment Plant
8220 178th Avenue Court SW
Longbranch, Washington 98351

Dear Mr. Burgoon:

We are pleased to present the enclosed copy of the referenced report. This report summarizes the results of our subsurface exploration, geologic hazard analysis, and geotechnical engineering study, and offers recommendations for design of the project.

We have enjoyed working with you on this study and are confident that the recommendations presented in this report will aid in the successful completion of your project. Please contact me if you have any questions or if we can be of additional help to you.

Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington

Matthew A. Miller, P.E.
Principal Geotechnical Engineer

MM/jh – 20200440E001-007

SUBSURFACE EXPLORATION, GEOLOGIC HAZARD, AND GEOTECHNICAL ENGINEERING REPORT

TAYLOR BAY SEWAGE TREATMENT PLANT

Longbranch, Washington

Prepared for:
Gray and Osborne, Inc.
11 Spokane Street, Suite 211
Wenatchee, Washington 98801

Prepared by:
Associated Earth Sciences, Inc.
911 5th Avenue
Kirkland, Washington 98033
425-827-7701

June 22, 2023
Revised May 20, 2024
Project No. 20200440E001

I. PROJECT AND SITE CONDITIONS

1.0 INTRODUCTION

This report presents the results of Associated Earth Sciences, Inc.'s (AESI's) subsurface exploration, geologic hazard analysis, and geotechnical engineering study for the proposed demolition and replacement of the existing Taylor Bay sewer treatment facility in Longbranch, Washington. The site location is shown on the "Vicinity Map," Figure 1. The approximate locations of the explorations completed for this study are shown on the "Site and Exploration Plan," Figure 2. A Light Detection and Ranging (LiDAR)-based site and exploration map is included as "LiDAR-Based Topography," Figure 3. Interpretive logs of subsurface explorations completed for this study are included in Appendix A

1.1 Purpose and Scope

The purpose of this study is to provide subsurface soil and groundwater data to be utilized in the design and development of the subject project. Our recommendations are preliminary in that project plans were not fully completed at the time of our study. Our scope of work included reviewing selected available geologic literature, advancing two exploration borings (EB-1 and EB-2), and performing geologic studies to assess the type, thickness, distribution, and physical properties of the subsurface sediments and groundwater conditions. Geotechnical engineering studies were also completed to assess geologic hazards, and to formulate geotechnical recommendations for landslide and erosion hazard mitigation, site preparation, structural fill placement, foundations and floor slabs, drainage considerations, and seismic design recommendations. This report summarizes our current fieldwork and offers design recommendations based on our present understanding of the project.

1.2 Authorization

Authorization to proceed with this study was provided by Mr. Peter Burgoon with Gray and Osborne, Inc. through our contract agreement. This report has been prepared for the exclusive use of Gray and Osborne, Inc. and their agents for specific application to this project. Within the limitations of scope, schedule, and budget, our services have been performed in accordance with generally accepted geotechnical engineering and engineering geology practices in effect in this area at the time our report was prepared. No other warranty, express or implied, is made.

2.0 PROJECT AND SITE DESCRIPTION

The subject site consists of a single parcel of approximately 0.25 acres located at 8220 178th Avenue Court SW in unincorporated Pierce County, Longbranch, Washington (Pierce County Parcel No. 6925000230). The parcel is located at the top of a steep marine bluff approximately 60 feet tall. The remainder of the parcel slopes uphill to the east at inclinations of

less than 15 percent. The site is occupied by a sewage treatment plant reported to have been constructed in the early 1970's, based on provided as-built drawings. It is our understanding that a landslide occurred on the upper portion of the bluff in 1994. The location of the 1994 landslide, identified as "1994 slide," is shown on Figures 2 and 3. Landslide mitigation efforts subsequent to the slide included construction of a gabion wall at the top of the bluff in the slide area.

We understand that current plans include demolition of the existing sewage treatment plant and construction of a new sewage treatment facility. Discharge from the new sewage treatment facility will be directed to an outfall located at the toe of the bluff. The effluent will be conveyed to the outfall by an effluent pipe that will extend down the face of the bluff. A copy of the plans for the existing sewage treatment plant is included in Appendix B. The layout of the proposed sewage treatment plan improvements are shown on the civil plan in Appendix C and on Figure 2.

2.1 Previous Site Work

In July of 2018, we visited the site to complete a reconnaissance of the slope to the west of the subject property. While onsite we spoke with Mr. Steve Stemhagen and Mr. Tom McDowell, both long-term residents of the community. They informed us that a gabion wall was constructed at the top of the bluff to mitigate damage caused by the 1994 landslide. The gabion wall has an exposed height of approximately 14 feet. It is our understanding that the wall was constructed shortly after the landslide occurred and it is not known if it is an engineered structure. It appears to currently be in good condition and has performed well since its construction. The top width of the gabion wall is approximately 3 feet. Based on anecdotal information received by Mr. Stemhagen, it is believed that the base of the wall is approximately 8 feet wide. Mr. McDowell indicated that the wall was built by some of the area residents, including him, shortly after the landslide occurred.

An area of subsidence is located directly behind the gabion wall. A chain-link fence located in the area appears to have undergone some distortion as a result of the subsidence. At the time of our 2018 site visit, Mr. Stemhagen indicated that the floor of the Equipment and Lab Building, located approximately 16 feet behind the face of the gabion wall, exhibits some "hairline cracks". Mr. Stemhagen also indicated that the subsidence, fence distortion, and floor cracking were present when he moved to the neighborhood in approximately 2002, and it does not appear to have worsened since that time.

3.0 SUBSURFACE EXPLORATION

Our field investigation for the current study was conducted in April of 2023 and included advancing two exploration borings. The existing site conditions, and the approximate locations of subsurface explorations referenced in this study, are presented on the "Site and Exploration Plan" (Figure 2). The various types of sediments, as well as the depths where the characteristics

of the sediments changed, are indicated on the exploration logs presented in Appendix A. The depths indicated on the logs where conditions changed may represent gradational variations between sediment types. If changes occurred between sample intervals in our exploration borings, they were interpreted. Our explorations were approximately located in the field by measuring from known site features shown on an aerial photo of the site.

The conclusions and recommendations presented in this report are based, in part, on the explorations completed for this study. The number, locations, and depths of the explorations were completed within site and budgetary constraints. Because of the nature of exploratory work below ground, extrapolation of subsurface conditions between field explorations is necessary. It should be noted that differing subsurface conditions may be present due to the random nature of deposition and the alteration of topography by past grading and/or filling. The nature and extent of variations between the field explorations may not become fully evident until construction. If variations are observed at that time, it may be necessary to re-evaluate specific recommendations in this report and make appropriate changes.

3.1 Exploration Borings

For this study, the borings were performed by an independent firm working under subcontract to AESI at the locations shown on Figure 2. The borings were completed by advancing a 6-inch, outside-diameter hollow-stem auger using a track-mounted drill. During the drilling process, samples were generally obtained at 2½- to 5-foot-depth intervals. After completion of drilling, the borehole was backfilled with bentonite chips, and the surface was patched with on-site material.

Disturbed, but representative samples were obtained by using the Standard Penetration Test (SPT) procedure in accordance with *ASTM International* (ASTM) D-1586. This test and sampling method consists of driving a standard 2-inch, outside-diameter, split-barrel sampler a distance of 18 inches into the soil with a 140-pound hammer free-falling a distance of 30 inches. The number of blows for each 6-inch interval is recorded, and the number of blows required to drive the sampler the final 12 inches is known as the Standard Penetration Resistance ("N") or blow count. If a total of 50 is recorded within one 6-inch interval, the blow count is recorded as the number of blows for the corresponding number of inches of penetration. The resistance, or N-value, provides a measure of the relative density of granular soils or the relative consistency of cohesive soils; these values are plotted on the attached exploration boring logs.

The borings were continuously observed and logged by a geologist from our firm. The samples obtained from the split-barrel sampler were classified in the field and representative portions placed in watertight containers. The samples were then transported to our laboratory for further visual classification. The exploration logs presented in Appendix A are based on the N-values, field observations, drilling action, and laboratory test results, if conducted.

4.0 SUBSURFACE CONDITIONS

4.1 Regional Geology and Soils Mapping

Review of the geologic map "*Geologic map of the Longbranch 7.5-minute quadrangle, Thurston, Pierce, and Mason Counties, Washington,*" by Logan, R.L., Walsh, T.J., and Polenz, Michael, Washington Division of Geology and Earth Resources, Open File Report 2003-21, 2003 indicates that the site is underlain at shallow depth by Holocene landslide deposits. Underlying the slide deposits, the mapping describes Pre-Fraser sandy deposits overlying coarser grained Pre-Fraser aged gravels. Our findings were generally consistent with the mapped geology of the local and regional area. Although, we did encounter silty interbeds located in the Pre-Fraser sandy deposits.

Review of the Natural Resources Conservation Service (NRCS) *Web Soils Survey* shows that the upland portion of the site is mapped as Bow silt loam, 8 to 15 percent slopes. The NRCS describes this soil as being glaciolacustrine in origin deposited over basal till. The marine bluff leading down to the beach is mapped as Xerochrepts, 45 to 70 percent slopes. The NRCS describes this soil as being mainly found on valley walls and originates from sandy or gravelly outwash soils. Our findings were generally consistent with the mapped soils described in the NRCS.

4.2 Site Stratigraphy

Subsurface conditions at the project site were inferred from our previous site work, the field explorations accomplished for this study, visual reconnaissance of the site, and review of selected applicable geologic literature. As shown on the exploration logs, sediments encountered in our borings generally consisted of fill of variable thickness overlying native sediments interpreted as mass wasting deposits, Pre-Fraser non-glacial deposits, and Pre-Fraser till. During our visual reconnaissance of the area very dense, silty gravel deposits were observed on the lower portion of the bluff, consistent with the Pre-Fraser aged gravel depicted on the regional geologic map. The elevation of the pre-Fraser aged gravel deposits exposed on the bluff is below the minimum elevation (maximum depths) explored in our borings. The following section presents more detailed subsurface information on the sediment types encountered at the site.

Fill

Fill soils (those not naturally placed), were observed in both borings. The observed fill depths ranged between 2 feet (EB-2) and 7 feet (EB-1). The fill generally consisted of loose to medium dense, moist, light brown to brown, fine to medium sand with variable silt content and variable gravel content. Organic debris and faint organic odors were observed in the fill at the locations of both borings. Existing fill is not recommended for foundation support and may require remedial preparation below new paving. Excavated existing fill material is suitable for reuse in structural fill applications if such reuse is specifically allowed by project plans and specifications,

if excessively organic and any other deleterious materials are removed, and if moisture content is adjusted to allow compaction to the specified level and to a firm and unyielding condition.

Mass Wasting Deposits

In exploration boring EB-1, we observed medium dense to dense, unsorted to massive sand with trace silt which included interbeds of sandy silt interpreted to represent Holocene-aged mass wasting deposits. The observed deposits exhibited a broken, chaotic texture with some retention of the primary bedding structure. Mass wasting deposits consist of sediments that have undergone downslope movement in the past. It is important to distinguish that the mass wasting deposits observed in EB-1 are not related to the recent bluff landslide that occurred in 1994. Due to the lack of large-scale geomorphic indications of a landslide associated with the mass wasting deposits, and their moderately high to high relative density, it is our opinion that slope movement associated with these deposits occurred prior to recent times (i.e. prior to the last 100 years).

Pre-Fraser Non-Glacial

Both exploration borings encountered dense to very dense/very stiff to hard, massive sands and hard silts, containing scattered organic inclusions and glacially consolidated peat interpreted to be representative of Pre-Fraser non-glacial sediments. The observed depths to the top of these sediments ranged between 2 feet (EB-2) and 17 feet (EB-1). The Pre-Fraser non-glacial sediments can be thin to thick, cross-bedded sand interbedded with laminated silt and minor peat and varying amounts of gravel. The referenced geologic map describes this unit as deposited by rivers and streams during the Olympia interglaciation, approximately 30,000 to 60,000 years old.

Excavated, granular portions of the Pre-Fraser non-glacial sediments are suitable for reuse in structural fill applications if such reuse is specifically allowed by project plans and specifications, if excessively organic and any other deleterious materials are removed, and if the moisture content at the time of construction is compatible with achieving the specified level of compaction. Those portions of this geologic unit consisting predominantly of fine-grained (silt and clay sized) sediments are not recommended for use as structural fill.

Pre-Fraser Till

Sediments encountered below the pre-Fraser non-glacial deposits in boring EB-2 generally consisted of dense to very dense, unsorted, silty, fine sand with varying amounts of gravels interpreted to represent Pre-Fraser lodgement till. The observed depth to the top of these sediments was approximately 22.5 feet below existing ground surface elevation. The till is interpreted to be pre-Fraser in age due to its stratigraphic position below the pre-Fraser non-glacial deposits. The high relative density of the unweathered till is due to its consolidation by the massive weight of the glacial ice from which it was deposited. Consequently, these

materials are dense to very dense, possess high-strength, low-compressibility characteristics, and are relatively impermeable.

The lodgement till is suitable for foundation support with proper preparation and excavated lodgement till is suitable for use in structural fill applications provided that its moisture content at the time of construction is compatible with achieving the specified level of compaction. The lodgement till has a large proportion of fine-grained material making it susceptible to disturbance when wet.

Pre-Fraser Gravel

We observed dense to very dense, unsorted to stratified, gravel within a silty matrix exposed on the lower portion of the marine bluff which we interpreted to be Pre-Fraser gravel sediments. We did not observe these sediments in any of our explorations completed onsite as they terminated at elevations above the top of the unit. The referenced geologic map describes the pre-Fraser gravel as typically resistant to erosion and commonly tinted orange with iron-oxide staining. It is generally accepted to be glacial in origin because interglacial streams are not thought to be conducive to streams with adequate competency to transport gravels widespread across the Puget lowlands and because the majority of the unit comprises northern originated clasts. We do not anticipate that construction activities will be deep enough to encounter the Pre-Fraser gravel.

4.3 Hydrology

Groundwater was observed in both exploration borings at the time of drilling (April 2023).

The groundwater in boring EB-1 was observed within the mass-wasting deposits at a depth of approximately 12 feet below ground surface, contained in sandier beds above the siltier Pre-Fraser non-glacial sediments. Groundwater in EB-2 was present at two different depths, 2 and 20 feet. The shallower groundwater at 2 feet was observed in the fill soils and is interpreted to be perched and of limited extent. The deeper groundwater at 20 feet was observed in a sandy layer of the Pre-Fraser non-glacial deposit above dense, silty Pre-Fraser till. The groundwater within the pre-Fraser nonglacial sediments may receive upslope recharge contributions and be regional in extent.

At the time of our site exploration, slow groundwater seepage was also observed to be flowing from a weep pipe installed at the base of the gabion wall.

Perched water occurs when surface water infiltrates down through relatively permeable soils, such as existing fill, and becomes trapped or “perched” atop a comparatively low-permeability barrier, such as the underlying fine-grained pre-Fraser nonglacial sediments. When water

becomes perched, it may travel laterally and may follow flow paths related to permeable zones that may not correspond to ground surface topography.

Groundwater within the sandier pre-Fraser nonglacial sediments may be part of a more extensive aquifer system that is recharged by the upland.

The presence and quantity of groundwater will largely depend on the soil grain-size distribution, topography, seasonal precipitation, site use, on- and off-site land usage, and other factors.

II. GEOLOGIC HAZARDS AND MITIGATIONS

The following discussion of potential geologic hazards is based on the geologic and groundwater conditions, as observed and discussed herein.

5.0 LANDSLIDE HAZARDS AND MITIGATIONS

Section 18E.80.020 of the Pierce County Code (PCC) includes a list of indicators used to identify Landslide Hazard Areas. These Landslide Hazard Indicators include (but are not limited to):

1. Areas of historic failures.
2. Areas with active bluff retreat that exhibit continuing sloughing or calving of bluff sediments, resulting in a vertical or steep bluff face with little or no vegetation.
3. Areas with the following characteristics:
   a. Slopes steeper than 20 percent with a vertical relief of 20 feet or more; and,
   b. Hillsides that intersect geologic contacts with relatively permeable sediment overlying relatively impermeable sediment or bedrock.
4. Areas exhibiting geomorphological features indicative of past failures.
5. The occurrence of toppling, leaning, bowed, or jackstrawed trees that are caused by disruption of the ground surface by active movement.
6. Areas where seeps or springs are observed on or adjacent to the face of a slope.
7. Any area with a slope of 40 percent or steeper with a vertical relief of 15 or more feet.

Any area that includes at least one of these indicators and including any adjacent area within a distance of 65 feet is considered a Potential Landslide Hazard Area under this section of the PCC. In addition, any area within 300 feet of a slope with an inclination of at least 50 percent over a height of at least 100 feet is also considered a Potential Landslide Hazard Area.

Landslide Hazard Areas are further categorized under the PCC as either Active Landslide Areas or Stable Areas. These are defined as follows:

Active Landslide Areas include:

- Areas of historical landslide movement on a site which have occurred in the past century.
- Unstable areas that exhibit geological and geomorphologic evidence of past slope instability or landsliding or possess Landslide Hazard Indicators that have been determined through a geologic assessment to be presently failing or may be subject to future landslide activity.
- Interim areas located between areas identified through the geological assessment process to be active landslide hazard areas.

Stable Slide Areas include:

Stable Areas include areas that have been identified as Potential Landslide Hazard Areas, but meet one of the following conditions:

- A slope stability analysis has indicated that there is no apparent landslide potential.
- Adequate engineering or structural measures have been provided that mitigate the potential for a future landslide. In this case, the engineering or structural measures must provide a minimum factor of safety of 1.5 for static conditions and 1.1 for dynamic (seismic) conditions.
- A geologic assessment of the area indicates that it is not an Active Landslide Hazard Area.

5.1 Topographic Mapping

The topographic contours shown on Figures 2 and 3 indicate that inclinations on the bluff at the west end of the site generally range from approximately 45 to 80 percent over a height of approximately 60 feet. The topography in the remaining portion of the site, within the area of the existing and proposed sewage treatment plant, is relatively flat to moderately sloping with inclinations of approximately between 5 and 11 percent over a height of approximately 14 feet.

5.2 LiDAR Shaded Relief Mapping

LiDAR is a remote sensing technology that can be used to generate a detailed expression of ground surface topography even in densely vegetated areas. For this reason, LiDAR-based topographic imagery can be helpful in distinguishing surface features (such as old landslide features) that may otherwise not be easily recognizable. A LiDAR-based shaded relief map of the subject site and surrounding area is included in Figure 3. No evidence of historical landslide activity was evident in the LiDAR-based shaded relief map. Because the boring data and regional geologic mapping indicates that past sliding has occurred, is it possible that geomorphic features indicative of past sliding have been obliterated by previous grading activities.

5.3 Site Reconnaissance

We completed a reconnaissance of the project area, including the bluff at the west end of the site at the time of our exploration. The following is a summary of our observations.

- The slope is heavily vegetated with small deciduous trees, ivy, and small shrubs.
- Slight distortion of a chain link fence was observed near the top of the slope in the area of the 1994 slide.
- Slow seepage was observed from a weep pipe located at the bottom of the gabion wall.

- A small, vegetated mound of soil was observed at the base of the bluff on the beach below the subject site. Based on the size of the mound at its location, we interpret this material to consist of debris from the 1994 slide.
- The older onsite buildings associated with the sewage plant (upslope of the bluff) appeared to be in condition with no evidence of settlement, movement, or deformation observed.
- Soil exposures on the bluff were largely obscured due to heavy vegetation, although silty gravel deposits interpreted to be representative of Pre-Fraser gravels were observed on the lower portion of the bluff, above the beach.

5.4 Aerial Photograph Review

We completed a review of historical aerial photos of the site obtained from the Washington Department of Ecology Shoreline Photo Viewer. This included aerial photographs from the years 1977, 1990, 2000, 2006, and 2016. We were also able to review historical photographs using Google Earth during this same time period and continuing on to the most current aerial photo in 2024.

On the 2010 and 2016 images shown below we have identified an area on the slope where there is an exposed surface indicative of a shallow slope failure approximately 150 feet south of the subject site. In both photos the slide appears to be in approximately the same location. In aerial photos from subsequent years the area is covered by native growth and no indications of additional sliding are visible. The slope below the treatment plant site shows no change during this period. Another small slide is visible on the slope in the 2016 photo approximately 400 feet north of the subject site, below the road to the boat launch. This failure was observed during our recent site visits and is visible in a recent (2024) aerial photo. During a previous site visit, we observed that this slide appears to be related to a drainage issue associated with the road. Specifically, the topography of the road causes runoff from the upslope portion of the road to flow over the top of the slope at this location. This condition does not exist on the subject parcel.



2010



2016

In the 2018 photograph some clearing is visible on the portion of the bluff fronting the adjoining lot to the south, extending slightly into the portion of the bluff below the treatment plant site. This clearing was recent, and possibly in progress, at the time of our 2018 site visit. The clearing is not slide related and may have been conducted for view enhancement.

Review of the photographs indicates that minor slope regression has occurred on nearby portions of the bluff over the 47-year period of record reviewed. The sliding/regression that has occurred appears to be surficial in nature. The cause of the sliding/slope regression observed approximately 150 feet south of the subject site is unknown. As is the case of the failure below the road approximately 400 feet north of the site, uncontrolled drainage is a potential cause.



2018

5.5 Slope Stability Analysis

An analysis of the stability of the marine bluff at the west end of the site was completed using the computer program Slope/W 2016 by GeoSlope International. The program used the Morgenstern-Price method for evaluating a rotational failure. Input parameters for the analysis included slope geometry, geology, and soil strength parameters. The slope geometry used for our analysis was based on the topographic profile along Section Line A-A' as shown on Figure's 2 and 3. An analysis of the bluff slope was completed for both the existing and proposed site conditions. Analysis of the slope for the proposed site conditions was based on the plan layout shown in Appendix C. Loads from buildings and other site structures were modeled assuming a surcharge load ranging between 500 and 2000 pounds per square foot, as shown on the slope stability models in Appendix D. Our analysis also assumed that the gabion wall constructed at the top of the bluff is locally stable (i.e. the wall is not subject to failure).

The geology of the slope was based on the subsurface conditions encountered in borings EB-1 and EB-2 and our reconnaissance of the site. Soil strength parameters used for our analysis

were assumed based on published values of similar deposits provided in the 2019 Washington State Department of Transportation *Geotechnical Design Manual* (WSDOT Manual), typical published values for similar materials and our prior experience. The values assumed for our analysis were selected to be conservatively low and are shown on the SLOPE/W profiles included in Appendix D.

Groundwater was modeled using the data collected during our onsite subsurface explorations, EB-1 and EB-2. We inferred that the piezometric surface is sloping uphill to the east. For the analysis, saturated soil conditions were applied below the piezometric surface to the fill soils, mass wasting deposits, and the Pre-Fraser non-glacial deposits.

For assessment of slope stability under seismic conditions, a horizontal ground acceleration of 0.32g was used. This value is equivalent to ½ of the peak horizontal ground acceleration based on a seismic event with a 2-percent probability of exceedance in 50 years in accordance with the *International Building Code* (IBC) and ASCE 7-16.

The factor of safety of a slope is the ratio between the forces that resist sliding to the forces that drive sliding. For example, a factor of safety of 1.0 would indicate a slope where the driving forces and the resisting forces are exactly equal. Increasing factor of safety values greater than 1.0 indicate increased stability. Minimum factors of safety of 1.63 and 1.11 were calculated for the subject slope under static and seismic conditions, respectively. These values meet or exceed the minimum values specified in Section 18.80.020(C)(2)(c) of the PCC of 1.5 (static) and 1.1 (seismic). Copies of the results of the slope stability analysis are included in Appendix D.

5.6 Landslide Hazard Mitigation

As previously discussed, the PCC includes a list of landslide hazard indicators used to identify Potential Landslide Hazard Areas. Potential Landslide Hazard Areas are further characterized as either Active Landslide Areas or Stable Areas.

Section 18E.80.020C1 of the PCC classifies areas of historical landslide movement within the past century as Active Landslide Areas. Section 18E.80.050A of the PCC requires that a buffer be established around all sides of Active Landslide Areas. The minimum required buffer width at the top of the slope is 1/3 of the slope height or 50 feet, whichever is greater. Given the height of the bluff at the subject site of approximately 60 feet, a 50-foot buffer would apply if the slope is considered an Active Landslide Area.

Based on our findings, the minimum 50-foot buffer required for Active Landslide Areas will provide suitable mitigation of landslide hazards for the project. Figure 2 illustrates that the limits of the proposed project lie outside of the 50-foot buffer, where the buffer is defined as the area within 50 feet of the top of the 1994 slide area (i.e. the landward edge of the top of the gabion

wall). The PCC also requires a 15-foot building setback from the edge of Active Landslide Area buffers.

Development, including grading, clearing, and placement of structures is generally prohibited in Active Landslide Areas and their buffers, but the code allows for some exceptions for utilities and trail construction. Additional exceptions apply to the building setback, including clearing and grading, paving, landscaping, decks, and building overhangs.

As shown in Figure 2, several structures are proposed in the 15-foot building setback. These include a Waste Activated Sludge (WAS) tank and a stand-by generator and pad for an odor control system. An influent pump station and a Return Activated Sludge (RAS) pump station lie partially within the 15-foot building setback. These structures are described by the civil engineer as non-essential in that slide related damage to these structures will not affect the ability of the sewage treatment plant to produce high quality effluent. It is our opinion that placement of the non-essential structures within the 15-foot buffer does not create a greater risk than what current exists by the existing building that encroaches into the 50-foot buffer.

Section 18E.80.020C2 of the PCC states that areas where adequate engineering or structural improvements have been provided to mitigate the potential for future landslides to occur, resulting in minimum factors of safety of at least 1.5 for static conditions and 1.1 for dynamic (seismic) conditions classify as Stable Areas. As previously discussed, a gabion wall has been constructed in the area of the 1994 slide to mitigate slide hazards at this location. In addition, the leak in the effluent pipe in this area which may have contributed to the 1994 slide has been repaired. As demonstrated in Section 5.5, minimum factors of safety calculated for the slope exceed the minimum threshold values of 1.5 (static) and 1.1 (dynamic). Based on these criteria, the subject slope classifies as a Stable Area under the PCC and the 50-foot buffer and 15-foot building setbacks do not apply.

6.0 SEISMIC HAZARDS AND MITIGATIONS

All of Western Washington is at risk of strong seismic events resulting from movement of the tectonic plates associated with the Cascadia Subduction Zone (CSZ), where the offshore Juan de Fuca plate subducts beneath the continental North American plate. The site lies within a zone of strong potential shaking from subduction zone earthquakes associated with the CSZ. The CSZ can produce earthquakes up to magnitude 9.0, and the recurrence interval is estimated to be on the order of 500 years. Geologists infer the most recent subduction zone earthquake occurred in 1700 (Goldfinger et al., 2012[1]). Three main types of earthquakes are typically associated with

[1] Goldfinger, C., Nelson, C.H., Morey, A.E., Johnson, J.E., Patton, J.R., Karabanov, E., Gutierrez-Pastor, J., Eriksson, A.T., Gracia, E., Dunhill, G., Enkin, R.J, Dallimore, A., and Vallier, T., 2012, *Turbidite Event History—Methods and Implications for Holocene Paleoseismicity of the Cascadia Subduction Zone*: U.S. Geological Survey Professional Paper 1661–F, 170 .

subduction zone environments: crustal, intraplate, and interplate earthquakes. Seismic records in the Puget Sound region document a distinct zone of shallow crustal seismicity (e.g., the Seattle Fault Zone). These shallow fault zones may include surficial expressions of previous seismic events, such as fault scarps, displaced shorelines, and shallow bedrock exposures. The shallow fault zones typically extend from the surface to depths ranging from 16 to 19 miles. A deeper zone of seismicity is associated with the subducting Juan de Fuca plate. Subduction zone seismic events produce intraplate earthquakes at depths ranging from 25 to 45 miles beneath the Puget Lowland including the 1949, 7.2-magnitude event; the 1965, 6.5-magnitude event; and the 2001, 6.8-magnitude event) and interplate earthquakes at shallow depths near the Washington coast including the 1700 earthquake, which had a magnitude of approximately 9.0. The 1949 earthquake appears to have been the largest in this region during recorded history and was centered in the Olympia area. Evaluation of earthquake return rates indicates that an earthquake of the magnitude between 5.5 and 6.0 is likely within a given 20-year period.

Generally, there are four types of potential geologic hazards associated with large seismic events: 1) surficial ground rupture, 2) seismically induced landslides or lateral spreading, 3) liquefaction, 4) ground motion. The potential for each of these hazards to adversely impact the proposed project is discussed below.

6.1 Surficial Ground Rupture

We reviewed mapped faults on the DNR Geologic Map Portal. The DNR map shows an inferred tectonic fault trace approximately 6.5 miles southwest of the site known as the Olympia structure. The Olympia structure is a feature approximately 50 miles long that separates the sedimentary deposits of the Tacoma basin from the basalt of the Black Hills uplift. There is very little seismicity south of the Tacoma Basin as far south as Chehalis and the structure has not been conclusively determined to be a fault (Gower et al., 1985[2]). We are available to seismic mapping further on request. Due to the suspected long recurrence interval, and the distance from mapped structure traces, the potential for surficial ground rupture is considered to be low during the expected life of the proposed structures.

6.2 Seismically Induced Landslides

It is our opinion that the risk of damage to the proposed project by landslides under either static or seismic conditions is low and the proposed project will not adversely impact current hazards. Landslide hazards were discussed in greater detail in the Landslide Hazards and Mitigations section of this report.

[2] Gower, H. D.; Yount, J. C.; Crosson, R. S. (1985), "Seismotectonic map of the Puget Sound region, Washington", U. S. Geological Survey, Miscellaneous Investigations Map I-1613, 1 sheet, scale 1:250,000, 15 p. text.

6.3 Liquefaction

Liquefaction is a process through which unconsolidated soil loses strength as a result of vibrations, such as those which occur during a seismic event. During normal conditions, the weight of the soil is supported by both grain-to-grain contacts and by the fluid pressure within the pore spaces of the soil below the water table. Extreme vibratory shaking can disrupt the grain-to-grain contact, increase the pore pressure, and result in a temporary decrease in soil shear strength. The soil is said to be liquefied when nearly all of the weight of the soil is supported by pore pressure alone. Liquefaction can result in deformation of the sediment and settlement of overlying structures. Areas most susceptible to liquefaction include those areas underlain by very soft to stiff, non-cohesive silt and very loose to medium dense, non-silty to silty sands with low relative densities, accompanied by a shallow water table.

In our opinion, the subsurface conditions at the site do not pose a substantial risk of liquefaction because of the high relative density of the underlying sediments and the lack of adverse groundwater conditions. No mitigation of liquefaction hazards is recommended, and in our opinion none is warranted.

6.4 Ground Motion/Seismic Site Class (2018 *International Building Code*)

Structural design of the new structures should follow 2018 *International Building Code* (IBC) standards. We recommend that the project be designed in accordance with Site Class "D" in accordance with the 2018 IBC, and the publication *American Society of Civil Engineers* (ASCE) 7 referenced therein, the most recent version of which is ASCE 7-16.

7.0 EROSION HAZARDS AND MITIGATIONS

A review of the PCC indicated that the site is classified as a Potential Erosion Hazard Area based on section 18.E.110.020.B. A potential erosion hazard area is defined as those areas where the suspected risk of erosion through either loss of soil, slope instability, or land regression is sufficient to require additional review to assess the potential for active erosion activity or apply additional standards.

The PCC further divides potential erosion hazard areas into five categories and the site falls within the Shoreline Erosion Hazard Area based on section 18.E.110.020.B.1.a. The PCC defines a shoreline erosion hazard area as areas within 200 feet of a marine shoreline, as measured landward perpendicularly from the edge of the ordinary high water mark (See Figure 18E.110-1 from the PCC in Appendix C).

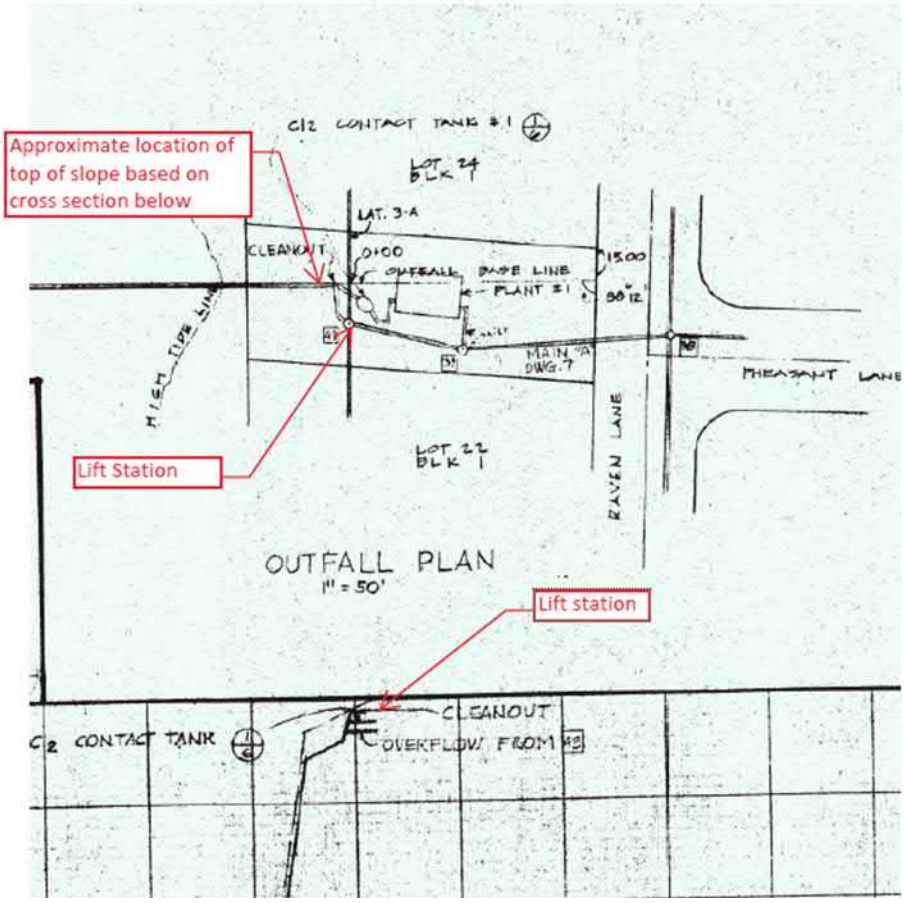
The PCC defines buffer width criteria in section 18.E.110.050. The buffer width shall be measured on a horizontal plane from a perpendicular line established at the edge of the active shoreline

erosion hazard area limits. (See Figure 18E.110-3 from the PCC in Appendix C) and fifty feet from all edges of the shoreline erosion hazard area limits.

Based on the provided proposed improvement plans it appears that the main building and any ancillary structures will be close to the required buffer/setback limits. We recommend that a survey is completed to verify these dimensions and that the proposed building conforms with the PCC buffers.

7.1 Shoreline Erosion

Section 18E.110.030 of the PCC requires a shoreline erosion hazard assessment due to the toe of the bluff being located in a Potential Marine Shoreline Erosion Hazard Area. A geological assessment of shoreline erosion hazards associated with the project was provided in our letter report dated March 14, 2024. Based on the findings of the assessment a regression rate of 0.25 feet per year was estimated, which equates to 30 feet over the 120-year time period specified in the code. The location of the 30-foot, 120-year recommended slope regression setback line is shown on Figure 2. A copy of the letter report is included in Appendix E. In order to provide additional confirmation of the accuracy of the results of the estimated, 120-year slope regression analysis, and to address a review comment received from Pierce County, we reviewed the as-built drawing of the site dated December 23, 1970, and the aerial photographs previously discussed in Section 5.4 for this report. Below is a clip from the as-built outfall plan dated December 23, 1970. The full copy of this plan is included in Appendix B. The top of slope is not called out specifically on the site plan but is inferred on the cross section. This is noted on the outfall plan below. Also noted on the outfall plan is the location of the lift station that is currently in the same location. This is evidence that the top of the slope has not significantly changed since 1970. The current site conditions and slope profile are shown on the civil plan from Gray and Osborne, Inc. included in Appendix B.



Based on our discussion with longtime residents Steve Stemhagen and Tom McDowell during a site visit in 2018, it is our understanding that there has been no further disturbance to the slope below the treatment plant noted since construction of the gabion wall following the 1994 slide event.

With the exception of the 1994 surface failure at the top of the slope that was repaired and stabilized with a gabion wall, there does not appear to be substantial loss to the slope since 1970. By estimation from review of the available as-built data, about 5 feet of the slope has been lost in the last 54 years. This amounts to about 0.1 feet per year. The loss which has occurred is limited to that which resulted from the 1994 landslide, which has since been mitigated by construction of the wall. The 1994 slide may have been related to discharge resulting from a leak in the treatment plant outfall pipe, located near the top of the slope in this area. We understand that this leak has since been repaired. Because the 1994 slide occurred at the top of the slope, it does not appear to be related to erosion of the toe of the slope by wave action.

As previously discussed in Section 5.4, slide events/slope regression evident in historical aerial photos of the area appear to be surficial in nature. Based on the documented history of the site since 1970 and the 47-year period of historical aerial photo review completed for our study, it

appears that the 30-foot slope regression estimate provided in our March 14, 2024 letter (Appendix E) is conservatively high.

7.2 Abandonment of Lift Station and Sewer Collection System On Bluff

The existing lift station and sewer collection system near the top of the bluff is located within the 30-foot shoreline erosion regression buffer and the 50-foot Active Landslide Buffer (if applicable). The Taylor Bay Beach Club is aware of this risk and is initiating discussion to evaluate how to manage and mitigate this risk. One option being considered is installing grinder pumps on lots in this service area. The grinder pumps could be installed as far as possible from the top of the bluff and could discharge into the existing gravity sewer on 178th Avenue Court SW. The logistics, expenses, and schedule will also be under consideration. This approach would allow abandonment of the lift station and collection pipe.

III. DESIGN RECOMMENDATIONS

8.0 INTRODUCTION

Our explorations indicate that, from a geotechnical engineering standpoint, the property is suitable for the proposed improvements provided the recommendations contained herein are properly followed. Sediments suitable for foundation support were encountered at relatively shallow depths and conventional spread footings may be used.

9.0 SITE PREPARATION

Following demolition of the existing structures, any remaining foundation elements should be removed. Site preparation within the locations of the proposed structures should include removal of all vegetation, topsoil, pavement and any other deleterious materials. Any existing fill beneath planned footing and floor slab areas should be removed. Any depressions below planned final grades resulting from demolition activities should be backfilled with structural fill, as discussed under the "Structural Fill" section of this report. All soils disturbed by stripping and grubbing operations should be recompacted as described below for structural fill.

9.1 Temporary and Permanent Cut Slopes

In our opinion, stable construction slopes should be the responsibility of the contractor and should be determined during construction based on the local conditions encountered at that time. For planning purposes, we anticipate that temporary, unsupported cut slopes in areas of existing fill or loose to medium dense, natural sediments can be made at a maximum slope of 1.5H:1V (Horizontal:Vertical). Temporary, unsupported cut slopes within the dense to very dense natural sediments can be planned at a maximum slope of 1H:1V. Temporary vertical cuts up to 4 feet in height may be planned in all of these materials. Flatter inclinations may be recommended in areas of seepage. As is typical with earthwork operations, some sloughing and raveling may occur, and cut slopes may have to be adjusted in the field. In addition, WISHA/OSHA regulations should be followed at all times.

Permanent cut slopes should not exceed an inclination of 2H:1V.

9.2 Site Disturbance

The sediments underlying the site generally contain a high percentage of fine-grained (silt- and clay-sized) material. These soils are considered to be highly moisture-sensitive and subject to disturbance when wet. The contractor must use care during site preparation and excavation operations so that the underlying soils are not softened. If disturbance occurs, the softened soils should be removed and the area brought to grade with structural fill.

Consideration should be given to protecting access and staging areas with an appropriate section of crushed rock or asphalt treated base (ATB). If crushed rock is considered for the access and staging areas, it should be underlain by engineering stabilization fabric (such as Mirafi® 500X or approved equivalent) to reduce the potential of fine-grained materials pumping up through the crushed rock during wet weather and turning the area to mud. The fabric will also aid in supporting construction equipment, thus reducing the amount of crushed rock required. We recommend that at least 10 inches of crushed rock be placed over the fabric. Crushed rock used for access and staging areas should have a particle size of at least 2 inches.

9.3 Pavement Areas

After stripping of the site has been completed, we recommend that the soil exposed in pavement areas be recompacted to a firm and unyielding condition using a 20-ton (minimum) vibratory roller. The recompacted area should then be proof-rolled with a fully loaded tandem-axle dump truck. Any soft or yielding areas identified during proof-rolling should be overexcavated and backfilled with structural fill.

10.0 STRUCTURAL FILL

All references to structural fill in this report refer to subgrade preparation, fill type and placement, and compaction of materials, as discussed in this section. If a percentage of compaction is specified under another section of this report, the value given in that section should be used.

After stripping, planned excavation, and any required overexcavation have been performed to the satisfaction of the geotechnical engineer, the upper 12 inches of exposed ground in areas to receive fill should be recompacted to a firm and unyielding condition as determined by the geotechnical engineer. If the subgrade contains silty soils and too much moisture, adequate recompaction may be difficult or impossible to obtain and should probably not be attempted. In lieu of recompaction, the area to receive fill should be blanketed with washed rock or quarry spalls to act as a capillary break between the new fill and the wet subgrade. Where the exposed ground remains soft and further overexcavation is impractical, placement of an engineering stabilization fabric may be necessary to prevent contamination of the free-draining layer by silt migration from below.

After recompaction of the exposed ground is tested and approved, or a free-draining rock course is laid, structural fill may be placed to attain desired grades. Structural fill is defined as non-organic soil, acceptable to the geotechnical engineer, placed in maximum 8-inch loose lifts, with each lift being compacted to 95 percent of the modified Proctor maximum density using ASTM D-1557 as the standard. For on-site utility trench backfill, including the backfill resulting

from the removal of existing utility lines**,** we recommend the structural fill standard described above.

The contractor should note that any proposed fill soils must be evaluated by AESI prior to their use in fills. This would require that we have a sample of the material 72 hours in advance to perform a Proctor test and determine its field compaction standard. Soils in which the amount of fine-grained material (smaller than the No. 200 sieve) is greater than approximately 5 percent (measured on the minus No. 4 sieve size) should be considered moisture-sensitive. Use of moisture-sensitive soil in structural fills should be limited to favorable dry weather conditions. The granular on-site soils that are free of excessive organic debris or other deleterious materials are suitable for use as structural fill if their moisture content is compatible with achieving the specified level of compaction. Much of the native sediments and existing fill soils present onsite contain variably high amounts of silt and are considered moisture-sensitive. If the moisture content of the soil at the time of construction is over the optimum to achieve suitable compaction, moisture-conditioning of the soil may be required. This could be achieved by aerating the soil during periods of warm, dry weather. The portions of the on-site soils that consist predominantly of silt are not recommended for use as structural fill.

Construction equipment traversing the site when the moisture-sensitive soils are wet can cause considerable disturbance. If fill is placed during wet weather or if proper compaction cannot be obtained, a select import material consisting of a clean, free-draining gravel and/or sand should be used. Free-draining fill consists of non-organic soil with the amount of fine-grained material limited to 5 percent by weight when measured on the minus No. 4 sieve fraction with at least 25 percent retained on the No. 4 sieve.

A representative from our firm should inspect the stripped subgrade and be present during placement of structural fill to observe the work and perform a representative number of in-place density tests. In this way, the adequacy of the earthwork may be evaluated as filling progresses, and any problem areas may be corrected at that time. It is important to understand that taking random compaction tests on a part-time basis will not assure uniformity or acceptable performance of a fill. As such, we are available to aid in developing a suitable monitoring and testing program.

11.0 FOUNDATIONS

Portions of the site are underlain by existing fill soils that are not considered suitable for foundation support. For this reason, the depth to suitable foundation bearing sediments varies below the site, ranging from approximately 2 to 6.5 feet in our borings. Foundation support could be provided by spread footing foundations as described below but the deeper fill soils may make the use of spread footings impractical in some areas. As an alternative to spread footings, foundation support could be provided by small diameter pipe piles. This option would be most

useful if plans call for footings in the northeastern corner of the site. Geotechnical design recommendations for both foundation types are provided below.

11.1 Spread Footings

11.1.1 Allowable Foundation Soil Bearing Pressure

Spread footings may be used for building support when founded either directly on the medium dense to very dense Pre-Fraser non-glacial deposits, dense mass wasting deposits, or on structural fill placed over the competent soil described above. If structural fill is placed below footing areas, it should extend horizontally at least two feet beyond the footing edges. We recommend that an allowable foundation soil bearing pressure of 2,500 pounds per square foot (psf) be used for design purposes, including both dead and live loads. An increase in the allowable bearing pressure of one-third may be used for short-term wind or seismic loading.

Included in the project are the construction of two tanks that extend up to 15 feet below grade. Foundations for these tanks will be below the presence of the fill soils and will be placed upon the dense to very dense Pre-Fraser non glacial deposits. For foundations placed directly upon undisturbed native deposits at this depth the allowable soil bearing pressure may be increased to 4,000 psf.

11.1.2 Footing Depths

Perimeter footings for the proposed structures should be buried a minimum of 18 inches into the surrounding soil for frost protection. No minimum burial depth is required for interior footings; however, all footings must penetrate to the prescribed stratum, and no footings should be founded in or above loose, organic, or existing fill soils.

11.1.3 Footings Adjacent to Cuts

The area bounded by lines extending downward at 1H:1V from any footing must not intersect another footing or intersect a filled area that has not been compacted to at least 95 percent of ASTM D-1557. In addition, a 1.5H:1V line extending down from any footing must not daylight because sloughing or raveling may eventually undermine the footing. Thus, footings should not be placed near the edges of steps or cuts in the bearing soils.

11.1.4 Footing Settlement

Anticipated settlement of footings founded as described above should be on the order of 1 inch or less. However, disturbed soil not removed from footing excavations prior to footing placement could result in increased settlements.

11.1.5 Footing Subgrade Bearing Verification

All footing subgrade areas should be observed by AESI prior to footing placement. Foundation bearing verification may be required by Pierce County.

11.2 Small-Diameter Pipe Piles

In those areas where the depth to suitable foundation bearing soils makes the use of spread footing foundations impractical, foundation support could be provided by small diameter driven pipe piles that fully penetrate the existing fill and are driven to refusal in the underlying Pre-Fraser non-glacial sediments. Allowable axial capacities for small diameter driven pipe piles are provided below in Table 1.

Table 1
Small Diameter Pipe Pile Recommendations

Nominal Pipe Diameter	Minimum Wall Thickness	Minimum Hammer Size	Allowable Axial Capacity	Driving Time (seconds/inch)
2-inch	Schedule 80	90 Lb. Jackhammer	6 kips	60
3-inch	Schedule 40	850 Lbs	12 kips	10
4-inch	Schedule 40	1100 Lbs	17 kips	10
6-inch	Schedule 40	3000 Lbs	30 kips	6

In order for the stated pile capacities to apply, the pipe piles should be driven to refusal, which is defined as less than 1 inch of penetration during the specified period of continuous driving.

No lateral capacity would be provided by vertically installed pipe piles. Lateral capacity could be attained through the use of batter piles or passive resistance over the buried portions of the grade beams. An allowable passive equivalent fluid of 250 pounds per cubic foot may be used for foundation design. Piles may be battered up to 15 degrees to develop additional lateral capacity. Lateral capacity of battered piles may be taken as the horizontal component of the axial pile load. Battered piles inclined up to 15 degrees should be designed with an allowable axial compressive capacity equal to that used for vertical piles. Pile spacing, locations, splicing details, foundation connection details, grade beam design, and any other structural design recommendations should be determined by a structural engineer.

Installation of the pipe piles should be observed by an AESI representative to verify that the refusal and embedment criteria are met, and that materials, equipment, and procedures conform with our recommendations. This may also be required by Pierce County.

For pipe piles larger than 2-inches in diameter, we recommend that load testing in accordance with the ASTM Quick Load Test (ASTM D1143) be conducted to 200 percent of the allowable pile capacity on a minimum of 3 percent (1 pile minimum, 5 piles maximum) of the piles.

11.3 Foundation Drainage

Perimeter footing drains should be provided as discussed under the "Drainage Considerations" section of this report.

12.0 LATERAL WALL PRESSURES

All backfill behind walls or around foundations should be placed following our recommendations for structural fill and as described in this section of the report. Horizontally backfilled walls, that are free to yield laterally at least 0.1 percent of their height, may be designed using an equivalent fluid equal to 35 pounds per cubic foot (pcf). Fully restrained, horizontally backfilled, rigid walls that cannot yield should be designed for an equivalent fluid of 50 pcf. Walls that retain sloping backfill at a maximum angle of 50 percent should be designed for 55 pcf for yielding conditions and 75 pcf for restrained conditions. If parking areas or driveways are adjacent to walls, a surcharge equivalent to 2 feet of retained soil should be added to the wall height in determining lateral design forces.

12.1 Wall Backfill

The lateral pressures presented above are based on the conditions of a uniform backfill consisting of imported sand and gravel compacted to 90 to 95 percent of ASTM D-1557. A higher degree of compaction is not recommended, as this will increase the pressure acting on the walls. A lower compaction may result in unacceptable settlement behind the walls. Thus, the compaction level is critical and must be tested by our firm during placement.

12.2 Wall Drainage

It is imperative that proper drainage be provided so that hydrostatic pressures do not develop against the walls. This would involve installation of a minimum 1-foot-wide blanket drain for the full wall height using imported, washed gravel against the walls.

12.3 Passive Resistance and Friction Factor

Lateral loads can be resisted by friction between the foundation and the supporting sediments, or by passive earth pressure acting on the buried portions of the foundations. The foundations must be backfilled with compacted structural fill to achieve the passive resistance provided below. We recommend the following design parameters:

- Passive equivalent fluid = 250 pcf
- Coefficient of friction = 0.30

The above values are allowable.

12.4 Seismic Surcharge

As required by the 2018 IBC, retaining wall design should include a seismic surcharge pressure in addition to the equivalent fluid pressures presented above. We recommend a seismic surcharge pressure of 10H and 12H psf where H is the wall height in feet for the "active" and "at-rest" loading conditions, respectively. The seismic surcharge should be modeled as a rectangular distribution with the resultant applied at the midpoint of the wall.

13.0 TEMPORARY SHORING

Excavation depths in excess of 16 feet are planned for the project, and it is anticipated that temporary shoring may be needed in some areas. This section of the report presents preliminary design considerations and criteria for use in the design of the excavation shoring. *With this information and other pertinent data, it should be the responsibility of the shoring subcontractor(s) to determine the appropriate design details, construction methods, and procedures for installation of the shoring system.*

13.1 Soldier Piles

One of the most common types of temporary shoring used in the Puget Sound area consists of a soldier pile shoring system. For excavations greater than approximately 15 feet in depth, the soldier beams are typically laterally restrained with drilled tieback anchors. Soldier piles, which are wide-flange beams, are placed in pre-drilled holes that extend beyond the bottom of the excavation. The portion of each soldier pile extending below the bottom of the excavation is grouted in place with sufficient-strength concrete to transmit the vertical loads of the soldier beams to the soil below the excavation level. The upper portion of the soldier pile is then backfilled with a relatively weak grout so that it may be removed, as necessary, for placement of lagging. In our opinion, lagging would be required throughout the excavation. We recommend that timber lagging be backfilled with a flowable lean-mix sand during installation to reduce the potential for movement of the cut soil and provide drainage behind the wall. The lagging should span a maximum of 8 feet. A 50 percent reduction of the lateral pressures presented subsequently can be used for timber lagging design to account for soil arching.

13.2 Single Row or No Tiebacks

Portions of the excavation may only require a single row of tieback anchors or possibly no tiebacks, depending upon the situation. In this case, the applied lateral pressure can be represented by a triangular pressure distribution termed as an equivalent fluid. The wall design can be based on either “active” or "at-rest" soil pressure conditions. Active pressure assumes that the soil is allowed to yield slightly, resulting in lower design earth pressures. “At-rest” or “fully restrained” conditions assume that the soil is not allowed to yield and results in higher design pressures. Active earth pressure design provides a more economic, lighter wall, but increased lateral movement and settlement behind the wall. The use of active pressure for the shoring system assumes sufficient deformation of the soil occurs to develop an active condition, typically on the order of 0.001 to 0.002 times the height of the excavation. Theoretically, an equal amount of settlement occurs behind the wall. The settlement is typically greatest immediately adjacent to the wall and decreases with distance away from the wall. The limits of settlement are typically within a distance of one wall height behind the top of wall. At-rest pressure design results in a heavier, more costly wall, but a reduced risk of lateral displacement and settlement behind the wall, as well as adjacent structures. Selection of the appropriate approach should address the potential damage/cost impacts and level of risk. We recommend that the at-rest pressures be used where settlement-sensitive structures are located, such as adjacent buildings and settlement sensitive utilities. Regardless of whether the wall design is based on active or at-rest earth pressures, we recommend that a comprehensive survey of the surrounding streets, structures, and other critical reference points be performed prior to construction activities. These points should then be accurately monitored within 0.01 foot, both horizontally and vertically, until the excavation and backfilling to surrounding site grade has been completed. This may be required by Pierce County.

For shoring design based on horizontal backslope conditions, we recommend using an equivalent fluid equal to 35 pcf for active earth pressure conditions. For fully restrained (at-rest) earth pressure conditions, we recommend an equivalent fluid of 50 pcf. For inclined backslope conditions up to maximum inclination of 2H:1V, we recommend an equivalent fluid equal to 50 pcf for active earth pressure conditions and 75 pcf for at-rest earth pressure conditions. The active or at-rest pressure distribution should be assumed to act over the tributary area of the piles above the excavation base and one concreted pile diameter below the base.

In addition to the design earth pressures, where the area adjacent to the top of the wall will be subject to vehicle traffic, a traffic surcharge equal to 250 psf should be applied at the ground surface behind the wall. A pressure diagram showing the recommended design parameters for a cantilever or single-row tieback wall are depicted in Figure 4.

From a soil standpoint, the grouted soldier piles must be designed for sufficient vertical capacity, and should include the vertical component of the inclined tieback loads. It should be noted that settlement of the soldier piles under load could also cause a reduction in anchor pre-stress,

allowing lateral tilting about the base. For design purposes, the vertical load capacity should be determined based on an allowable adhesion or side friction of 2,000 psf in the dense to very dense natural sediments, and an allowable end bearing of 15,000 pounds per square foot. The recommended allowable end bearing value assumes a minimum embedment of at least 10 feet below the base of the excavation. For computing bending moments in piles, 80 percent of the above earth pressures should be used. Additional vertical capacity of the pile may be obtained from skin friction assuming 750 pounds per square foot over depth "D" as shown in Figure 4.

The soldier piles also need to be located a sufficient depth below the base of the excavation to provide adequate lateral or "kick-out" resistance to horizontal loads below the lowest brace or tieback level. In this regard, the lateral resistance may be computed on the basis of passive pressure in the form of an allowable "passive" earth pressure equivalent to 250(D) psf where D is the depth of embedment below the base of the excavation in feet. This pressure may be considered to be acting against twice the diameter of the grouted soldier pile section. As graphically depicted in Figure 3, passive earth pressure should be neglected within 2 feet of the base of the excavation.

Groundwater seepage was encountered in borings EB-1 and EB-2 at depths ranging from approximately 20 to 20 feet. We recommend that the contractor be prepared to use special soldier pile installation techniques, such as casing or drilling under a fluid head in the event that caving or heaving sediments are encountered.

13.3 Tieback Anchors

For tiebacks used in the shoring system, the grouted anchors must be located far enough behind the soldier pile wall to develop anchorage within a stable soil mass to prevent system failure or excessive deformation. We recommend that this anchorage be obtained behind an assumed failure plane defined by a horizontal line extending a distance equal to H/4 behind the shoring wall at the base of the excavation, which then rotates 60 degrees from the horizontal and extends upward to the ground surface. The area between this assumed failure plane and the retained excavation is referred to as the "no load zone." These recommendations are presented graphically on Figure 4. The anchor loads are transmitted to the surrounding soil by side friction or adhesion with the soil. For 6-inch-diameter, pressure-grouted anchors installed fully within the dense to very dense native sediments may be designed using a presumptive allowable shaft friction of 2,000 psf. The assumed anchor design loads should be confirmed by proof-testing, as outlined subsequently. All anchors should be a minimum of 10 feet in length past the no load zone. Typical anchors are inclined at 15 to 30 degrees to the horizontal.

Care must be exercised when installing tiebacks to avoid existing utilities and foundations. Demonstration of utility and foundation protection will be required to obtain temporary tieback easements from adjoining property owners if the tiebacks will extend beyond the property boundaries. All tiebacks will need to be de-stressed subsequent to construction.

We recommend that each anchor be sized for a design or allowable load of not more than 50 percent of the ultimate load available through the anchor (as indicated by 200-percent verification tests). The test anchors should be capable of holding the ultimate load without excessive yield or creep so that a factor of safety of at least 2.0 is available for production anchors should further stressing occur. The rods or cables should transmit the anchor load to the soldier pile in such a manner to avoid eccentric loading.

13.4 Tieback Testing

A series of anchor tests should be performed to verify the design and ultimate skin friction or adhesion of the tieback anchors. Because of the variation in the sediments at the site, we recommend that AESI monitor the anchor test program. A common anchor testing program would consist of at least two 200-percent verification tests per side of the excavation plus proof-loading every production anchor to 130 percent of the design load. Verification test anchors are usually loaded in 25-percent increments that are held for 5 minutes up to the final load of 200 percent design load. The 200 percent load is commonly held for an hour and creep measured. The other component of the anchor test program for the project would be proof-loading each of the production anchors to 130 percent of the design load. Each anchor should withstand this load for at least 5 minutes. The anchor should then be locked off at the design load.

Subsequent to locking off the tiebacks at the design load, all of the tieback holes should be backfilled to prevent possible collapse of the holes and any related consequences. Typically, sand is used as backfill material; however, most non-cohesive mixtures are suitable (subject to approval by the geotechnical engineer) provided there is no bonding to the anchor rods or cables.

13.5 Internal Bracing

Where obstructions or easement restrictions make the use of tiebacks impractical, an internally braced shoring system can be used. An internal bracing system can typically use inclined rakers anchored into the base of the excavation or cross bracing near the corners or across the middle. However, internal bracing may conflict with the opening size and the excavation may have to increase in size to allow the installation of the tank. Rakers are relatively easy to install but have the disadvantage that they are obstructions that must be worked around during the remaining excavation and foundation construction. If inclined rakers are used to brace the shoring system, we recommend that the raker footings be founded only in the undisturbed, dense to very dense natural sediments. The raker footings should be embedded into the foundation soil such that the base of each footing is at least 2 feet below the base of the excavation in order to take advantage of the passive pressure of the base soils. An allowable bearing pressure of 5,000 psf could be utilized for design purposes. For stability against sliding, a passive equivalent fluid pressure value of 300 pcf would be appropriate. A coefficient of base friction of 0.35 could also be used in the design.

13.6 Vertical and Horizontal Dynamic Spring Constants

Vertical and horizontal spring constants for the dense to very dense natural sediments were established using empirical charts. We have used the concept of elastic subgrade modulus as follows:

$$k_n = S_n A$$

Where: k_n = the spring constant for the selected mode of oscillation
S_n = the dynamic subgrade modulus for the mode of oscillation
A = the area of wall or foundation under evaluation

For this project, it can be assumed that the vertical and horizontal dynamic subgrade modulus for the dense to very dense natural sediments (below approximately 3 to 7 feet) are 150 pounds per cubic inch (pci) and 75 pci, respectively.

13.7 Drainage

Where permanent walls are cast directly against temporary shoring, proper drainage should be provided to control moisture and prevent the buildup of hydrostatic pressure against the wall. At a minimum, we recommend that a geosynthetic drainage composite, such as Miradrain, be installed on the face of the soldier pile wall. The bottom of the drainage mats should communicate with a permanent perimeter drainage system consisting of a rigid, perforated PVC pipe, fully enveloped in washed pea gravel. This system could consist of either an exterior or interior perimeter foundation drain and be tightlined to a sump/pump system or other approved discharge. If a sump/pump system is used, it should include a backup pump and emergency power backup system to maintain drainage in the event of a pump failure or power outage. The perimeter drain can be incorporated into the sub-slab drainage system, if required.

13.8 Monitoring Program

A program should be established to monitor the horizontal and vertical movement of the excavation sidewalls and the installed shoring wall. This monitoring program may be required by Pierce County. The monitoring should be performed by a licensed surveyor with monitoring points established on settlement-sensitive structures (buildings, manholes, poles, etc.) around the excavation and at regular intervals along the shoring wall. Monitoring should be performed at least twice a week and the specifics of the monitoring program should be provided to AESI for review prior to implementation. We recommend the monitoring program be prepared as part of the final shoring wall design.

14.0 DISCHARGE PIPE

If the effluent discharge pipe will extend down the bluff to the beach, we recommend that the pipe consist of High Density Polyethylene (HDPE) pipe with thermally fused joints. The pipe should be anchored at the top of the slope by a concrete block setback at least 15 feet from the top of the slope. Resistance of the block to lateral movement can be designed using the passive earth pressure and friction coefficient provided in Section 12.3 of this report.

15.0 FLOOR SUPPORT

Significant thicknesses of loose fill underlie the proposed building area, and support of slab-on-grade floors on competent natural sediments may not be practical in all areas. Three options for slab-on-grade floor support are provided below. Options 1 and 2 fully mitigate the risk of slab settlement, whereas Option 3 only partially mitigates the risk of settlement.

Option 1 – Support of Slab-On-Grade Floors on Competent Natural Sediments or Structural Fill
Slab-on-grade floors may be constructed either directly on the medium dense to dense, Pre-Fraser non-glacial sediments, dense mass wasting deposits, or on structural fill placed over these materials. Areas of the slab subgrade that are disturbed (loosened) during construction should be recompacted to an unyielding condition prior to placing the pea gravel, as described below.

Option 2 – Support of Slab Floors on Pipe Piles
Option 2 would be to support slab-on-grade floors on driven pipe piles. The pipe pile design recommendations provided in the *Foundations* section of this report may also be used for floor support. The spacing of the pipe piles would be determined by a structural engineer based on the amount of reinforcement included in the floor slab design and the amount of acceptable settlement for deflection of the slab.

Option 3: Floating Floor Slab
Another alternative would be to "float" the slab on a thin structural fill mat. This should be conducted by overexcavating the existing fill or loose, natural sediments below the floor slab area to a minimum of 1 foot below the final planned floor subgrade. The exposed soils in the excavation should then be recompacted to a firm and unyielding condition. A structural fill mat with a minimum thickness of 1 foot should then be placed below the entire floor slab area. After the structural fill placement is completed and approved, the capillary break material and moisture barrier may be placed as described below, and the floor slab cast. The floor slab should not be tied into the building's foundation, but should be free to settle independently. Floating floor slabs should contain sufficient bar-reinforcement to reduce differential movement across any cracks that might develop. This option should only be considered if some settlement and cracking of the floor slab can be tolerated.

Regardless of which floor support option is selected, if moisture intrusion through the floor slab is to be limited, we recommend that the floor slab be constructed atop a capillary break consisting of a minimum thickness of 4 inches of washed pea gravel. The pea gravel should be overlain by a 10-mil (minimum thickness) plastic vapor retarder.

16.0 DRAINAGE CONSIDERATIONS

All retaining and perimeter foundation walls should be provided with a drain at the base of the footing elevation. Drains should consist of rigid, perforated, PVC pipe surrounded by washed pea gravel. The level of the perforations in the pipe should be set at or slightly below the bottom of the footing grade beam, and the drains should be constructed with sufficient gradient to allow gravity discharge away from the building. In addition, all retaining walls should be lined with a minimum, 12-inch-thick, washed gravel blanket that extends to within 1 foot of the surface and is continuous with the foundation drain. Roof and surface runoff should not discharge into the foundation drain system, but should be handled by a separate, rigid, tightline drain. In planning, exterior grades adjacent to walls should be sloped downward away from the structure to achieve surface drainage.

17.0 INFILTRATION FEASIBILITY

Our explorations indicate that the site is underlain by fill soils of variable thickness (7 feet in EB-1). Undocumented fill soils contain unknown factors (grain size distribution, compaction) which could make infiltration problematic. The majority of the native onsite soils contained a fines component too great to support infiltration. The more granular soils observed do not likely extent laterally enough or are too deep to be utilized for infiltration. The proximity to the slope also poses a risk for offsite seepage and slope stability.

It is our conclusion that stormwater infiltration at the site is not feasible due to the lack of extensive coarser grained subsurface soils and the close proximity to the slope.

18.0 PROJECT DESIGN AND CONSTRUCTION MONITORING

We recommend that AESI perform a geotechnical review of the plans prior to final design completion. In this way, we can confirm that our recommendations have been correctly interpreted and implemented in the design. Pierce County may require a plan review by the geotechnical engineer as a condition of permitting.

We recommend that AESI be retained to provide geotechnical special inspections during construction, and preparation of a final summary letter when construction is complete. Pierce County may require such geotechnical special inspections. The integrity of the earthwork and

foundations depends on proper site preparation and construction procedures. In addition, engineering decisions may have to be made in the field in the event that variations in subsurface conditions become apparent.

We have enjoyed working with you on this study and are confident these recommendations will aid in the successful completion of your project. If you should have any questions or require further assistance, please do not hesitate to call.

Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington



Tim J. Peter, L.E.G., L.Hg.
Senior Engineering Geologist

Matt Miller, P.E.
Principal Engineer

Attachments:

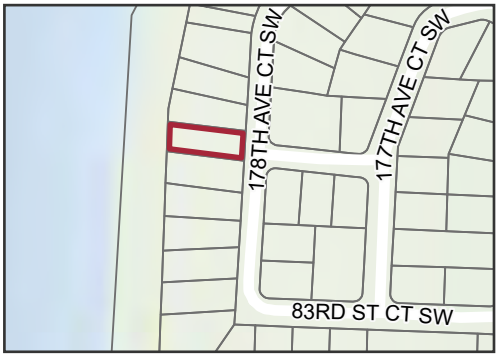
	Figure 1.	Vicinity Map
	Figure 2.	Site and Exploration Plan
	Figure 3.	LIDAR-Based Topography
	Figure 4.	Soldier Pile Shoring Wall Design Criteria
	Appendix A.	Exploration Logs
	Appendix B.	Civil Plans, Existing Facility
	Appendix C.	Civil Plans, Proposed Facility
	Appendix D.	Slope Stability Analysis
	Appendix E.	Shoreline Erosion Hazard Report



COUNTY LOCALE



LOCATION



ESRI, USGS, NATIONAL GEOGRAPHIC, DELORME, NATURALVUE, I-CUBED, GEBCO: ARCGIS ONLINE BASEMAP. WADOT STATE ROUTES 24K (12/20). PIERCE CO: PARCELS, ROADS (5/23).

NOTE: LOCATION AND DISTANCES SHOWN ARE APPROXIMATE. BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION.

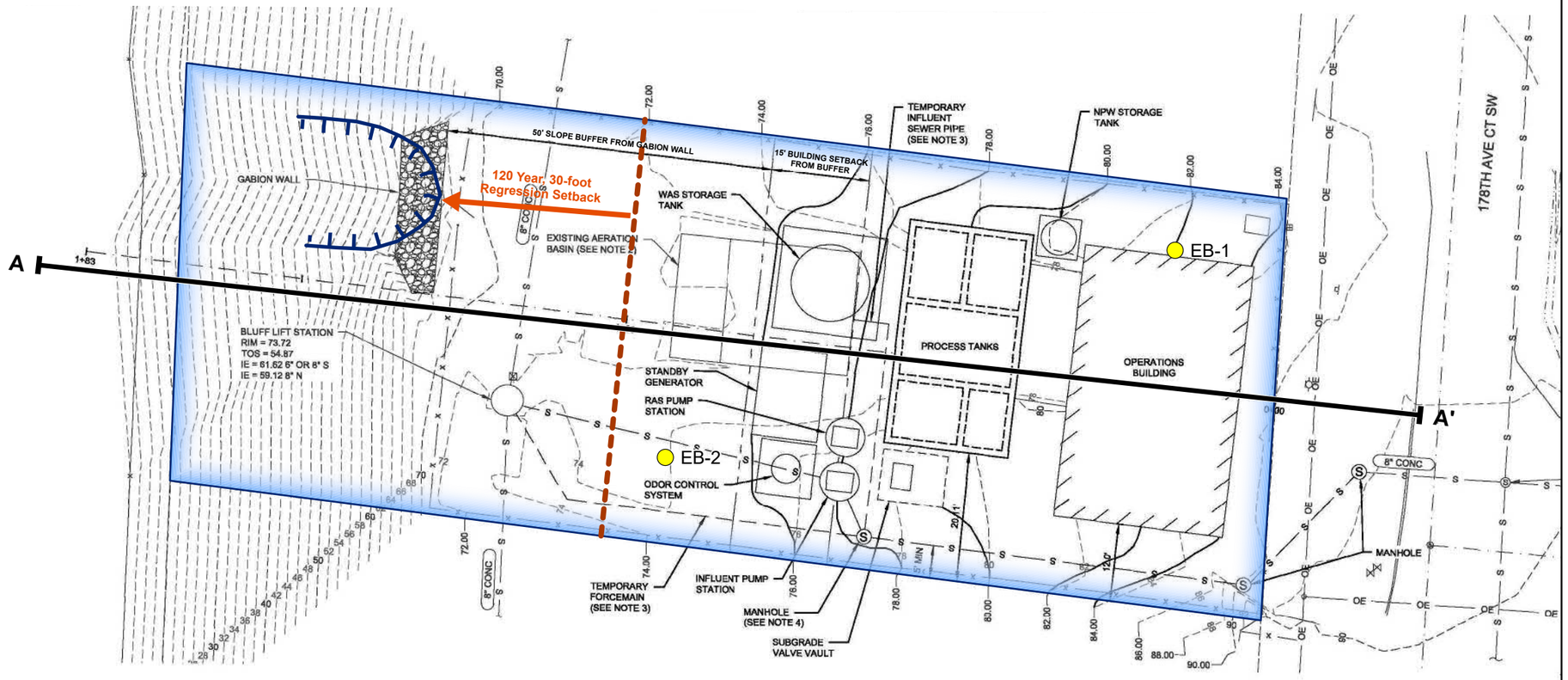
associated earth sciences incorporated

VICINITY MAP

TAYLOR BAY SEWAGE TREATMENT PLANT
PIERCE COUNTY, WASHINGTON

PROJECT NO.	DATE	FIGURE
20200440E001	5/24	1

G:\GIS_Projects\aa\2020\200440 Taylor Bay Sewage Treatment Plant_aprx\200440E001 F1 VM_TaylorBay.aprx | 20200440E001 F1 VM_Taylor | 2024-05-15 | mtrop



LEGEND

- SITE
- EXPLORATION BORING
- SETBACK
- CROSS-SECTION
- APPROXIMATE LOCATION OF 1994 SLIDE

N

0 20

FEET

DATA SOURCES/REFERENCES:
GRAY AND OSBORNE, INC. CONSULTING ENGINEERS, TAYLOR BAY BEACH CLUB HOA, FIGURE 5-1, 4/5/2024.

BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION. LOCATION AND DISTANCES SHOWN ARE APPROXIMATE.

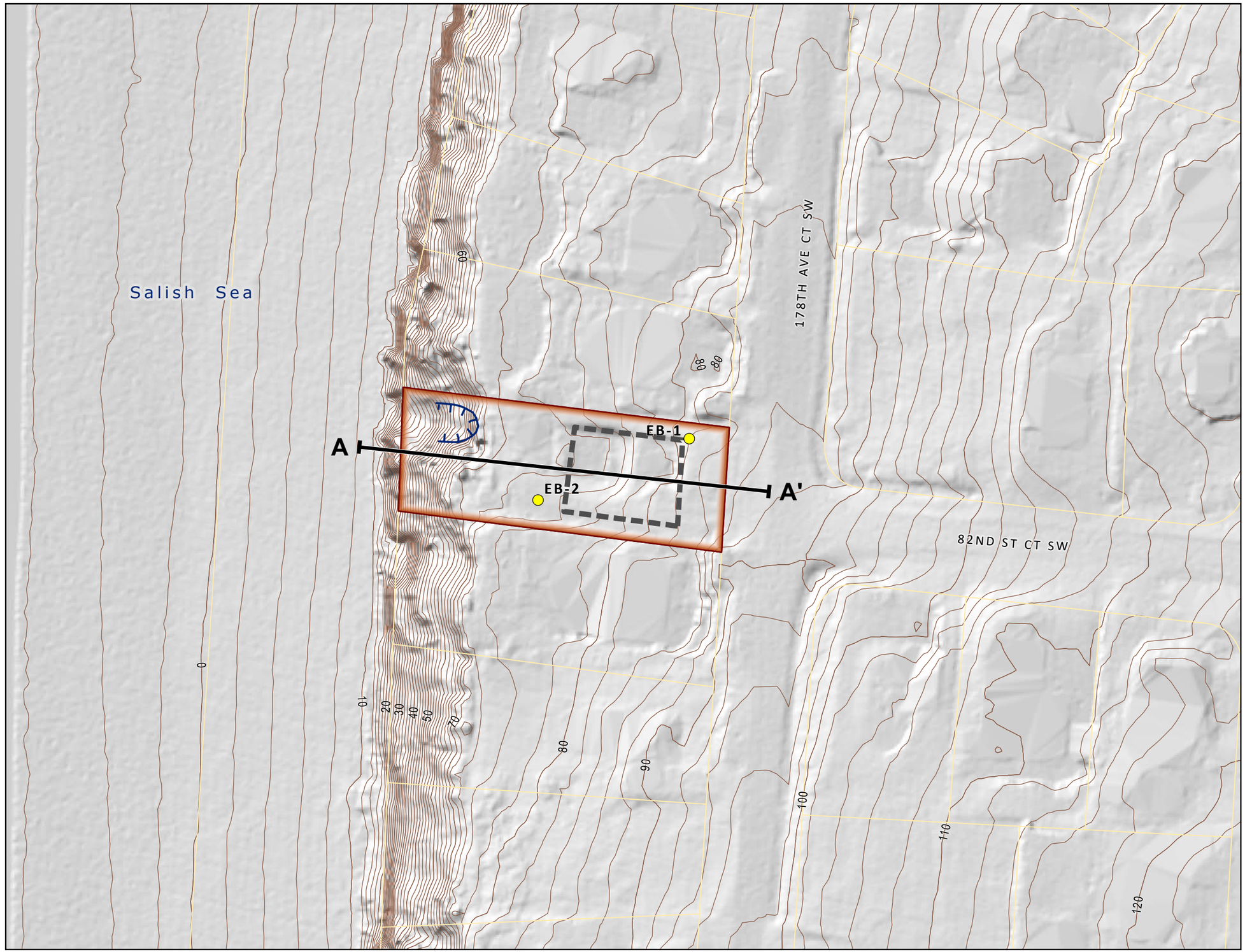
associated earth sciences incorporated

SITE AND EXPLORATION PLAN

TAYLOR BAY SEWAGE TREATMENT PLANT
PIERCE COUNTY, WASHINGTON

PROJECT NO.	DATE	FIGURE
20200440E001	5/24	2

G:\GIS_Projects\aa\Y2020\200440 Taylor Bay Sewage Treatment Plant_aprx\200440E001 F2 SP_TaylorBay.aprx | 20200440E001 F2_SP_TaylorBay | 2024-05-15 | mtrop



LEGEND

- SITE
- EXPLORATION BORING
- CROSS-SECTION
- PROPOSED DEVELOPMENT AREA
- APPROXIMATE LOCATION OF 1994 SLIDE
- PARCEL
- CONTOUR 10 FT
- CONTOUR 2 FT

N

0 50

FEET

DATA SOURCES / REFERENCES:
WADNR WGS: WA LIDAR PORTAL
PIERCE CO. 2020, USGS 3DEP, GRID CELL SIZE 1', FLOWN 4/20
CONTOURS AND SLOPE FROM LIDAR
PIERCE CO: CITIES, 2/21, STREETS, PARCELS 7/22

LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE

BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION. LOCATION AND DISTANCES SHOWN ARE APPROXIMATE.

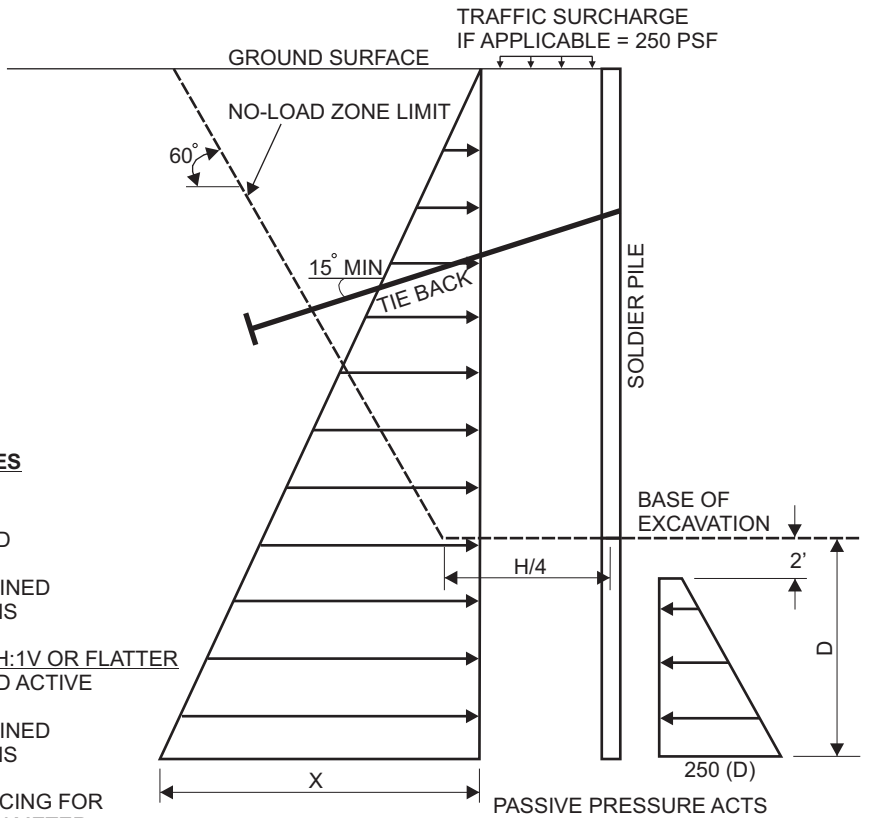
associated earth sciences incorporated

LIDAR BASED TOPOGRAPHY

TAYLOR BAY SEWAGE TREATMENT PLANT
PIERCE COUNTY, WASHINGTON

PROJECT NO.	DATE	FIGURE
20200440E001	5/24	3

G:\GIS_Projects\aaa\2020\20200440 Taylor Bay Sewage Treatment Plant_aprx\20200440E001 F3 Lidar_TaylorBay.aprx | 20200440E001 F3 Lidar_TaylorBay | 2024-05-15 | mtrop



SINGLE LEVEL TIEBACKS/BRACES OR CANTILEVER

FOR LEVEL BACKSLOPE
X = 35 H PSF FOR UNRESTRAINED CONDITIONS
X = 50 H PSF FOR FULLY RESTRAINED AT-REST CONDITIONS

FOR INCLINED BACKSLOPE OF 2H:1V OR FLATTER
X = 55 H PSF FOR UNRESTRAINED ACTIVE CONDITIONS
X = 75 H PSF FOR FULLY RESTRAINED AT-REST CONDITIONS

PRESSURES ACT OVER PILE SPACING FOR LAGGED PORTION, AND 1 PILE DIAMETER BELOW LAGGING.

NOTES:

1. SOLDIER PILE EMBEDMENT DEPTH "D" SHOULD CONSIDER NECESSARY VERTICAL CAPACITY, KICKOUT, AND OVERTURNING RESISTANCE.

2. ALL TIEBACK ANCHORS - IF USED - SHALL BE PRESTRESSED TO 130 PERCENT OF DESIGN LOAD AND LOCKED OFF AT 100 PERCENT OF DESIGN LOAD. AT LEAST TWO ANCHORS ON EACH SIDE OF THE EXCAVATION SHALL BE PRESTRESSED TO 200 PERCENT AND MONITORED FOR CREEP. TIE-BACK ANCHOR ZONE IS TO BE LOCATED BEHIND THE NO-LOAD ZONE.

3. PASSIVE PRESSURES INCLUDE A FACTOR OF SAFETY OF 1.5.

4. DIAGRAM DOES NOT INCLUDE HYDROSTATIC PRESSURES OR SLOPE SURCHARGES AND ASSUMES WALLS ARE SUITABLY DRAINED TO PREVENT BUILDUP OF HYDROSTATIC PRESSURE WITH NO SLOPE AT TOP OF WALL.

5. DIAGRAM IS ILLUSTRATIVE AND NOT REFERENCED TO A PARTICULAR LOCATION.

6. DIAGRAM DOES NOT INCLUDE PRESSURES DUE TO SURFACE SURCHARGES FROM ANY ADJACENT STRUCTURES. THESE PRESSURES MUST BE PROVIDED BY THE STRUCTURAL ENGINEER.

7. ALLOWABLE SKIN FRICTION OF SOLDIER PILE - 0.75 KSF OVER DEPTH "D". ALLOWABLE END BEARING = 15 KSF.

8. PRESUMPTIVE ALLOWABLE TIEBACK - SOIL ADHESION = 2.0 KSF TO BE CONFIRMED BY 200 PERCENT VERIFICATION TEST. POST INSTALLATION PRESSURE GROUTING MAY BE REQUIRED.

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SOLDIER PILE SHORING WALL DESIGN CRITERIA

TAYLOR BAY SEWAGE TREATMENT PLANT
PIERCE COUNTY, WASHINGTON

PROJ NO.	DATE:	FIGURE:
20200440E001	05/24	4

170366 Murray Residence \ 170366 F1 Soldier.cdr

APPENDIX A

Exploration Logs

Coarse-Grained Soils - More than 50%[1] Retained on No. 200 Sieve	Gravels - More than 50%[1] of Coarse Fraction Retained on No. 4 Sieve	≤5% Fines[2]	GW	Well-graded gravel and gravel with sand, little to no fines
			GP	Poorly-graded gravel and gravel with sand, little to no fines
		≥12% Fines[2]	GM	Silty gravel and silty gravel with sand
			GC	Clayey gravel and clayey gravel with sand
	Sands - 50%[1] or More of Coarse Fraction Passes No. 4 Sieve	≤5% Fines[2]	SW	Well-graded sand and sand with gravel, little to no fines
			SP	Poorly-graded sand and sand with gravel, little to no fines
		≥12% Fines[2]	SM	Silty sand and silty sand with gravel
			SC	Clayey sand and clayey sand with gravel
Fine-Grained Soils - 50%[1] or More Passes No. 200 Sieve	Silts and Clays Liquid Limit Less than 50		ML	Silt, sandy silt, gravelly silt, silt with sand or gravel
			CL	Clay of low to medium plasticity; silty, sandy, or gravelly clay, lean clay
			OL	Organic clay or silt of low plasticity
	Silts and Clays Liquid Limit 50 or More		MH	Elastic silt, clayey silt, silt with micaceous or diatomaceous fine sand or silt
			CH	Clay of high plasticity, sandy or gravelly clay, fat clay with sand or gravel
			OH	Organic clay or silt of medium to high plasticity
Highly Organic Soils			PT	Peat, muck and other highly organic soils

Terms Describing Relative Density and Consistency

Coarse-Grained Soils	Density	SPT[3] blows/foot
	Very Loose	0 to 4
	Loose	4 to 10
	Medium Dense	10 to 30
	Dense	30 to 50
	Very Dense	>50

Fine-Grained Soils	Consistency	SPT[3] blows/foot
	Very Soft	0 to 2
	Soft	2 to 4
	Medium Stiff	4 to 8
	Stiff	8 to 15
	Very Stiff	15 to 30
	Hard	>30

Test Symbols

G = Grain Size
M = Moisture Content
A = Atterberg Limits
C = Chemical
DD = Dry Density
K = Permeability

Component Definitions

Descriptive Term	Size Range and Sieve Number
Boulders	Larger than 12"
Cobbles	3" to 12"
Gravel	3" to No. 4 (4.75 mm)
Coarse Gravel	3" to 3/4"
Fine Gravel	3/4" to No. 4 (4.75 mm)
Sand	No. 4 (4.75 mm) to No. 200 (0.075 mm)
Coarse Sand	No. 4 (4.75 mm) to No. 10 (2.00 mm)
Medium Sand	No. 10 (2.00 mm) to No. 40 (0.425 mm)
Fine Sand	No. 40 (0.425 mm) to No. 200 (0.075 mm)
Silt and Clay	Smaller than No. 200 (0.075 mm)

[4] Estimated Percentage

Component	Percentage by Weight
Trace	<5
Some	5 to <12
Modifier (silty, sandy, gravelly)	12 to <30
Very *modifier* (silty, sandy, gravelly)	30 to <50

Moisture Content

Dry - Absence of moisture, dusty, dry to the touch
Slightly Moist - Perceptible moisture
Moist - Damp but no visible water
Very Moist - Water visible but not free draining
Wet - Visible free water, usually from below water table

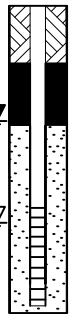
Symbols

Sampler Type and Description

- Blows/6" or portion of 6"
- Split-Spoon Sampler (SPT)
- California Sampler
- Ring Sampler
- Continuous Sampling
- Grab Sample
- Portion not recovered

Groundwater depth

- ATD At time of drilling
- Static water level (date)



- Cement grout surface seal
- Bentonite seal
- Filter pack with blank casing section
- Screened casing or Hydrotip with filter pack
- End cap

Classifications of soils in this report are based on visual field and/or laboratory observations, which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field or laboratory testing unless presented herein. Visual-manual and/or laboratory classification methods of ASTM D-2487 and D-2488 were used as an identification guide for the Unified Soil Classification System.

(1) Percentage by dry weight
(2) Combined USCS symbols used for fines between 5% and 12%
(3) (SPT) Standard Penetration Test (ASTM D-1586)
(4) In General Accordance with Standard Practice for Description and Identification of Soils (ASTM D-2488)

associated earth sciences incorporated

EXPLORATION LOG KEY

FIGURE: A1

Blocks\ dwg \ log_key 2022.dwg LAYOUT: Layout 5 - 2022 Logdraft

associated earth sciences incorporated

Exploration Boring — EB-1

Taylor Bay Sewage Treatment Plant — Sheet: 1 of 1

Pierce County, WA	Start Date: 4/12/23	Logged By: ART
20200440E001	Ending Date: 4/12/23	Approved By: JHS

Driller/Equipment: Geologic / Mini Track
Hammer Weight/Drop: 140#/30"
Hole Diameter (in): 4.25
Groundwater Depth ATD (ft): 12

Total Depth (ft): 21.5
Ground Surface Elevation (ft): ≈80
Datum: NAVD88
Groundwater Depth Post Drilling (ft) (Date): ()

Depth (ft)	Sample Type	Sample	% Recovery	Graphic Symbol	Description	Water Level	Blows/6"	Blows/Foot (10 20 30 40 50+)	Other Tests
0					**Fill**				
		1			Moist, brown to dark brown with iron oxide mottling, silty, fine SAND, some gravel; organics; unsorted (SM).		2 3 2	5	
5		2			No recovery.		2 4 8	12	
					Mass Wasting				
		3			Moist, brownish gray, fine SAND, some silt; unsorted; poor recovery, less than 1 inch (SP-SM).		10 15 17	32	
10		4			Wet, gray to brownish gray, fine SAND, trace silt, trace gravel; massive (SP).	▼	9 13 18	31	
15		5			Moist, gray to dark, gray, non-cohesive sandy, SILT; massive; disturbed texture (ML).		11 14 17	31	
					Pre-Fraser Nonglacial Deposits				
20		6			Moist, light gray, silty, fine SAND to SILT, some fine sand; organic inclusions; stratified (SM-ML).		30 40 50/3"	50/3"	
					Perched groundwater at 12 feet ATD.				
25									
30									
35									

6/5/2023

20200440E001

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Exploration Boring — EB-2

Taylor Bay Sewage Treatment Plant — Sheet: 1 of 1

Pierce County, WA	Start Date: 4/12/23	Logged By: ART
20200440E001	Ending Date: 4/12/23	Approved By: JHS

Driller/Equipment: Geologic / Mini Track
Hammer Weight/Drop: 140#/30"
Hole Diameter (in): 4.25
Groundwater Depth ATD (ft): 2 20

Total Depth (ft): 26.5
Ground Surface Elevation (ft): ≈73
Datum: NAVD88
Groundwater Depth Post Drilling (ft) (Date): ()

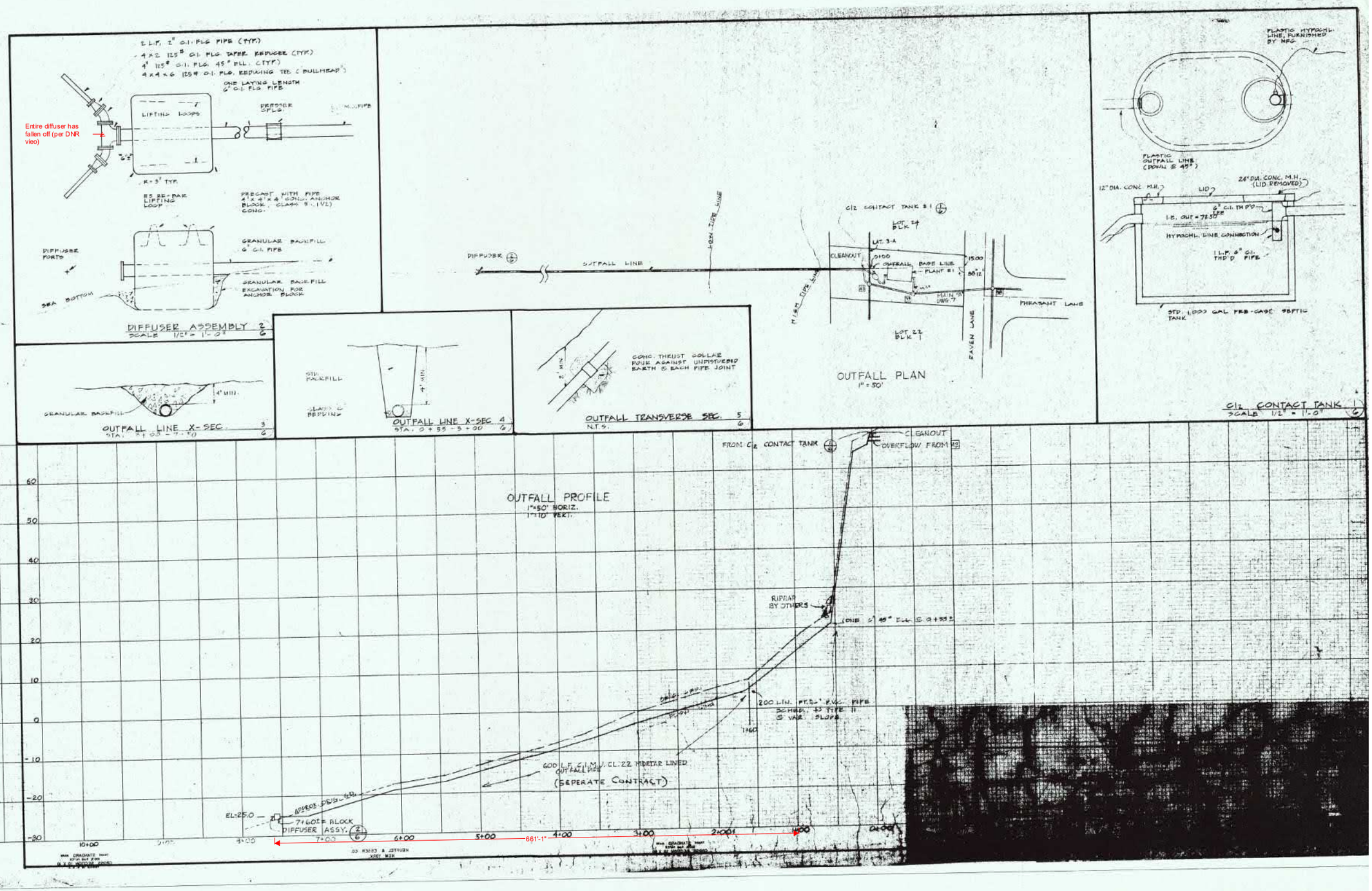
Depth (ft)	Sample Type	Sample	% Recovery	Graphic Symbol	Description	Water Level	Blows/6"	Blows/Foot (10 20 30 40 50+)	Other Tests
0		1			**Fill** Wet, brownish gray, fine SAND, some silt, some gravel; unsorted (SP-SM).	▼	3 7 7	14	
					Pre-Fraser Nonglacial Deposits				
5		2			Moist, brownish gray to light gray with iron oxide mottling, SILT to fine sandy, SILT; massive (ML).		7 20 31	51	
10		3			Moist, purple gray, SILT; massive; organics; interbeds of peat; organics odor (ML).		10 17 23	40	
15		4			Moist, brownish dark gray, silty, fine SAND; massive (SM).		14 20 25	45	
20		5			Wet, dark gray, fine SAND, trace silt, trace coarse sand; red sand grains (SP).	▼	21 50/6"	50/6"	
					Pre-Fraser Till				
25		6			Moist, brownish gray, SILT, some gravel; unsorted (ML). Driller calls refusal at 25 feet due to hard drilling conditions.		13 42 50/5"	50/5"	
					Perched groundwater at 2 feet and 20 feet ATD.				
30									
35									

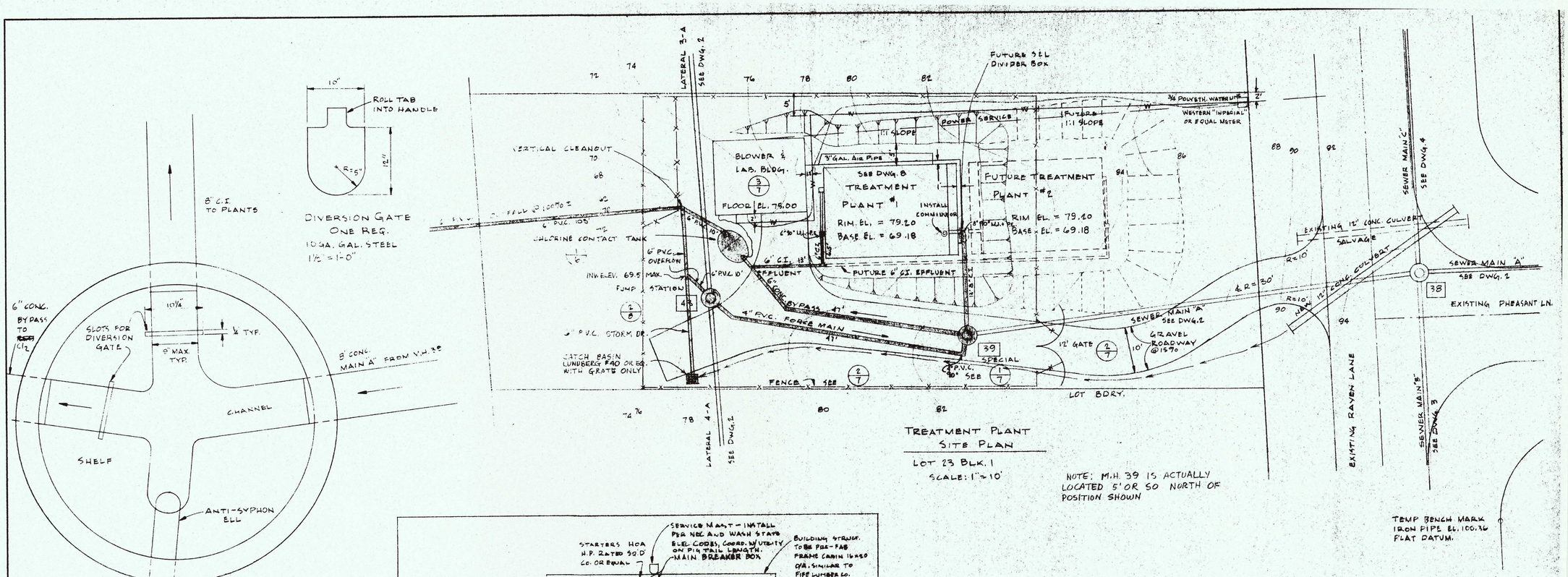
6/5/2023

20200440E001

APPENDIX B

Civil Plans
Existing Facility


2 L.F. 2" G.I. PLG PIPE (TYP.)
4 x 2 125# G.I. PLG. TAPER REDUCER (TYP.)
4" 125# G.I. PLG. 45° ELL. (TYP.)
4 x 4 x 6 125# G.I. PLG. REDUCING TEE (BULLHEAD)
ONE LAYING LENGTH 6" G.I. PLG. PIPE
LIFTING LOOPS
DIFFUSER OPTS.
Entire diffuser has fallen off (per DNR vieo)
R = 3' TYP.
#5 RE-BAR LIFTING LOOP
PRECAST WITH PIPE 4'-0" x 4'-0" x 8" CONC. ANCHOR BLOCK, CLASS B, (1 YD.) CONC.
GRANULAR BACKFILL
6" G.I. PIPE
DIFFUSER PORTS
SEA BOTTOM
GRANULAR BACK FILL EXCAVATION FOR ANCHOR BLOCK
DIFFUSER ASSEMBLY 2/6
SCALE 1/2" = 1'-0"
GRANULAR BACKFILL
4' MIN.
OUTFALL LINE X-SEC. 3/6
STA. 3+03 - 7+70
STD. BACKFILL
CLASS C BEDDING
4' MIN.
OUTFALL LINE X-SEC 4/6
STA. 0+55 - 3+00
CONC. THRUST COLLAR POUR AGAINST UNDISTURBED EARTH @ EACH PIPE JOINT
OUTFALL TRANSVERSE SEC. 5/6
N.T.S.
DIFFUSER
OUTFALL LINE
100' SAFE LINE
MISM. SAFE LINE
Cl2 CONTACT TANK # 1
LOT 24 BLK 24
LOT 3-A
CLEANOUT
OUTFALL BASE LINE - PLANT #1
MAIN "A" DWG. 7
LOT 22 BLK 1
PHEASANT LANE
RAVEN LANE
OUTFALL PLAN
1" = 50'
PLASTIC HYPOCHL. LINE, FURNISHED BY MFG.
PLASTIC OUTFALL LINE (DOWN @ 45°)
12" DIA. CONC. M.H.
LID
24" DIA. CONC. M.H. (LID REMOVED)
6" G.I. TH'D PIPE
I.E. OUT = 78.35
HYPOCHL. LINE CONNECTION
1 L.F. 6" G.I. THD'D PIPE
STD. 1,000 GAL PRE-CAST SEPTIC TANK
Cl2 CONTACT TANK 1/6
SCALE 1/2" = 1'-0"
OUTFALL PROFILE
1"=50' HORIZ.
1"=10' VERT.
FROM Cl2 CONTACT TANK
CLEANOUT
OVERFLOW FROM
RIPRAP BY OTHERS
(ONE) 6" 45° ELL @ 9+33.2
200 LIN. FT. 6" P.V.C. PIPE SCHED. 40 TYPE II @ VAR. SLOPE
1460
600 L.F. C.I.M.V. CL. 22 MORTAR LINED OUTFALL PIPE (SEPERATE CONTRACT)
APPROX. GRADE
EL-25.0
7+60 ± BLOCK DIFFUSER ASSY. 2/6
661'-1"
60
50
40
30
20
10
0
-10
-20
-30
10+00
9+00
8+00
7+00
6+00
5+00
4+00
3+00
2+00
1+00
0+00



PANEL P1 NEO MAIN BREAKER 30 POLES 225 AMPS.

LOAD	CIRCUIT DIRECTORY	CIR NO	CIR BKR	PHASE	CIR BKR	CIR NO	CIRCUIT DIRECTORY	LOAD
3910	BLOWER #2	1	30A		30A	2	BLOWER #1	3910
345	RECEPT.	3	20A		15A	4	COMMINUTOR	
2750	MOTOR #1	5	20A		20A	6	MOTOR #2	2750
50	HYPOCHLOR	7	15A		15A	8	LIGHTS	300W
1350	HEATER	9	30A		SPACE	10	FUTURE BLOWER	3910
3910	FUTURE BLOWER	11	SPACE		SPACE	12	FUTURE MOTOR	2750
3910	FUTURE BLOWER	13	SPACE		SPACE	14	FUTURE MOTOR	2750
16195								16350

TOTAL VA 32,565 ÷ CURRENT 141.58

NOTES:

ALL WORK TO BE PERFORMED IN COMPLIANCE WITH BOTH A.P.W.A. AND TREATMENT PLANT MFGR'S SPECIFICATION & PLANS, AND IN ACCORDANCE WITH BUILDING, ZONING, ELEC., PLUMBING, AND OTHER APPLICABLE CODES.

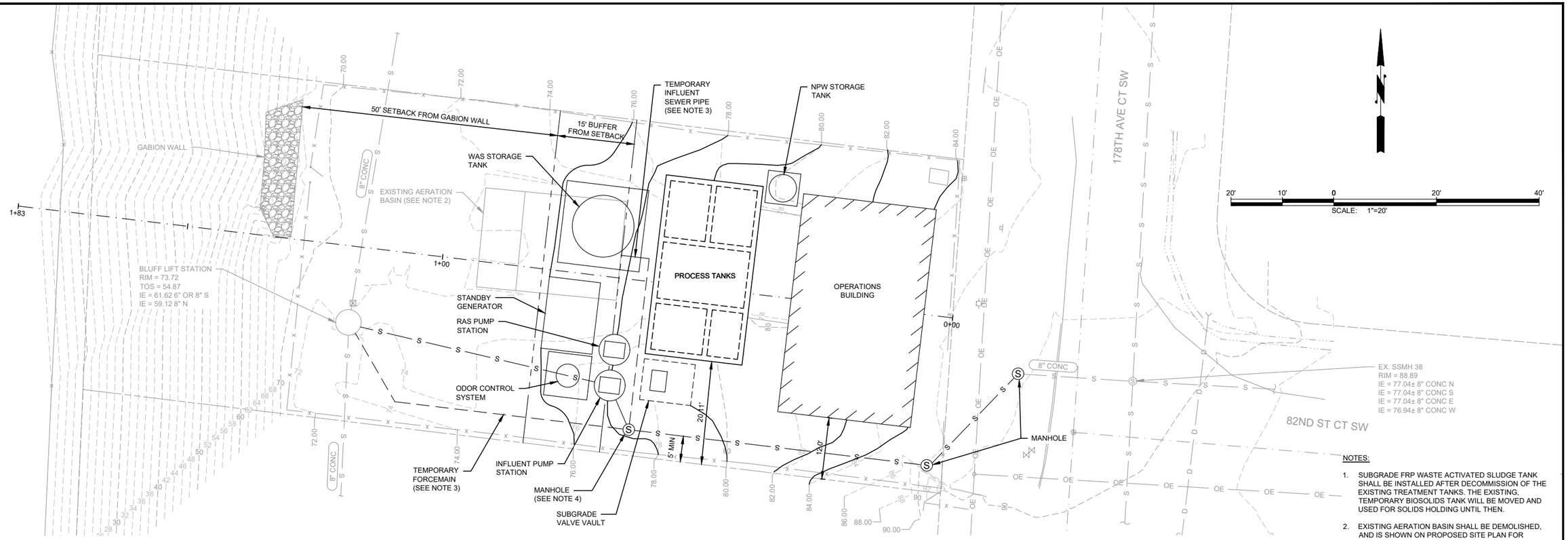
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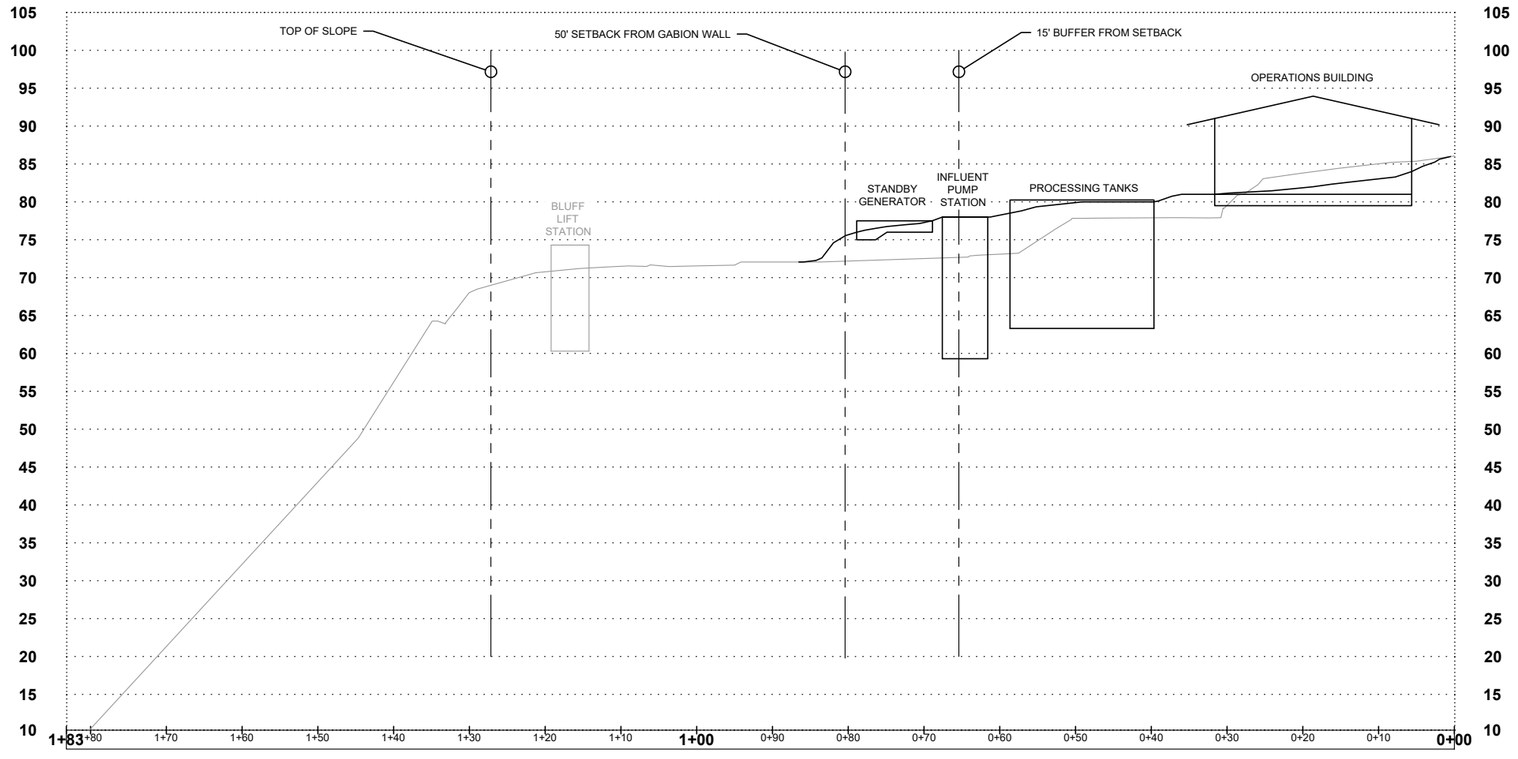
- SEWER PIPE & MANHOLE (39)
- TOP OF SLOPE / TOE OF SLOPE
- PROPERTY LINE
- MON. LINE
- CONTURE LINE
- CONDUIT UNDER OR IN SLAB.

AS-BUILT 12-23-70

POE'S TAYLOR BAY ESTATES
SEWAGE TREATMENT PLANT
SITE PLAN, LOT 23, BLK 1, & DETAILS

7





20' 10' 0 20' 40'
SCALE: HORIZONTAL 1"=20'
VERTICAL 1"=20'

0 1"
ONE INCH AT FULL SCALE. IF NOT, SCALE ACCORDINGLY

NOTES:

1. SUBGRADE FRP WASTE ACTIVATED SLUDGE TANK SHALL BE INSTALLED AFTER DECOMMISSION OF THE EXISTING TREATMENT TANKS. THE EXISTING, TEMPORARY BIOSOLIDS TANK WILL BE MOVED AND USED FOR SOLIDS HOLDING UNTIL THEN.
2. EXISTING AERATION BASIN SHALL BE DEMOLISHED, AND IS SHOWN ON PROPOSED SITE PLAN FOR LOCATION REFERENCE ONLY.
3. TEMPORARY BYPASS PIPING SHALL BE INSTALLED DURING CONSTRUCTION TO CONTINUE OPERATION OF THE EXISTING TREATMENT SYSTEM.
4. EXISTING INFLUENT FLOW METER AND SAMPLER SHALL BE RELOCATED TO MANHOLE DURING CONSTRUCTION.

TAYLOR BAY BEACH CLUB HOA

WWTF PRELIMINARY ENGINEERING REPORT

FIGURE 5-1

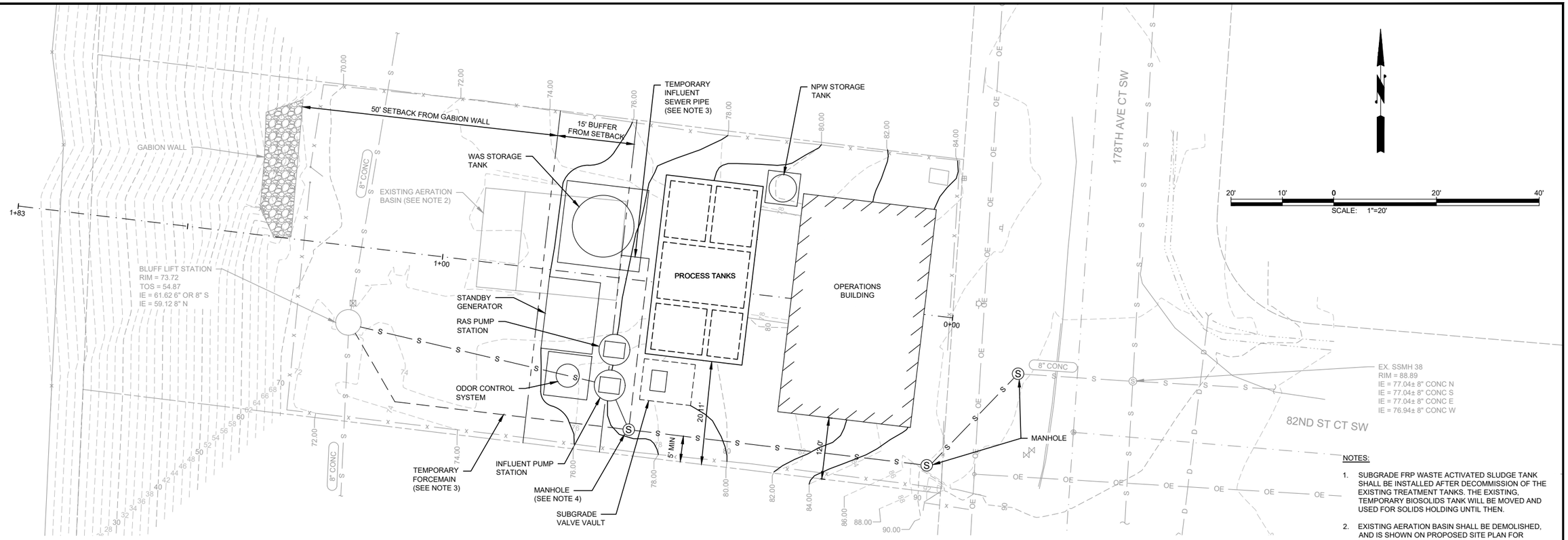
PROPOSED SITE PLAN

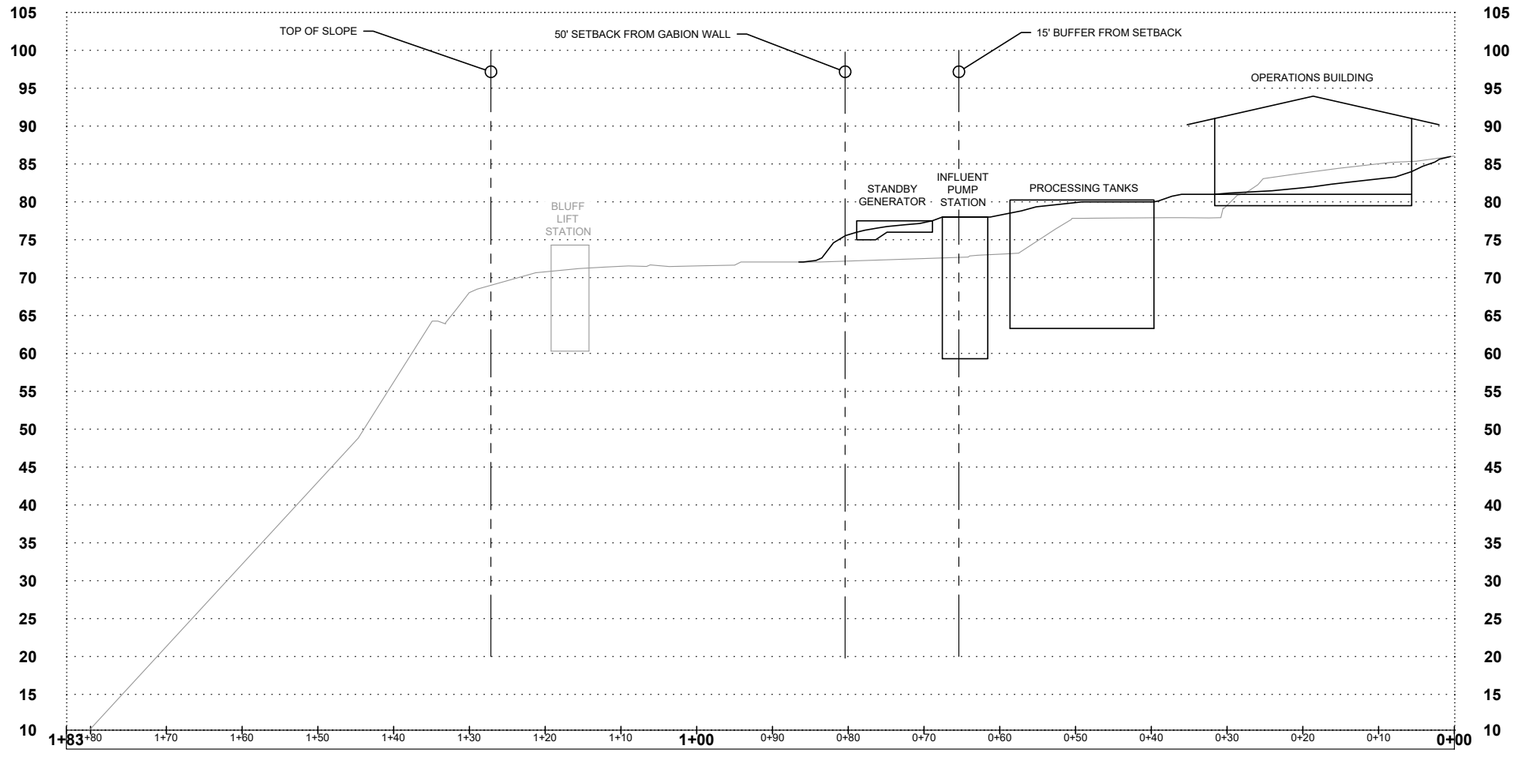
Gray & Osborne, Inc.
CONSULTING ENGINEERS

M:\Taylor Bay Beach Club HOA\22848 - Eng Report, Permitting, CIPP Plans\Planset\General\G-PSITE.dwg, 4/16/2024 3:10 PM, JACK MILFORD

APPENDIX C

Civil Plans
Proposed Facility







NOTES:

1. SUBGRADE FRP WASTE ACTIVATED SLUDGE TANK SHALL BE INSTALLED AFTER DECOMMISSION OF THE EXISTING TREATMENT TANKS. THE EXISTING, TEMPORARY BIOSOLIDS TANK WILL BE MOVED AND USED FOR SOLIDS HOLDING UNTIL THEN.
2. EXISTING AERATION BASIN SHALL BE DEMOLISHED, AND IS SHOWN ON PROPOSED SITE PLAN FOR LOCATION REFERENCE ONLY.
3. TEMPORARY BYPASS PIPING SHALL BE INSTALLED DURING CONSTRUCTION TO CONTINUE OPERATION OF THE EXISTING TREATMENT SYSTEM.
4. EXISTING INFLUENT FLOW METER AND SAMPLER SHALL BE RELOCATED TO MANHOLE DURING CONSTRUCTION.

0 1"

ONE INCH AT FULL SCALE. IF NOT, SCALE ACCORDINGLY

TAYLOR BAY BEACH CLUB HOA

WWTF PRELIMINARY ENGINEERING REPORT

FIGURE 5-1

PROPOSED SITE PLAN

Gray & Osborne, Inc.
CONSULTING ENGINEERS

M:\Taylor Bay Beach Club HOA\22848 - Eng Report, Permitting, CIPP Plans\Planset\General\G-PSITE.dwg, 4/16/2024 3:10 PM, JACK MILFORD

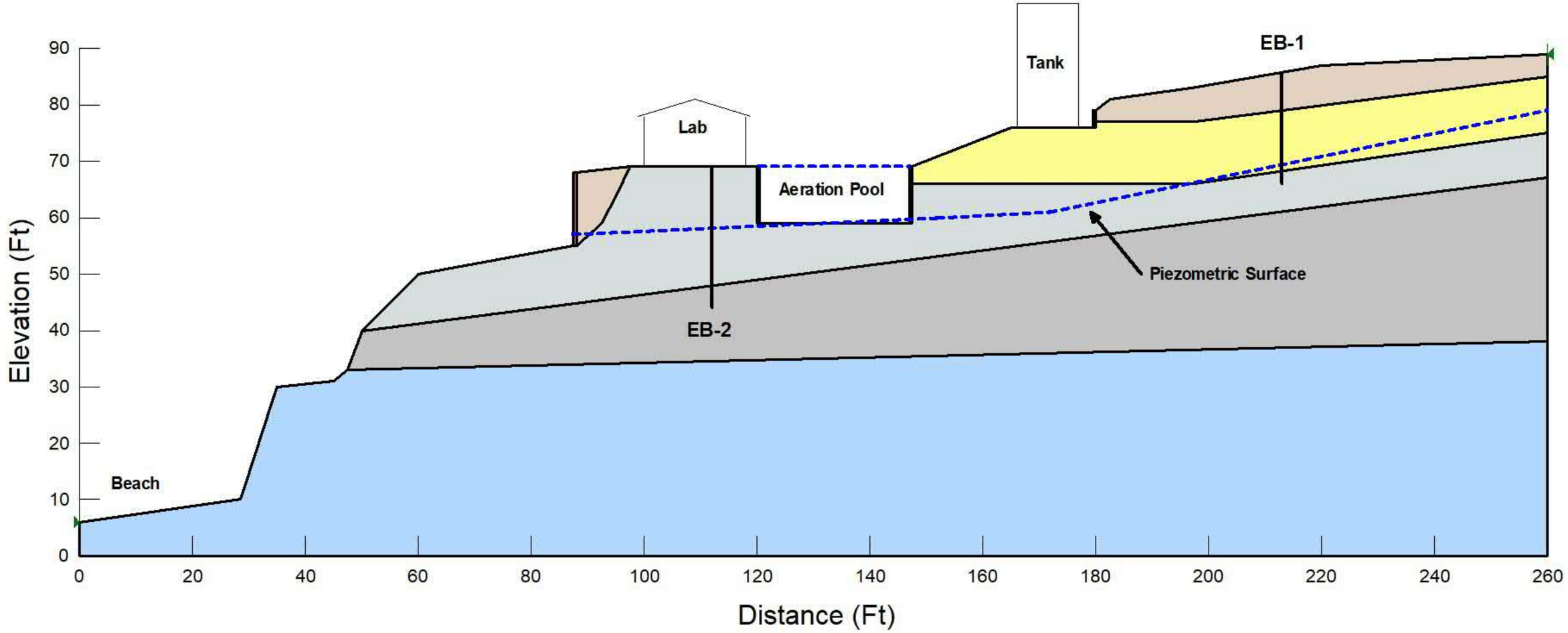
APPENDIX D

Slope Stability Analysis

Taylor Bay Wastewater Treatment Plant
Section A-A'
Existing Site Conditions

Materials

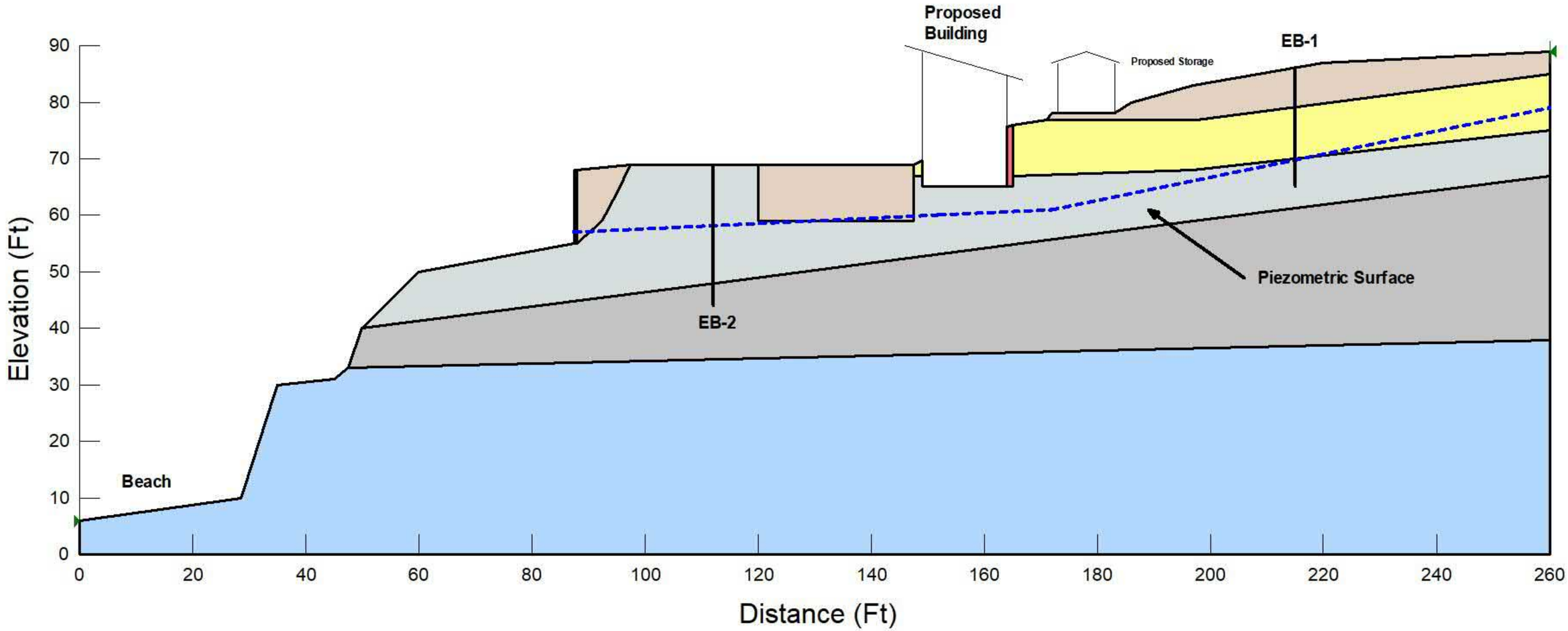
- Fill- 115 pcf, 30 deg, 50 psf
- Mass Wasting- 120 pcf, 29 deg, 300 psf
- Pre-Fraser Gravel- 140 pcf, 40 deg, 300 psf
- Pre-Fraser Non-glacial- 125 pcf, 27 deg, 500 psf
- Pre-Fraser Till- 140 pcf, 40 deg, 300 psf
- Retaining Wall



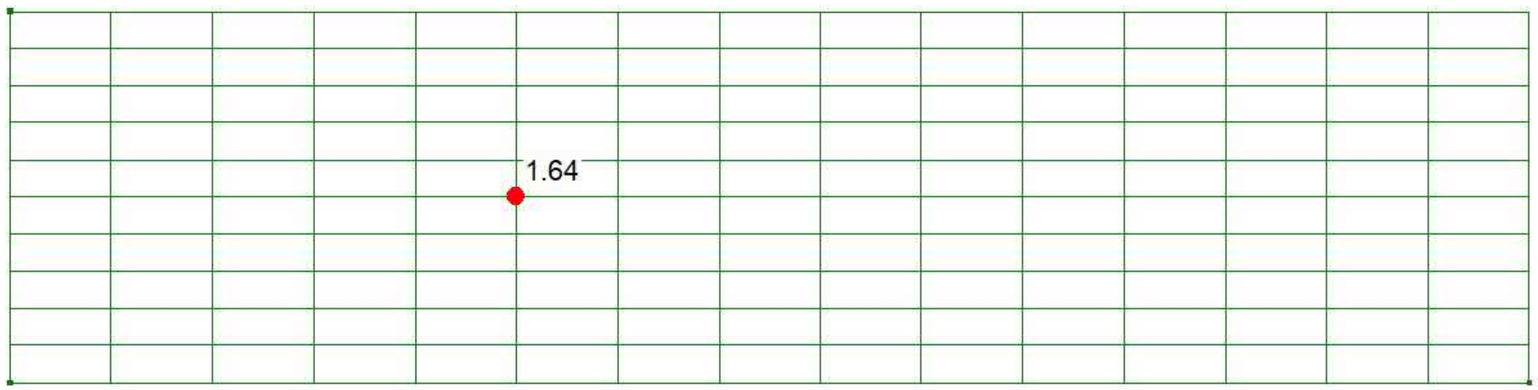
Taylor Bay Wastewater Treatment Plant
Section A-A'
Proposed Site Conditions

Materials

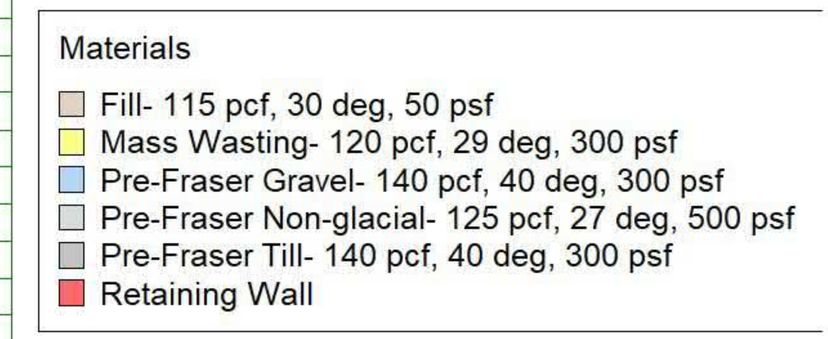
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- Pre-Fraser Gravel- 140 pcf, 40 deg, 300 psf
- Pre-Fraser Non-glacial- 125 pcf, 27 deg, 500 psf
- Pre-Fraser Till- 140 pcf, 40 deg, 300 psf
- Retaining Wall

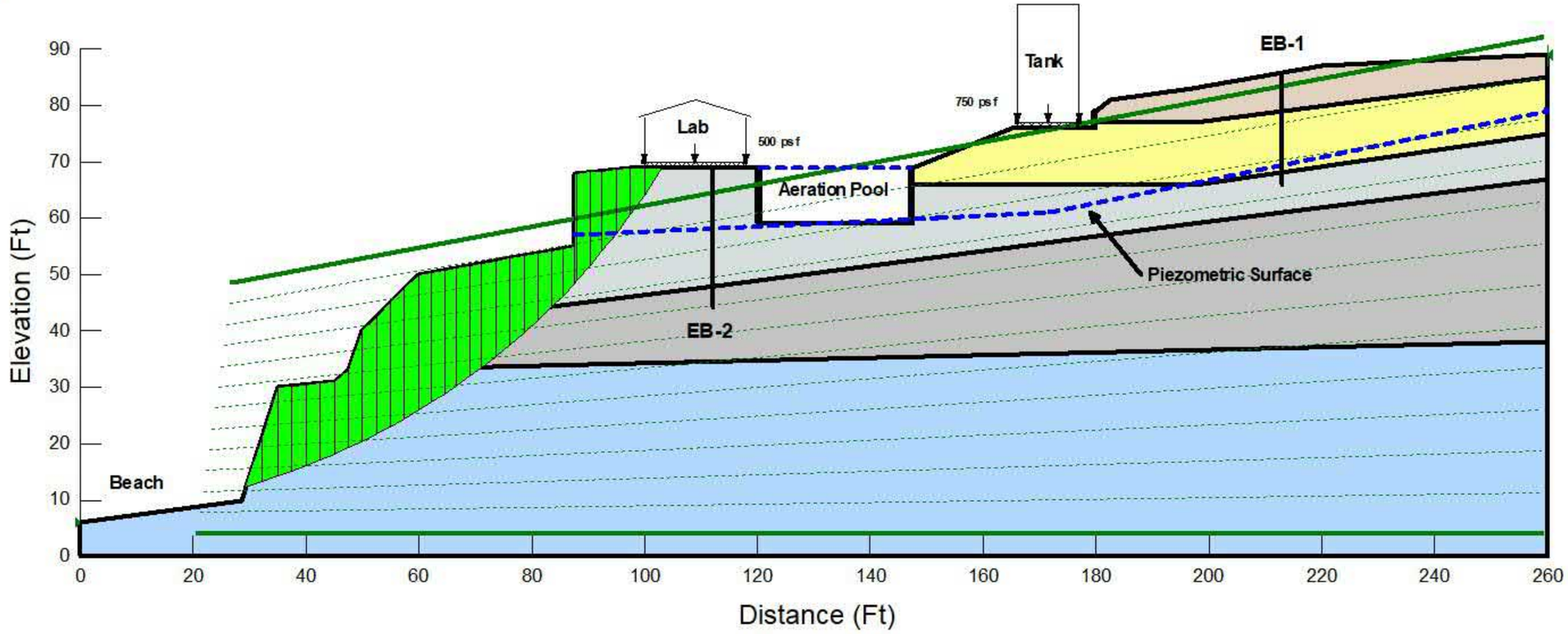


Taylor Bay Wastewater Treatment Plant
Section A-A'
Existing Site Conditions, Static Scenario

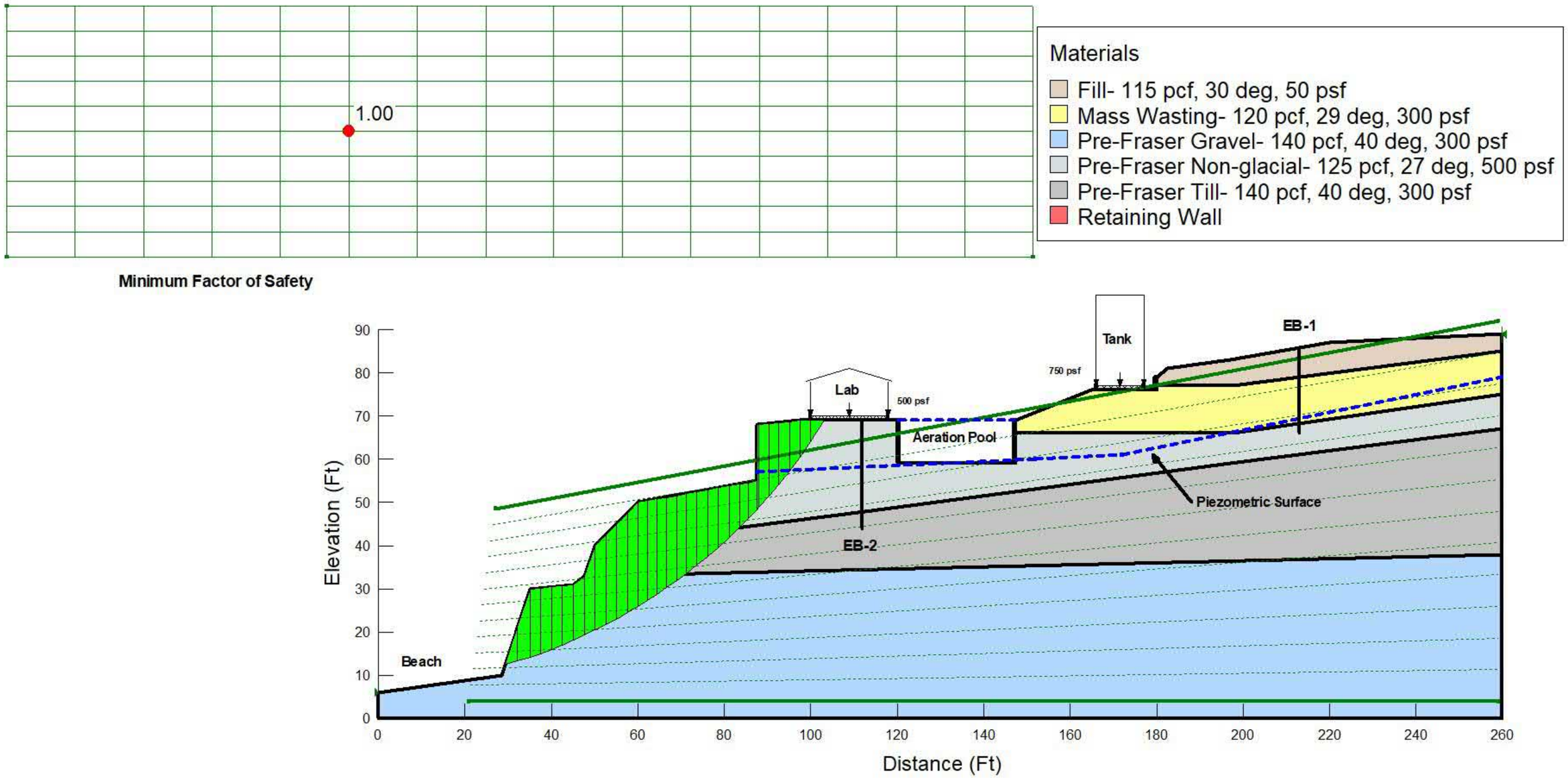


Minimum Factor of Safety

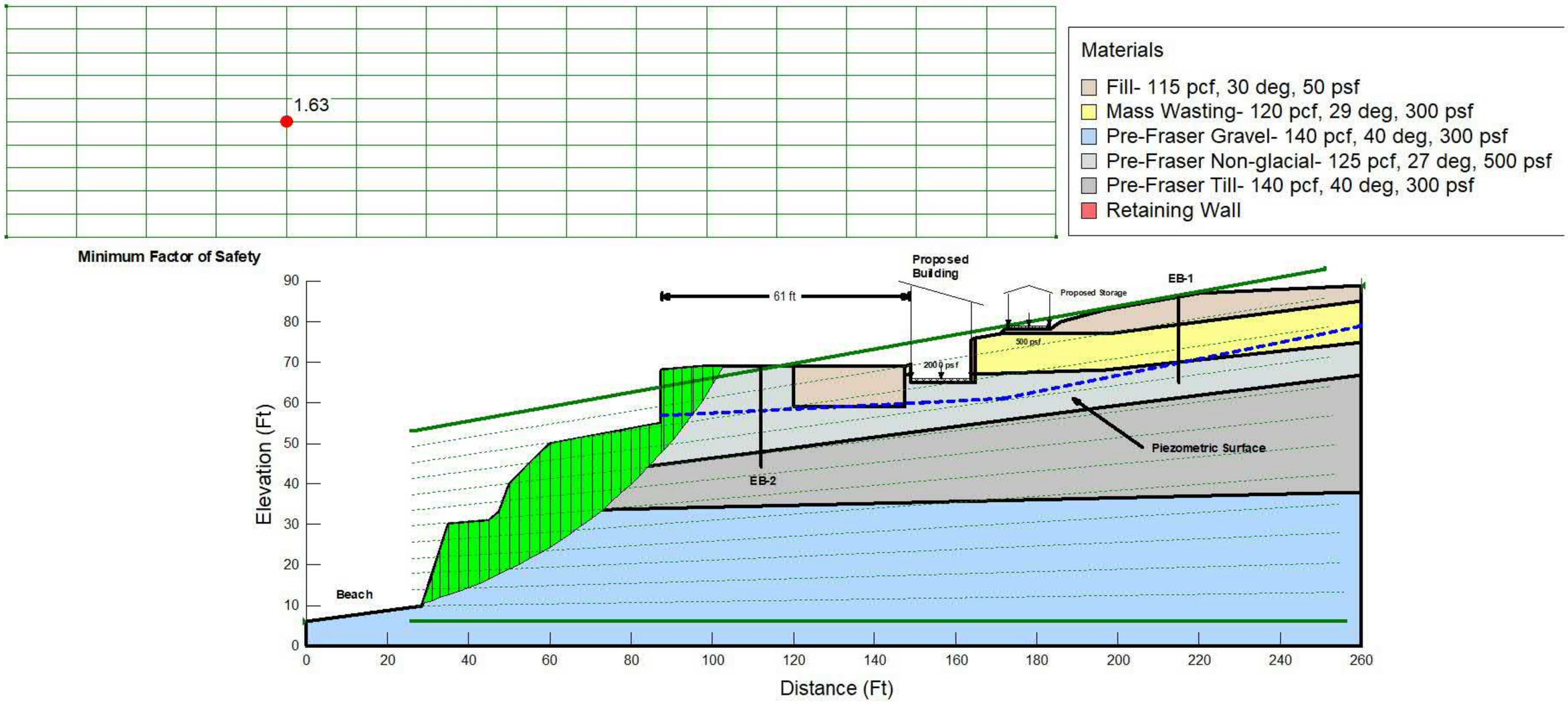




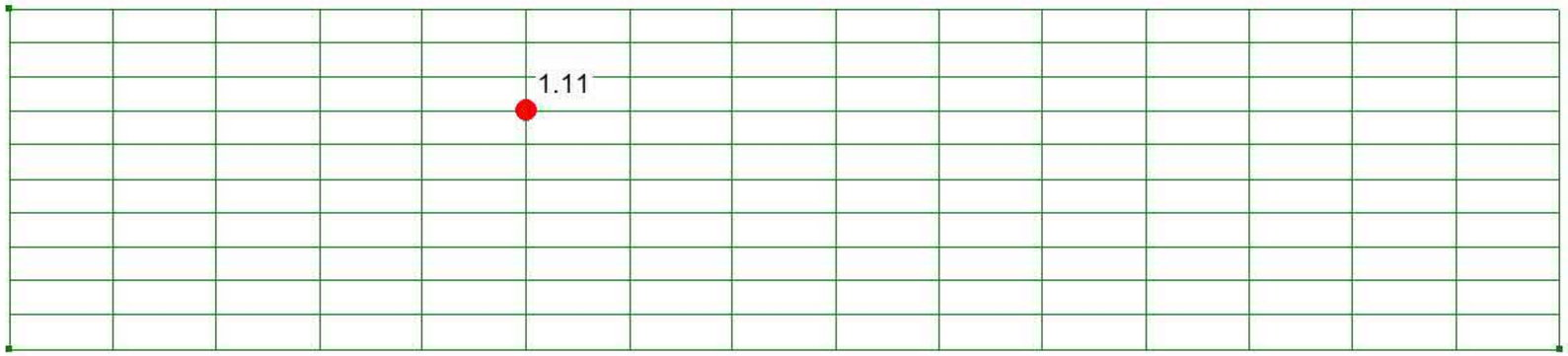
Taylor Bay Wastewater Treatment Plant
Section A-A'
Existing Site Conditions, Seismic Scenario- 0.32g



Taylor Bay Wastewater Treatment Plant
Section A-A'
Proposed Site Conditions, Static Scenario

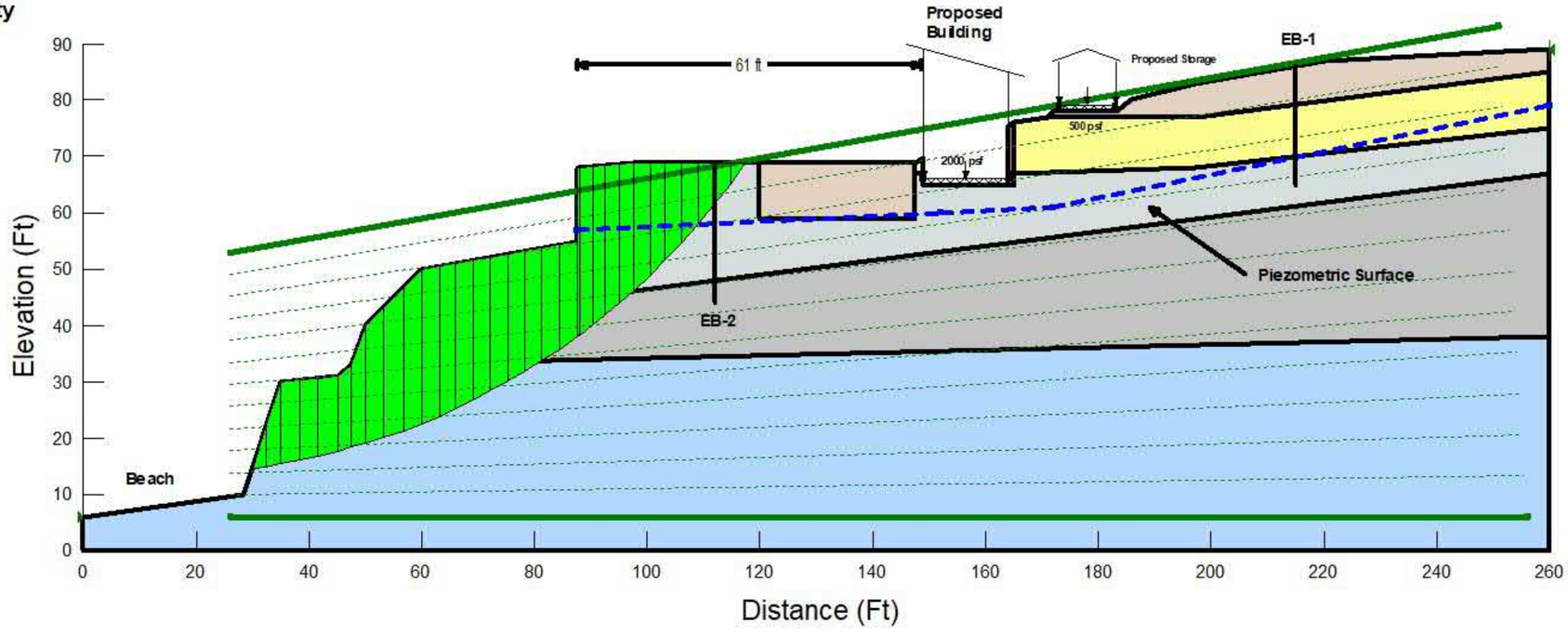


Taylor Bay Wastewater Treatment Plant
Section A-A'
Proposed Site Conditions, Seismic Scenario- 0.32g



Materials
- Fill- 115 pcf, 30 deg, 50 psf
- Mass Wasting- 120 pcf, 29 deg, 300 psf
- Pre-Fraser Gravel- 140 pcf, 40 deg, 300 psf
- Pre-Fraser Non-glacial- 125 pcf, 27 deg, 500 psf
- Pre-Fraser Till- 140 pcf, 40 deg, 300 psf
- Retaining Wall

Minimum Factor of Safety



APPENDIX E

Shoreline Erosion Hazard Report

associated earth sciences incorporated

March 14, 2024
Project No. 20200440E001

Gray and Osborne, Inc.
11 Spokane Street, Suite 211
Wenatchee, Washington 98801

Attention: Mr. Peter Burgoon

Subject: Shoreline Erosion Hazard Geotechnical Report
Taylor Bay Sewage Treatment Plant
8220 178th Avenue Court SW
Longbranch, Washington 98351
Parcel No. 6925000230

Dear Mr. Burgoon:

Associated Earth Sciences, Inc. (AESI) is pleased to present this report containing the results of our site reconnaissance and geotechnical assessment concerning the Shoreline Erosion Hazard at the Taylor Bay Sewage Treatment plant site. This report is in response to the review comments from Pierce County after submittal of the AESI report titled "Subsurface Exploration, Geologic Hazard, and Geotechnical Engineering Report" dated June 22, 2023 for the project.

SITE AND PROJECT DESCRIPTION

The subject site consists of a single parcel of approximately 0.25 acres located at 8220 178th Avenue Court SW in unincorporated Pierce County, Longbranch, Washington (Pierce County Parcel No. 6925000230). The parcel is located at the top of a steep marine bluff approximately 60 feet high. The remainder of the parcel slopes uphill to the east at inclinations less than 15 percent. The depth of the lot from the top of the slope to the east property line is about 135 feet. The site is occupied by a sewage treatment plant reported to have been constructed in the 1970's, based on provided as-built drawings. It is our understanding that a small landslide occurred on the upper portion of the bluff in 1994. Landslide mitigation efforts subsequent to the slide included construction of a gabion wall at the top of the bluff in the slide area.

We understand that current plans include demolition of the existing sewage treatment plant and construction of a new sewage treatment plant. Discharge from the new sewage treatment plant will be directed to an outfall by an effluent pipe down the face of the bluff to a discharge located at the toe of the bluff similar to what currently exists.

Previous Work

In July of 2018, we visited the site to complete a reconnaissance of the slope at the west edge of the subject property. While onsite we spoke with Mr. Steve Stemhagen and Mr. Tom McDowell, both long-term residents of the community. They informed us that a gabion wall was constructed at the top of the bluff to mitigate damage caused by a 1994 landslide. The gabion wall has an

exposed height of approximately 14 feet. It is not known if the gabion wall is an engineered structure, but it appears to currently be in good condition. The top width of the gabion wall is approximately 3 feet. Based on anecdotal information received by Mr. Stemhagen, it is believed that the base of the wall is approximately 8 feet wide. Mr. McDowell indicated that the wall was built by some of the area residents, including himself, shortly after the landslide occurred.

An area of subsidence is located directly behind the gabion wall. A chain link fence located in the area appears to have undergone some distortion as a result of the subsidence. At the time of our 2018 site visit, Mr. Stemhagen indicated that the floor of the Equipment and Lab Building, located approximately 16 feet behind the face of the gabion wall, exhibited some "hairline cracks." Mr. Stemhagen also indicated that the subsidence, fence distortion, and floor cracking were present when he moved to the neighborhood in approximately 2002, and it does not appear to have worsened since that time.

Explorations for a geotechnical report were conducted in April of 2023 and included advancing two exploration borings. The borings were located at the east and west sides of the lot in order to generate a cross-section through the lot and the slope to the west for a slope stability analysis. The report, dated June 2023, addressed landslide hazards and mitigation associated with the steep slope at the west end of the site as required by the Pierce County Geological Hazard Code. The geotechnical report included a slope stability analysis, recommended top of slope setback, and foundation recommendations for the new development.

On March 8, 2024 we returned to the site to observe the current conditions. The slope had not changed from our previous site visits. The following is a summary of our observations:

- The slope is heavily vegetated with small deciduous trees, ivy, and small shrubs.
- Slight distortion of a chain link fence was observed near the top of the slope in the area of the 1994 slide, similar to the previous visit.
- The older on-site buildings associated with the sewage plant (upslope of the bluff) appeared to be in good condition with no evidence of settlement, movement, or deformation observed.
- Soil exposures on the bluff below the treatment plant were obscured due to heavy vegetation, although exposures to the north and south revealed silty gravel deposits interpreted to be representative of pre-Fraser gravels.
- No new exposures or failures of the slope were observed since our last visit in April 2023.

PURPOSE AND SCOPE

According to *Pierce County Code* (PCC) 18E.110.030 the site requires a Shoreline Erosion Hazard Geotechnical Report since the shoreline hazard is within 200 feet of the site. The report shall therefore follow the guidelines presented in PCC 18E.110.060 Appendix C. Our study included a review of available site plans and drainage information provided by the Client, review of published geologic maps and aerial photographs of the site and vicinity, and conducting an

additional site reconnaissance to observe existing site conditions and drainage patterns/ features on the slope. The results of our study are discussed below.

EXISTING DATA REVIEW

LIDAR Imaging

Light Detection and Ranging (LIDAR) is a remote sensing technology that can be used to generate a detailed expression of ground surface topography even in densely vegetated areas. For this reason, LIDAR-based topographic imagery can be helpful in distinguishing surface features (such as old landslide features) that may otherwise not be easily recognizable. No specific evidence of historical large-scale landslide activity was evident in the LiDAR-based shaded relief map other than the typical bluff erosion features.

Geologic Mapping

Review of the geologic map, *Geologic Map of the Longbranch 7.5-minute Quadrangle, Thurston, Pierce, and Mason Counties, Washington*, by R.L. Logan, T.J. Walsh, and Michael Polenz, Washington Division of Geology and Earth Resources, Open File Report 2003-21, 2003 indicates shallow depth by Holocene landslide deposits along the toe of the bluff. The bluff mapping describes pre-Fraser sandy deposits overlying coarser-grained pre-Fraser-aged gravels. Our findings were generally consistent with the mapped geology of the local and regional area. The findings of subsurface conditions are described in more detail within our June 2023 geotechnical report.

Coastal Zone Atlas

The coastal zone atlas was reviewed on the interactive Washington State Department of Ecology mapping website. The bluff adjacent to the site is mapped as “Unstable” (Figure 1). As noted previously from the reconnaissance and the LIDAR review, there is no evidence of the large-scale instability as mapped on the coastal zone atlas. The interactive site also has aerial photographs of the area from 1977 to 2022. The slope below the treatment plant site shows little change during this period with the exception of the photograph in 2018 (Figure 2). In 2018 it appears there was some clearing on the bluff for view enhancement. This clearing was in progress at the time of our 2018 site visit. The clearing is similar in location and shape to the area marked as “Unstable” on the coastal zone atlas map. It is our opinion that the mapped area of unstable slope is likely the result of vegetation clearing and not a large-scale slope failure as shown on the map.

Figure 1 - Coastal Zone Atlas



Yellow = Intermediate Slope

Light brown = Unstable

Dark Brown = Unstable (Recent Slide)

Figure 2 - Coastal Zone Atlas 2018 Aerial Photo

2018



Bluff Recession Rates

As part of our analysis, we reviewed a report by Coastal Geologic Services, titled *Long Term Bluff Recession Rates in Puget Sound: Implications for the Prioritization and Design of Restoration Projects*, dated March 19, 2018, Andrea MacLennan et al. In summary the report analyzes bluff recession rates using a data set that includes 185 bluff recession rates from sites throughout the region. The rates were measured using aerial photo and field-based methods. The data is further categorized according to the geology and orientation relative to the prevailing winds. It is noted in the report that the prevailing winds typically come from the south, and it is hypothesized that bluffs exposed to the south generally incur more erosion during change events than those exposed to the north or other aspects. The treatment plant slope is a west-facing bluff.

The report contained two sites in close proximity to the treatment plant with similar bluff aspects and geology. Figure 3 below indicates the two sites labeled Bluff Site 31 and Bluff Site 175 that were found near the Taylor Bay treatment plant site.

Figure 3 - Regression Sites (Google Earth Image)



Site 31 is located about 0.75 miles northwest of the treatment plant. The site has similar geology, but is oriented with a southern exposure and a much greater fetch. Review of the shoreline photographs indicate that the bluff face is also exposed and lacks vegetation. The reported retreat rate for Site 31 is 0.26 feet per year over a 50-year period. Site 175 is located about 2 miles to the southwest of the treatment plant. This site also has similar geology with north-facing exposure. Review of the shoreline photographs notes that this area is also more exposed with a lack of vegetation. The reported retreat rate for Site 175 is 0.25 feet per year over a 35-year period.

Slope Stability Analysis

In preparation of our original report in response to the landslide hazard area designation, a slope stability analysis was performed using the computer program Slope/W 2016 by GeoSlope International. The slope geometry used for our analysis was based on the topographic profile along through the center of the site. An analysis of the bluff slope was completed for both the existing and proposed layout of the new treatment plant. Loads from new buildings and seismicity were also included. Our analysis also assumed that the gabion wall constructed at the top of the bluff is locally stable (i.e., the wall is not subject to failure). The geology of the slope and groundwater conditions were based on the subsurface conditions encountered in the borings and our reconnaissance of the site. Soil strength parameters used for our analysis were assumed based on published values of similar deposits and past experience.

It was determined that with a 50-foot buffer and a 15-foot building setback, minimum factors of safety of 1.63 and 1.11 were calculated for the subject slope under static and seismic conditions, respectively. These values meet or exceed the minimum values specified in Section 18.80.020(C)(2)(c) of the PCC of 1.5 (static) and 1.1 (seismic).

Based on our findings, it was our opinion that the minimum 50-foot buffer from the Active Landslide Area required by the code will provide suitable mitigation of landslide hazards for the project. The upslope limit of the Active Landslide Area is interpreted to be the upslope side of the gabion wall at the top of the bluff. In accordance with the PCC, a 15-foot building setback is required from the edge of the buffer, resulting in a combined minimum buffer/building setback of 65 feet from the Active Landslide Area. Figure 4 (attached) illustrates the limits of the proposed project and the adherence to the recommended buffer and setback of 50 feet and 15 feet, respectively.

CONCLUSION

According to PCC 18E.110.060 – Appendix C Section A.6.a a summary of the results, conclusions, and recommendations resulting from the geological assessment, as set forth in PCC 18E.110.030 B shall be provided.

> *a. In the case of proposed development, whether it is possible given the physical constraints of the property (size, shape, building setbacks, utility requirements, etc.) to locate the proposed development outside of the 120-year area of regression based on natural shoreline processes.*

Using similar data from the nearby bluff regression, a slope stability analysis, and observations during the reconnaissance-level survey of the slope it is our opinion that a regression rate of 0.25 feet per year for the bluff is suitable for the treatment plant site. In our opinion, this projected regression rate is conservatively high because the subject section of shoreline, which is located inside of Taylor Bay, has less exposure to the prevailing wind and waves than Sites 31 and 175. With a regression rate of 0.25 feet per year the 120-year area of regression would be 36 feet from the top of the slope. Therefore, it will be possible to locate the development outside the regression area. According to the proposed site plan, the new development will comply with our previous recommendation of a 50-foot setback and a 15-foot buffer for a total setback of 65 feet. Therefore, the development will be set back beyond the projected 36-foot regression limit and no further setbacks are required, provided the recommendations in our previous report are followed.

CLOSURE

We appreciate the opportunity to have been of service to you on your project. If you should have any questions regarding this report or require additional information, please contact us at your earliest convenience.

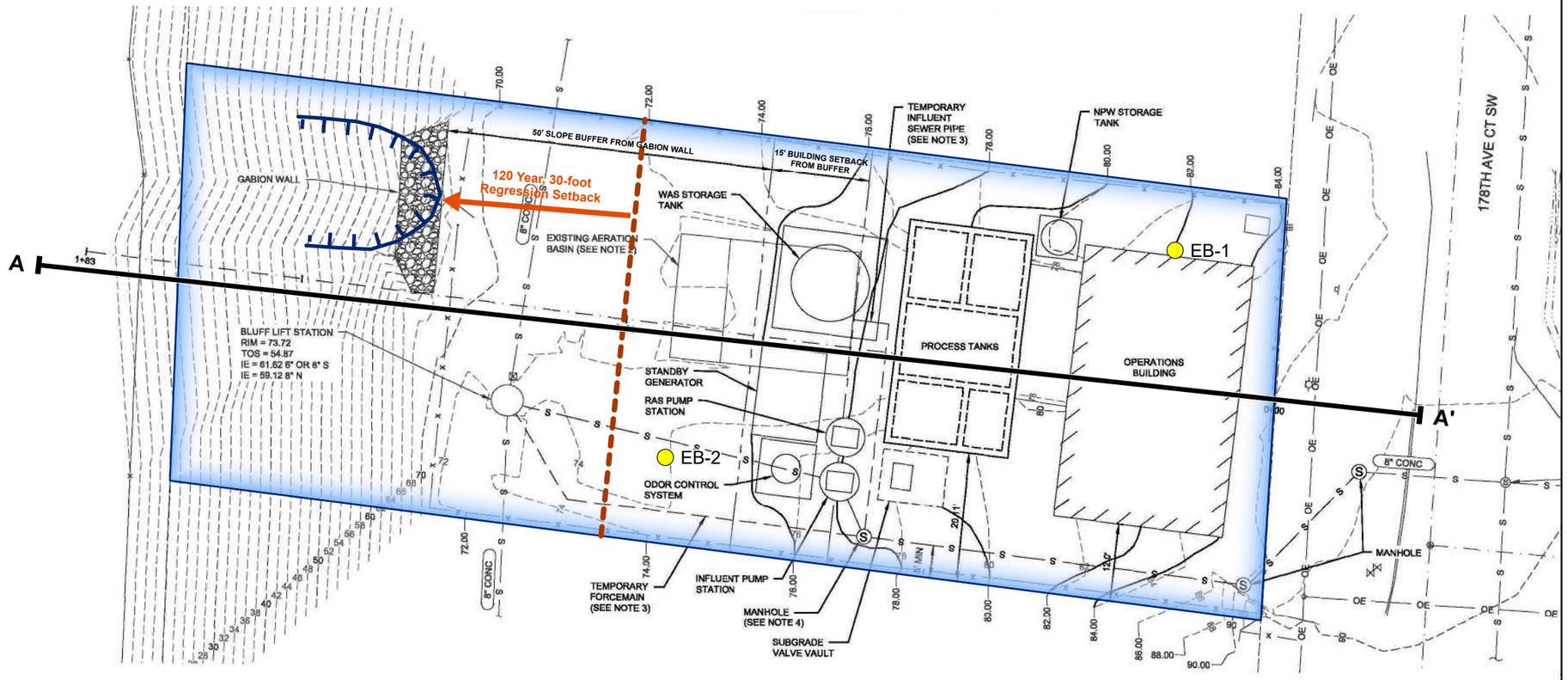
Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington



Matthew A. Miller, P.E.
Principal Engineer

Attachment: Figure 4. Site and Exploration Plan

Note: Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.



LEGEND

- SITE
- EXPLORATION BORING
- SETBACK
- CROSS-SECTION
- APPROXIMATE LOCATION OF 1994 SLIDE

N

0 20

FEET

DATA SOURCES/REFERENCES:
GRAY AND OSBORNE, INC. CONSULTING ENGINEERS, TAYLOR BAY BEACH CLUB HOA, FIGURE 5-1, 4/5/2024.

BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION. LOCATION AND DISTANCES SHOWN ARE APPROXIMATE.

associated earth sciences incorporated

SITE AND EXPLORATION PLAN

TAYLOR BAY SEWAGE TREATMENT PLANT
PIERCE COUNTY, WASHINGTON

PROJECT NO.	DATE	FIGURE
20200440E001	5/24	4

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SUPPLEMENTAL SLOPE STABILITY ANALYSIS REPORT

December 11, 2025
Project No. 20200440E002

Gray and Osborne, Inc.
11 Spokane Street, Suite 211
Wenatchee, Washington 98801

Attention: Peter Burgoon

Subject: Supplemental Slope Stability Analysis
Taylor Bay Sewage Treatment Plant
8220 178th Avenue Court SW
Longbranch, Washington
Parcel No. 6925000230

Dear Peter Burgoon:

This letter presents the findings of our supplemental slope stability analysis completed for the subject project. Our services have been performed in accordance with generally accepted geotechnical engineering and engineering geology practices in effect in this area at the time our letter was prepared. No other warranty, express or implied, is made.

SITE AND PROJECT DESCRIPTION

The subject site consists of a single parcel of approximately 0.25 acres located at 8220 178th Avenue Court SW in unincorporated Pierce County, Longbranch, Washington (Pierce County Parcel No. 6925000230). The location of the site is shown on the "Vicinity Map," Figure 1. The site is the location of the existing Taylor Bay sewage treatment plant. Current plans include demolition of selected portions of the existing site improvements and construction of a new sewage treatment plant. Previous reports prepared by Associated Earth Sciences, Inc. (AESI) for the project include the following:

> *Subsurface Exploration, Geologic Hazard, and Geotechnical Engineering Report, Taylor Bay Sewage Treatment Plant*, dated June 22, 2023, revised May 20, 2024.
>
> *Construction Dewatering Flow Rate Estimate, Taylor Bay Sewage Treatment Plant*, dated November 19, 2025.

The west end of the subject site is located near the top of a steep slope that extends down to the Puget Sound shoreline. The results of an assessment of landslide risk associated with this slope were included in our May 2024 report.

At the time of our 2024 report, our understanding of subsurface conditions at the site was based on two exploration borings, EB-1 and EB-2, and a reconnaissance of the steep slope at the west end of the site. Since that time, one additional boring (EB-3W) was drilled at the site to provide additional subsurface information in the area of an excavation proposed for construction of the new process tanks and pump station. This boring was completed as a monitoring well, developed, and instrumented with an electronic data logger to allow monitoring of the groundwater level. Monitoring of groundwater levels in this well began in June 2025 and is currently ongoing. Detailed descriptions of the soil and groundwater conditions encountered in the explorations and observed during our reconnaissance were provided in our November 2025 letter. The locations of the explorations are shown on Figure 2. Copies of the exploration logs are included in Appendix A. A copy of the EB-3W hydrograph, showing the groundwater elevations measured in this well to date, is included in Appendix B.

Since the time of our 2024 report, project plans have also been revised, resulting in some changes to the locations and depths of some of the proposed structures. This letter presents the results of the supplemental slope stability analysis completed to address the changes included in the current (90 percent) plans, as well as minor changes to our understanding of the subsurface conditions based on the recent subsurface exploration and groundwater monitoring. The proposed facility layout based on the current plan set is shown on Figure 2.

SUPPLEMENTAL SLOPE STABILITY ANALYSIS

The supplemental slope stability analysis was completed using the computer program Slope/W, GeoStudio 2025.11 by Seequent. The topography of the ground surface and structure locations were based on those shown on Figure 2 along Section Line A-A'. The distribution of the geologic units along Section A-A' was based on the conditions encountered in our explorations and observed during our slope reconnaissance. This information is shown on the Slope/W profiles in Appendix C.

In order to assess the sensitivity of the stability of the slope to groundwater levels, the slope was modeled for both low and high groundwater conditions. Groundwater levels for the low water case were based on the following:

- The groundwater level at the location of boring EB-1 was assumed to be equal to that observed at the time of drilling on April 12, 2023 (elevation 68 feet). This value is considered to be conservatively high because groundwater levels in unconfined aquifers in the Puget Lowland are typically near their seasonal high at this time of year.

- A groundwater elevation at the location of monitoring well EB-3W of 62.0 feet. This value is considered to be conservatively high given that the measured groundwater elevation in EB-3W during the period of monitoring (June 24 to November 11, 2025) ranged from 60.5 to 62.3 feet, with the groundwater level only rising above elevation 62.0 after November 5th.

- The groundwater surface was projected from these locations to the slope face at the contact between the water-bearing pre-Fraser non-glacial deposits and the underlying low-permeability (non-water-bearing), pre-Fraser till deposits.

For the high water case, groundwater levels at the locations of EB-1 and EB-3W were assumed to be 5 feet higher than those used for the low water case. From these exploration locations, the groundwater surface was projected out to the slope face at an elevation 1 foot above that used for the low water case. The 5-foot seasonal fluctuation assumed for the locations of EB-1 and EB-3W is estimated to be conservatively high, given that the seasonal groundwater level fluctuation in monitoring well EB-3W during the current period of monitoring has only been 1.8 feet. In addition, the groundwater elevation for the low water case at this location was selected to be near the upper end of range observed to date.

Similar to our previous analysis, a horizontal ground acceleration of 0.32g was used to assess slope stability under seismic conditions. This value is equal to one-half of the peak ground acceleration, adjusted for site class, in accordance with ASCE 7-16.

The factor of safety of a slope is the ratio between the forces that resist sliding to the forces that drive sliding. For example, a factor of safety of 1.0 would indicate a slope where the driving forces and the resisting forces are exactly equal. Factors of safety below 1.0 indicate slope failure. Increasing factors of safety greater than 1.0 indicate increased stability. Under the *Pierce County Code* (PCC), factors of safety of 1.5 and 1.1 are considered to be the minimum acceptable values for static and seismic conditions, respectively.

Under static conditions, the minimum factor of safety calculated for both the low and high water cases was fairly similar, ranging from 1.53 to 1.55. These values exceed the minimum acceptable threshold value of 1.50 required by the PCC.

Under seismic conditions, factors of safety near the top of the bluff were found to be below the minimum threshold value required by the code of 1.10. Specifically, slip surfaces with factors of safety below 1.10 were found to extend up to 30 feet and 35 feet beyond the top of the slope for the low and high water cases, respectively. Factors of safety for slip surfaces extending farther back from the top of the slope exceeded the minimum threshold value of 1.10. Based on our previous recommendations, the proposed sewage treatment plant layout maintains a 50-foot top of slope buffer. The findings of our supplemental slope stability analysis confirms that the 50-foot top of slope buffer incorporated into the current plans provides suitable

mitigation of landslide risk and complies the PCC requirements. Copies of the Slope/W profiles showing the results of the slope stability analysis are included in Appendix C.

We appreciate this opportunity to be of service to Gray and Osborne, Inc. If you have any questions regarding this letter, please do not hesitate to call.

Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington



Timothy J. Peter, L.E.G., L.Hg.
Senior Engineering Geologist

Matthew A. Miller, P.E.
Principal Geotechnical Engineer

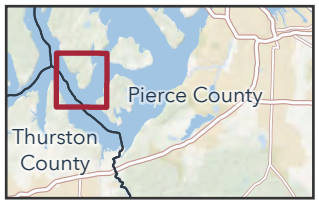
Attachments:

Figure 1. Vicinity Map
Figure 2. Site and Exploration Plan

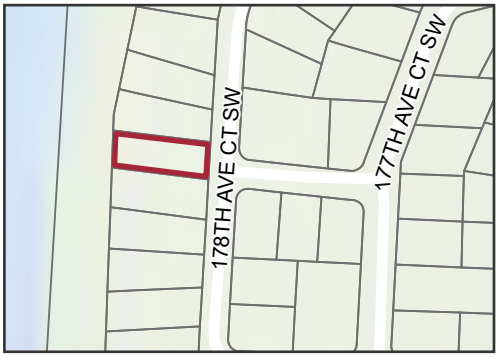
Appendix A. Exploration Logs
Appendix B. EB-3W Hydrograph
Appendix C. Slope/W Profiles



COUNTY LOCALE



LOCATION



ESRI, USGS, NATIONAL GEOGRAPHIC, DELORME, NATURALVUE, I-CUBED, GEBCO: ARCGIS ONLINE BASEMAP. WADOT STATE ROUTES 24K (12/20). PIERCE CO: PARCELS, ROADS (8/25).

NOTE: LOCATION AND DISTANCES SHOWN ARE APPROXIMATE. BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION.

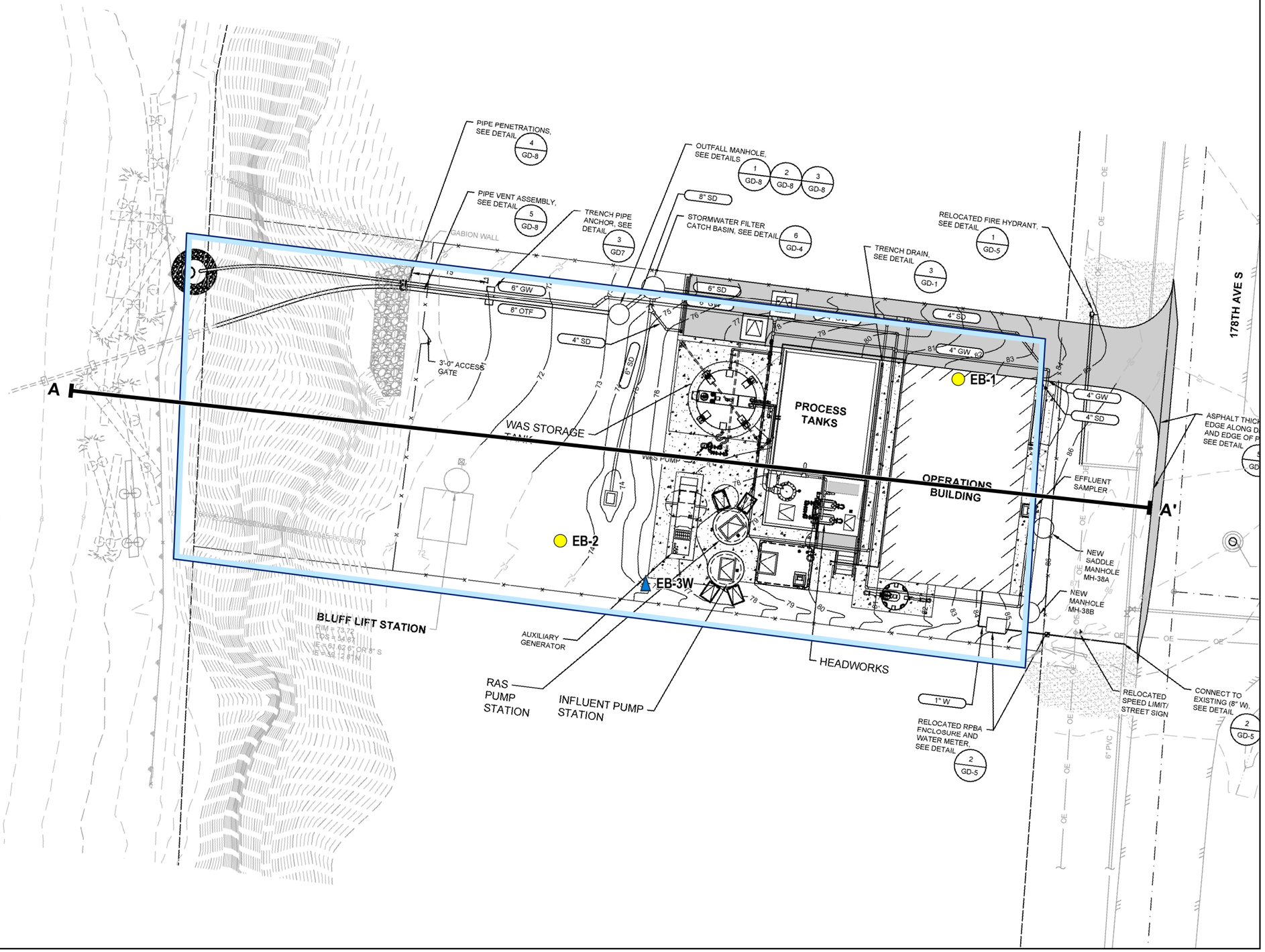
associated earth sciences incorporated

VICINITY MAP

TAYLOR BAY SEWAGE TREATMENT PLANT
PIERCE COUNTY, WASHINGTON

PROJECT NO.	DATE	FIGURE
20200440E002	10/25	1

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LEGEND

- SITE
- EXPLORATION BORING
- MONITORING WELL
- CROSS-SECTION

N

0 20

FEET

DATA SOURCES/REFERENCES:
GRAY & OSBORNE, INC., TAYLOR BAY BEACH CLUB, WASTEWATER TREATMENT FACILITY UPGRADE, GRADING AND STORMWATER AND GROUNDWATER PIPING PLAN, DRAWING G-13 OF 16, OCTOBER 2025.

BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION. LOCATION AND DISTANCES SHOWN ARE APPROXIMATE.

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SITE AND EXPLORATION PLAN

TAYLOR BAY SEWAGE TREATMENT PLANT
PIERCE COUNTY, WASHINGTON

PROJECT NO.	DATE	FIGURE
20200440E002	12/25	2

G:\GIS_Projects\as\Y2020\200440 Taylor Bay Sewage Treatment Plant_aprx\E002\Lt 1225\20200440E002 F2 SP_TaylorBay_1225.aprx | 20200440E002 F2 SP_TaylorBay_1225 | 2025-12-11 | mtrop

APPENDIX A

Exploration Logs

Coarse-Grained Soils - More than 50%[1] Retained on No. 200 Sieve	Gravels - More than 50%[1] of Coarse Fraction Retained on No. 4 Sieve	≤5% Fines[2]	GW	Well-graded gravel and gravel with sand, little to no fines
			GP	Poorly-graded gravel and gravel with sand, little to no fines
		≥12% Fines[2]	GM	Silty gravel and silty gravel with sand
			GC	Clayey gravel and clayey gravel with sand
	Sands - 50%[1] or More of Coarse Fraction Passes No. 4 Sieve	≤5% Fines[2]	SW	Well-graded sand and sand with gravel, little to no fines
			SP	Poorly-graded sand and sand with gravel, little to no fines
		≥12% Fines[2]	SM	Silty sand and silty sand with gravel
			SC	Clayey sand and clayey sand with gravel
Fine-Grained Soils - 50%[1] or More Passes No. 200 Sieve	Silts and Clays Liquid Limit Less than 50		ML	Silt, sandy silt, gravelly silt, silt with sand or gravel
			CL	Clay of low to medium plasticity; silty, sandy, or gravelly clay, lean clay
			OL	Organic clay or silt of low plasticity
	Silts and Clays Liquid Limit 50 or More		MH	Elastic silt, clayey silt, silt with micaceous or diatomaceous fine sand or silt
			CH	Clay of high plasticity, sandy or gravelly clay, fat clay with sand or gravel
			OH	Organic clay or silt of medium to high plasticity
Highly Organic Soils			PT	Peat, muck and other highly organic soils

Terms Describing Relative Density and Consistency

Coarse-Grained Soils	Density	SPT[3] blows/foot
	Very Loose	0 to 4
	Loose	4 to 10
	Medium Dense	10 to 30
	Dense	30 to 50
	Very Dense	>50

Fine-Grained Soils	Consistency	SPT[3] blows/foot
	Very Soft	0 to 2
	Soft	2 to 4
	Medium Stiff	4 to 8
	Stiff	8 to 15
	Very Stiff	15 to 30
	Hard	>30

Test Symbols

G = Grain Size
M = Moisture Content
A = Atterberg Limits
C = Chemical
DD = Dry Density
K = Permeability

Component Definitions

Descriptive Term	Size Range and Sieve Number
Boulders	Larger than 12"
Cobbles	3" to 12"
Gravel	3" to No. 4 (4.75 mm)
Coarse Gravel	3" to 3/4"
Fine Gravel	3/4" to No. 4 (4.75 mm)
Sand	No. 4 (4.75 mm) to No. 200 (0.075 mm)
Coarse Sand	No. 4 (4.75 mm) to No. 10 (2.00 mm)
Medium Sand	No. 10 (2.00 mm) to No. 40 (0.425 mm)
Fine Sand	No. 40 (0.425 mm) to No. 200 (0.075 mm)
Silt and Clay	Smaller than No. 200 (0.075 mm)

[4] Estimated Percentage

Component	Percentage by Weight
Trace	<5
Some	5 to <12
Modifier (silty, sandy, gravelly)	12 to <30
Very *modifier* (silty, sandy, gravelly)	30 to <50

Moisture Content

Dry - Absence of moisture, dusty, dry to the touch
Slightly Moist - Perceptible moisture
Moist - Damp but no visible water
Very Moist - Water visible but not free draining
Wet - Visible free water, usually from below water table

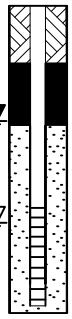
Symbols

Sampler Type and Description

- Blows/6" or portion of 6"
- Split-Spoon Sampler (SPT)
- California Sampler
- Ring Sampler
- Continuous Sampling
- Grab Sample
- Portion not recovered

Groundwater depth

- ATD At time of drilling
- Static water level (date)



- Cement grout surface seal
- Bentonite seal
- Filter pack with blank casing section
- Screened casing or Hydrotip with filter pack
- End cap

Classifications of soils in this report are based on visual field and/or laboratory observations, which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field or laboratory testing unless presented herein. Visual-manual and/or laboratory classification methods of ASTM D-2487 and D-2488 were used as an identification guide for the Unified Soil Classification System.

(1) Percentage by dry weight
(2) Combined USCS symbols used for fines between 5% and 12%
(3) (SPT) Standard Penetration Test (ASTM D-1586)
(4) In General Accordance with Standard Practice for Description and Identification of Soils (ASTM D-2488)

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EXPLORATION LOG KEY

FIGURE: A1

Blocks\ dwg \ log_key 2022.dwg LAYOUT: Layout 5 - 2022 Logdraft

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Exploration Boring EB-1

Taylor Bay Sewage Treatment Plant — Sheet: 1 of 1

Pierce County, WA	Start Date: 4/12/23	Logged By: ART
20200440E001	Ending Date: 4/12/23	Approved By: JHS

Driller/Equipment: Geologic / Mini Track
Hammer Weight/Drop: 140#/30"
Hole Diameter (in): 4.25
▼ Groundwater Depth ATD (ft): 12

Total Depth (ft): 21.5
Ground Surface Elevation (ft): ≈80
Datum: NAVD88
▽ Groundwater Depth Post Drilling (ft) (Date): ()

Depth (ft)	Sample Type	Sample	% Recovery	Graphic Symbol	Description	Water Level	Blows/6"	Blows/Foot (10 20 30 40 50+)	Other Tests
0					**Fill**				
		1			Moist, brown to dark brown with iron oxide mottling, silty, fine SAND, some gravel; organics; unsorted (SM).		2 3 2	5	
5		2			No recovery.		2 4 8	12	
					Mass Wasting				
		3			Moist, brownish gray, fine SAND, some silt; unsorted; poor recovery, less than 1 inch (SP-SM).		10 15 17	32	
10		4			Wet, gray to brownish gray, fine SAND, trace silt, trace gravel; massive (SP).	▼	9 13 18	31	
15		5			Moist, gray to dark, gray, non-cohesive sandy, SILT; massive; disturbed texture (ML).		11 14 17	31	
					Pre-Fraser Nonglacial Deposits				
20		6			Moist, light gray, silty, fine SAND to SILT, some fine sand; organic inclusions; stratified (SM-ML).		30 40 50/3"	50/3"	
					Perched groundwater at 12 feet ATD.				
25									
30									
35									

8/13/2025

20200440E001

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Exploration Boring EB-2

Taylor Bay Sewage Treatment Plant — Sheet: 1 of 1

Pierce County, WA	Start Date: 4/12/23	Logged By: ART
20200440E001	Ending Date: 4/12/23	Approved By: JHS

Driller/Equipment: Geologic / Mini Track
Hammer Weight/Drop: 140#/30"
Hole Diameter (in): 4.25
Groundwater Depth ATD (ft): 2 20

Total Depth (ft): 26.5
Ground Surface Elevation (ft): ≈73
Datum: NAVD88
Groundwater Depth Post Drilling (ft) (Date): ()

Depth (ft)	Sample Type	Sample	% Recovery	Graphic Symbol	Description	Water Level	Blows/6"	Blows/Foot (10 20 30 40 50+)	Other Tests
0		1			**Fill** Wet, brownish gray, fine SAND, some silt, some gravel; unsorted (SP-SM).	▼	3 7 7	14	
					Pre-Fraser Nonglacial Deposits				
5		2			Moist, brownish gray to light gray with iron oxide mottling, SILT to fine sandy, SILT; massive (ML).		7 20 31	51	
10		3			Moist, purple gray, SILT; massive; organics; interbeds of peat; organics odor (ML).		10 17 23	40	
15		4			Moist, brownish dark gray, silty, fine SAND; massive (SM).		14 20 25	45	
20		5			Wet, dark gray, fine SAND, trace silt, trace coarse sand; red sand grains (SP).	▼	21 50/6"	50/6"	
					Pre-Fraser Till				
25		6			Moist, brownish gray, SILT, some gravel; unsorted (ML). Driller calls refusal at 25 feet due to hard drilling conditions.		13 42 50/5"	50/5"	
					Perched groundwater at 2 feet and 20 feet ATD.				
30									
35									

8/13/2025

20200440E001

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Monitoring Well — EB-3W

Taylor Bay Sewage Treatment Plant — Sheet: 1 of 2

Longbranch, WA	Start Date: 6/23/2025	Logged By: LBK/SMS
20200440E002	Ending Date: 6/23/2025	Approved By: JHS

Driller/Equipment: Geologic Drill Part./tracked-HSA
Hammer Weight/Drop: 140#/30"
Hole Diameter (in): 8
Ground Surface Elevation (ft): 76
Water Level Elevation (ft): 62.9
Groundwater Depth ATD (ft): 19

Total Depth (ft): 22
Well Completion Depth (ft): 22
Well Tag No.: BQN 167
Top of Well Casing Elevation (ft): 75.7
Datum: NAVD88
Groundwater Depth Post Drilling (ft) (Date): 15.00 (7/9/2025)

Depth (ft)	Sample Type	Sample No.	Graphic Symbol	Description	Water Level	Blows/6"	Blows/Foot (10 20 30 40 50+)	Well Construction
0		1		**Fill - Access Road** Dry, brown, gravelly, fine SAND, some silt; abundant broken gravels (SP-SM).		6 12 9	21	Monument: Flush-mounted with 12-inch steel skirt Concrete 0 to 2 feet
2.5		2		**Fill** Slightly moist, dark blue-grey with orange (Fe-ox) staining, SILT, some fine sand to silty, fine SAND, trace gravel; unsorted (ML/SM).		18 5 7	12	Well Casing: 2-inch-diameter (nom) sch 40 PVC, threaded connections, J-plug cap, 0.3 to 20 feet Bentonite Seal: 3/8-inch bentonite chips, 2 to 19 feet
5		3		**Pre-Fraser Non-Glacial Deposits** Slightly moist, lavender brown, SILT, some to trace clay; massive (ML). Thin layer (≈1 to 2 inches) very moist, dark orange, silty, fine to medium SAND (SM). Moist, lavender brown, SILT, some to trace clay; massive (ML).		8 7 5	12	
7.5		4		As above.		2 7 12	19	
10		5		Moist, dark orangish brown, very silty, very fine SAND, trace gravel (SM). Very moist, dark purple grey, silty, very fine SAND; massive; mica present (SM). Abundant black, fine organics and thin wood pieces. Becomes very silty.		5 5 6	11	
12.5		6		Moist to very moist, dark purple brown to purple grey, SILT, some fine sand; abundant black, fine organics (ML). Occasional gravel (mudflow?)		6 5 7	12	
15		7		Very moist, dark purple brown to purple grey, very silty, very fine SAND; black, fine organics present; mica present (SM). Very moist, dark purple grey, fine sandy, SILT; black, fine organics present; mica present (ML).	▽	5 9 13	22	
17.5		8		As above.		11 27	60	

10/22/2025

20200440E002

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Monitoring Well — EB-3W

Taylor Bay Sewage Treatment Plant — Sheet: 2 of 2

Longbranch, WA	Start Date: 6/23/2025	Logged By: LBK/SMS
20200440E002	Ending Date: 6/23/2025	Approved By: JHS

Driller/Equipment: Geologic Drill Part./tracked-HSA
Hammer Weight/Drop: 140#/30"
Hole Diameter (in): 8
Ground Surface Elevation (ft): 76
Water Level Elevation (ft): 62.9
Groundwater Depth ATD (ft): 19

Total Depth (ft): 22
Well Completion Depth (ft): 22
Well Tag No.: BQN 167
Top of Well Casing Elevation (ft): 75.7
Datum: NAVD88
Groundwater Depth Post Drilling (ft) (Date): 15.00 (7/9/2025)

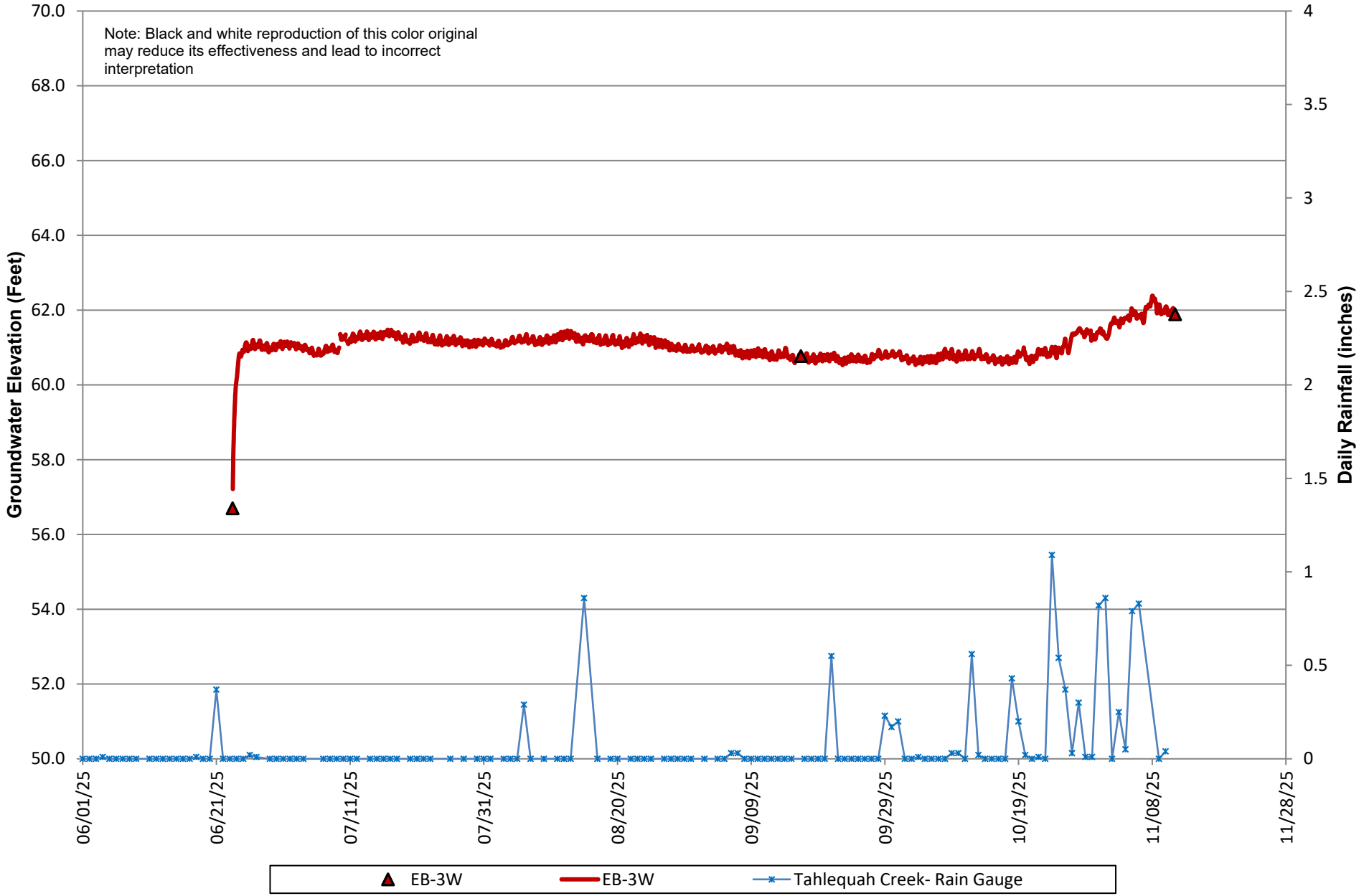
Depth (ft)	Sample Type	Sample No.	Graphic Symbol	Description	Water Level	Blows/6"	Blows/Foot (10 20 30 40 50+)	Well Construction
20		9		Very moist to wet, dark purple grey, silty, fine to medium SAND, trace gravel; fine laminae (SM).	▼	33		Sand Pack: 12/20 silica sand, 19 to 22 feet.
				Very moist to wet, dark purple grey, fine sandy, SILT, trace clay (ML). Wet, dark purple grey, fine to medium SAND, some silt; occasional fine laminae; otherwise massive (SP-SM).		8 17 28	45 ▲	Well Screen: 2-inch-diameter (nom) sch 40 PVC, 0.020-inch slot width, thread connections and end cap, 20 to 22 feet
22.5				Groundwater encountered at 18.73 feet after well installation. Well was developed about an hour after installation with a surge block and bailer. Water level immediately after development was 18.70 ft.				
25								
27.5								
30								
32.5								
35								

10/22/2025

20200440E002

APPENDIX B

EB-3W Hydrograph



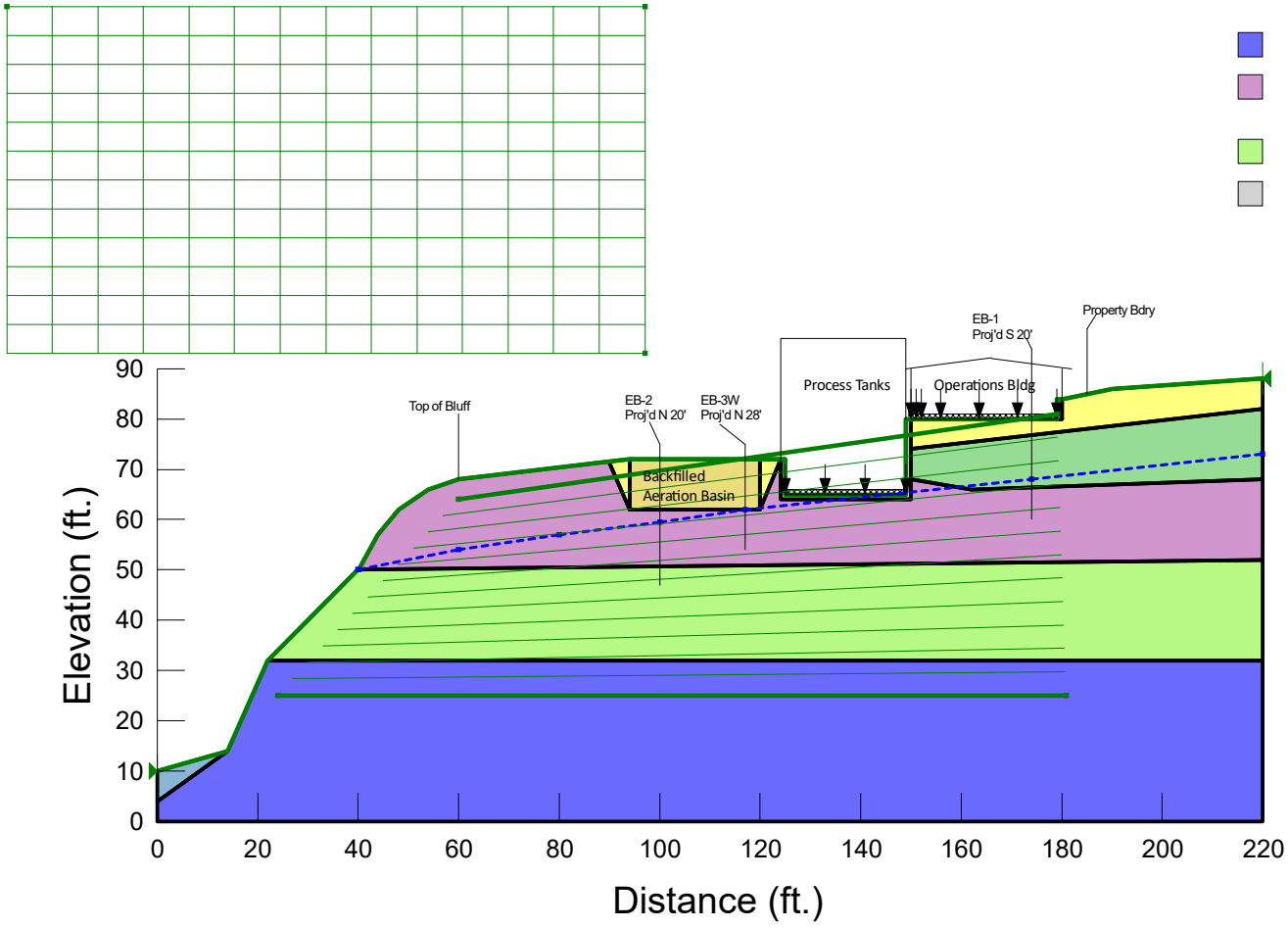
Groundwater Hydrograph
Taylor Bay Sewage Treatment Plant
Longbranch, Washington

APPENDIX C

Slope/W Profiles

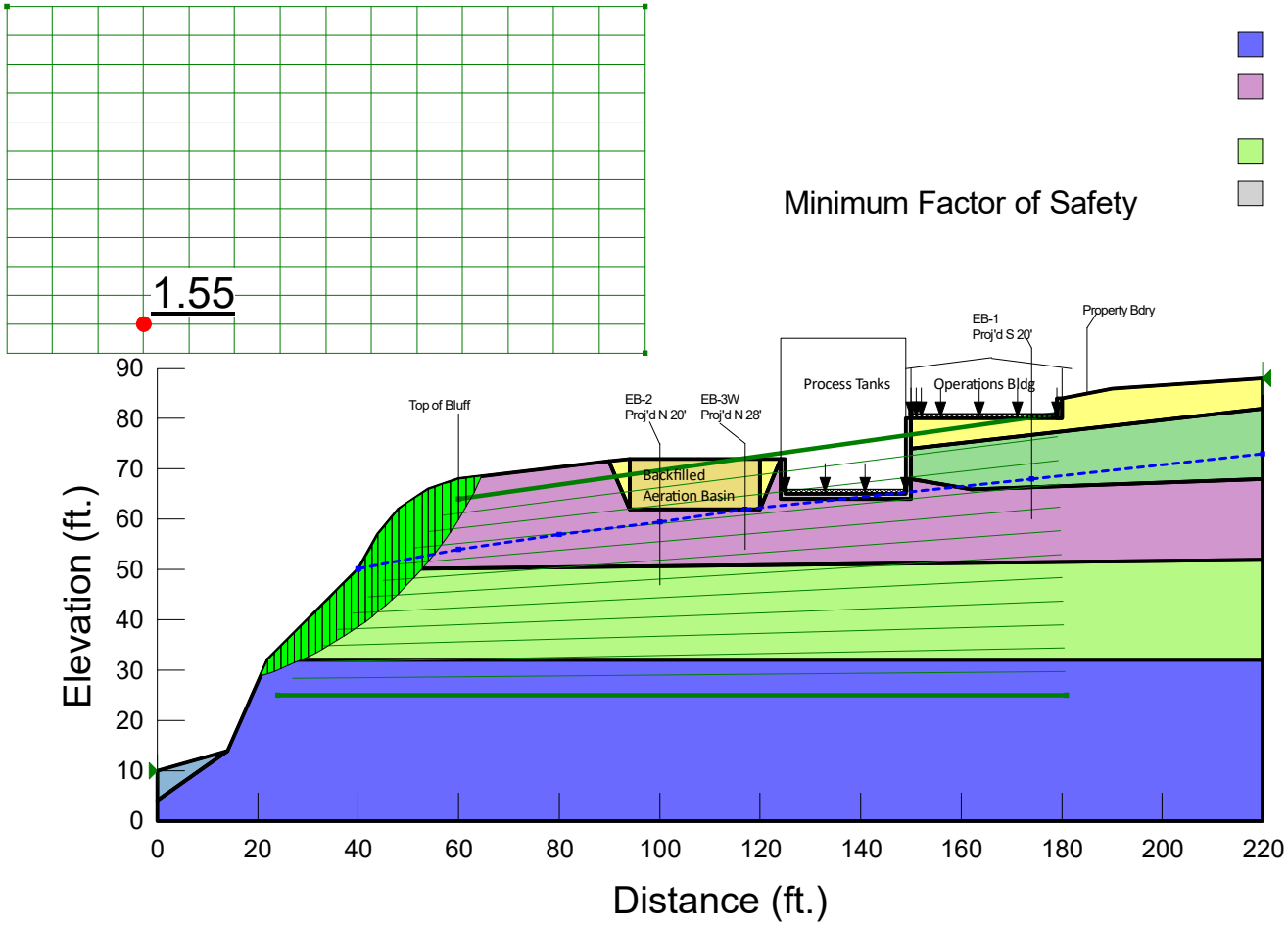
Taylor Bay Sewage Treatment Plant
20200440E002
Section A-A'
Model Setup - LOW WATER

Color	Name	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Piezom Surfac
	Aeration Basin Backfill	125	50	32	1
	Beach Deposits	100	0	30	
	Existing Fill	115	50	30	
	Mass Wasting Deposits	120	300	29	1
	Pre-Fraser Gravel	140	300	40	
	Pre-Fraser Non-Glacial Deposits	125	500	27	1
	Pre-Fraser Till	140	300	40	
	Process Tank and Building Foundation	150			

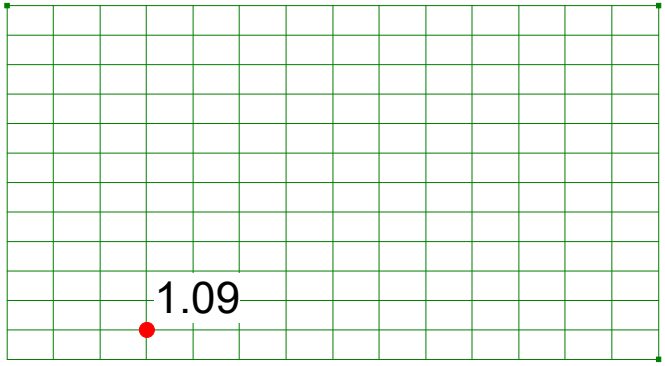


Taylor Bay Sewage Treatment Plant
20200440E002
Section A-A'
Static Condition - LOW WATER

Color	Name	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Piezom Surfac
	Aeration Basin Backfill	125	50	32	1
	Beach Deposits	100	0	30	
	Existing Fill	115	50	30	
	Mass Wasting Deposits	120	300	29	1
	Pre-Fraser Gravel	140	300	40	
	Pre-Fraser Non-Glacial Deposits	125	500	27	1
	Pre-Fraser Till	140	300	40	
	Process Tank and Building Foundation	150			

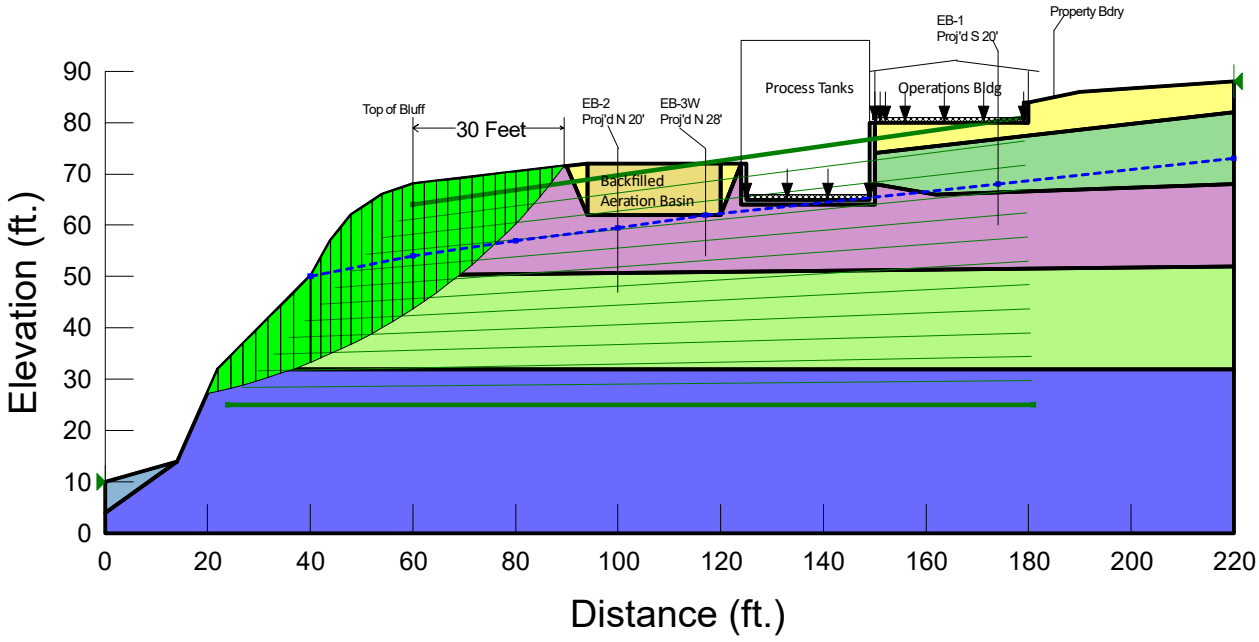


Taylor Bay Sewage Treatment Plant
20200440E002
Section A-A'
Seismic Condition, 0.32g - LOW WATER



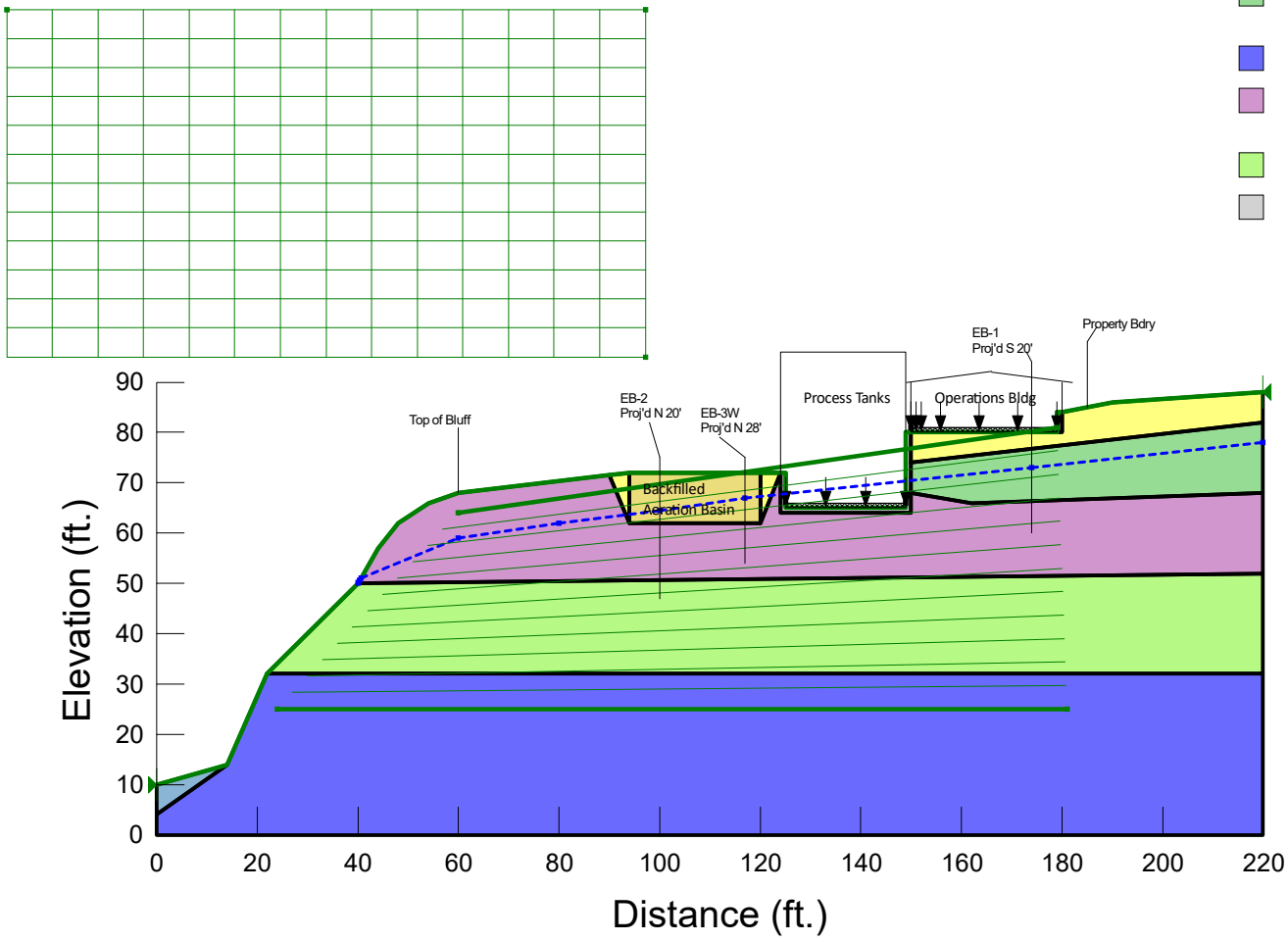
Largest Slip Surface with a Factor of Safety <1.10

Color	Name	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Piezom Surfac
	Aeration Basin Backfill	125	50	32	1
	Beach Deposits	100	0	30	
	Existing Fill	115	50	30	
	Mass Wasting Deposits	120	300	29	1
	Pre-Fraser Gravel	140	300	40	
	Pre-Fraser Non-Glacial Deposits	125	500	27	1
	Pre-Fraser Till	140	300	40	
	Process Tank and Building Foundation	150			



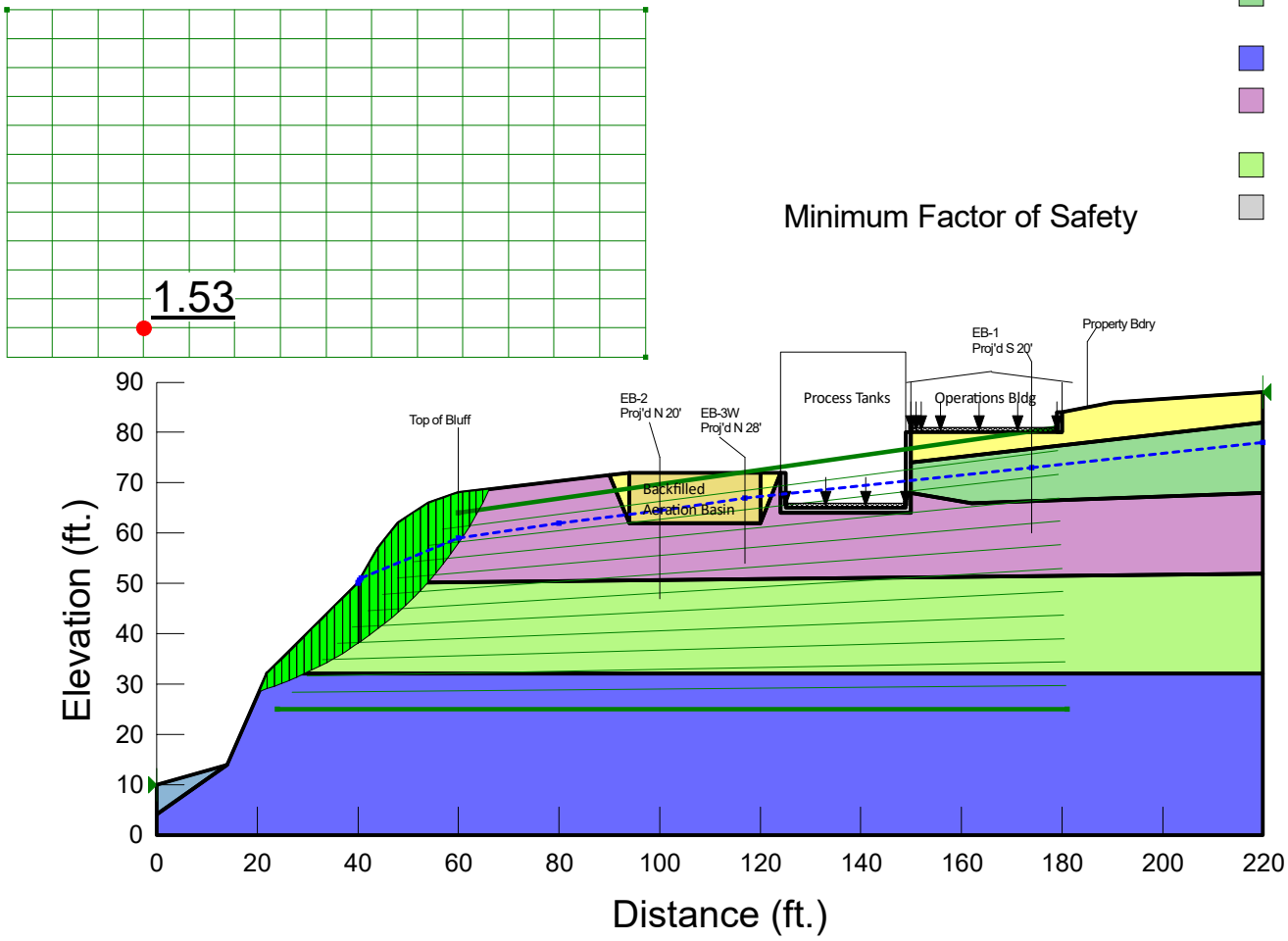
Taylor Bay Sewage Treatment Plant
20200440E002
Section A-A'
Model Setup - HIGH WATER

Color	Name	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Piezom Surfac
	Aeration Basin Backfill	125	50	32	1
	Beach Deposits	100	0	30	
	Existing Fill	115	50	30	
	Mass Wasting Deposits	120	300	29	1
	Pre-Fraser Gravel	140	300	40	
	Pre-Fraser Non-Glacial Deposits	125	500	27	1
	Pre-Fraser Till	140	300	40	
	Process Tank and Building Foundation	150			

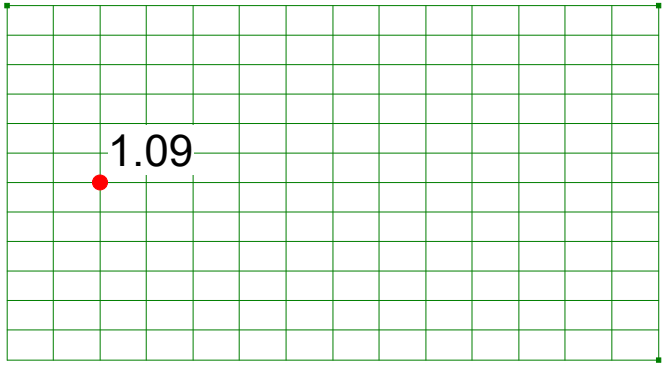


Taylor Bay Sewage Treatment Plant
20200440E002
Section A-A'
Static Condition - HIGH WATER

Color	Name	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Piezom Surfac
	Aeration Basin Backfill	125	50	32	1
	Beach Deposits	100	0	30	
	Existing Fill	115	50	30	
	Mass Wasting Deposits	120	300	29	1
	Pre-Fraser Gravel	140	300	40	
	Pre-Fraser Non-Glacial Deposits	125	500	27	1
	Pre-Fraser Till	140	300	40	
	Process Tank and Building Foundation	150			

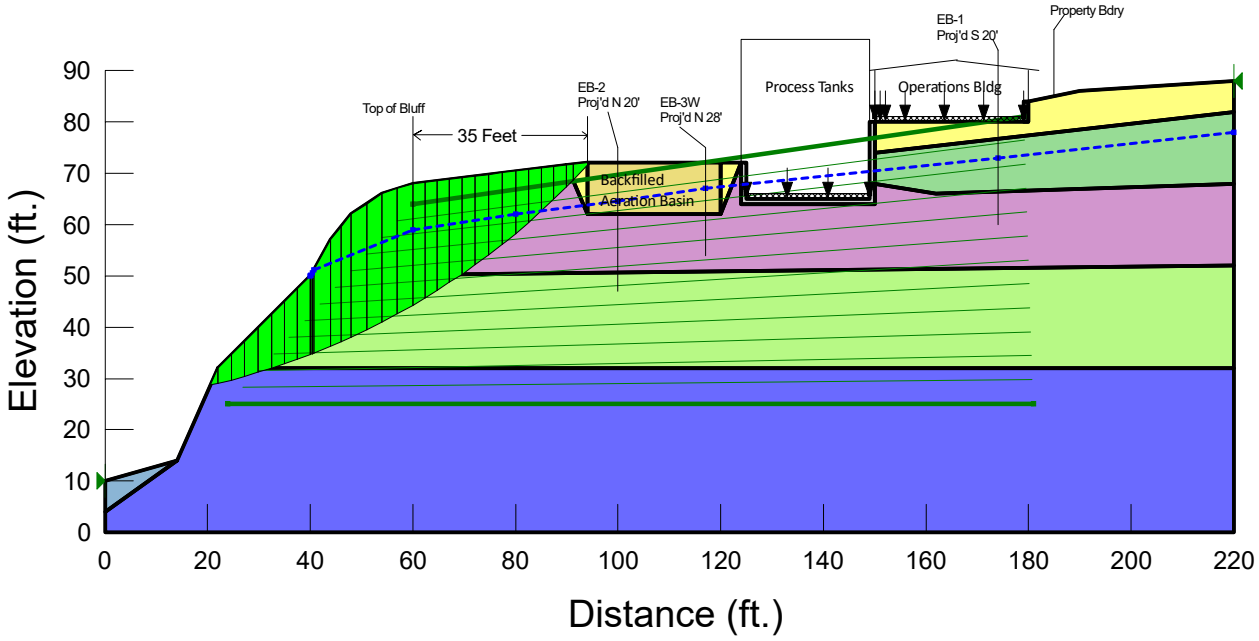


Taylor Bay Sewage Treatment Plant
20200440E002
Section A-A'
Seismic Condition, 0.32g - HIGH WATER



Largest Slip Surface with
a Factor of Safety <1.10

Color	Name	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Piezom Surfac
	Aeration Basin Backfill	125	50	32	1
	Beach Deposits	100	0	30	
	Existing Fill	115	50	30	
	Mass Wasting Deposits	120	300	29	1
	Pre-Fraser Gravel	140	300	40	
	Pre-Fraser Non-Glacial Deposits	125	500	27	1
	Pre-Fraser Till	140	300	40	
	Process Tank and Building Foundation	150			



CONSTRUCTION DEWATERING ESTIMATE REPORT

associated earth sciences incorporated

November 19, 2025
Project No. 20200440E002

Gray and Osborne, Inc.
11 Spokane Street, Suite 211
Wenatchee, Washington 98801

Attention: Peter Burgoon

Subject: Construction Dewatering Flow Rate Estimate
Taylor Bay Sewage Treatment Plant
8220 178th Avenue Court SW
Longbranch, Washington
Parcel No. 6925000230

Dear Peter Burgoon:

As requested, this report presents the findings of our assessment of estimated pumping rates for excavation dewatering during replacement of the Taylor Bay sewage treatment plant. Our services have been performed in accordance with generally accepted geotechnical engineering and engineering geology practices in effect in this area at the time our report was prepared. No other warranty, express or implied, is made.

SITE AND PROJECT DESCRIPTION

The subject site consists of a single parcel of approximately 0.25 acres located at 8220 178th Avenue Court SW in unincorporated Pierce County, Longbranch, Washington (Pierce County Parcel No. 6925000230). The location of the site is shown on the "Vicinity Map," Figure 1. The site is the location of the existing Taylor Bay sewage treatment plant. Current plans include demolition of selected portions of the existing site improvements and construction of a new sewage treatment plant. Two deep excavations are planned for the project which include the process tanks and pump station excavations. It is our understanding that these will consist of a single excavation with the southwestern portion of the excavation deepened for construction of the pump station. Depending on the time of year that construction occurs, it is anticipated that groundwater seepage could be encountered in both excavations. Proposed excavation depths are summarized below in Table 1. The locations of the excavations are shown on the "Site and Exploration Plan," Figure 2. Temporary shoring, consisting of soldier pile retaining walls, will be used to allow completion of the excavations within the site boundary limits.

Table 1. Summary of Excavation Depths

Excavation	Apx. Ground Surface Elevation (feet)	Bottom of Excavation Elevation (feet)	Apx. Depth to Bottom of Excavation (feet)
Process Tanks	74 to 80	64.5	9.5 to 15.5
Pump Station	74 to 77	62.5	11.5 to 14.5

SUBSURFACE CONDITIONS

Two exploration borings, EB-1 and EB-2, were drilled at the site in April 2023 for a geotechnical engineering study previously completed for the project by Associated Earth Sciences, Inc. (AESI). The findings of the geotechnical engineering study were documented in our report, titled "Subsurface Exploration, Geologic Hazard, and Geotechnical Engineering Report, Taylor Bay Sewage Treatment Plant," dated June 22, 2023, revised May 20, 2024.

Our current field study included drilling one additional boring in the area of the proposed excavations. This boring was completed as a 2-inch-diameter monitoring well. The approximate location of this boring, identified as boring EB-3W, is shown on Figure 2. The locations of borings EB-1 and EB-2 are also shown on Figure 2. Copies of the exploration logs are included in Appendix A. The various types of sediments, as well as the depths where characteristics of the sediments changed, are indicated on the attached exploration logs. The depths indicated on the logs where conditions changed may represent gradational variations between sediment types in the field. If changes occurred between sample intervals in our borings, they were interpreted.

The conclusions and recommendations presented in this report are based, in part, on the explorations completed at the site. The locations and depths of the explorations were completed within site and budgetary constraints. It should be noted that subsurface conditions differing from those depicted on the attached exploration logs may be present at the site due to the random nature of deposition and the alteration of topography by past grading and/or filling. The nature and extent of any variations between the field explorations may not become fully evident until construction. If variations are observed at that time, it may be necessary to re-evaluate specific recommendations in this report and make appropriate changes. Because of the nature of exploratory work below ground, extrapolation of subsurface conditions between the field explorations is necessary.

Exploration Borings

Subsurface exploration for this study was completed using a small, track-mounted, hollow-stem auger drilling rig operated by Geologic Drill Partners, Inc., an independent firm working under subcontract to AESI. During drilling, samples were generally obtained at 2.5- to 5-foot-depth intervals. The borings were continuously observed and logged by a geologist from our firm. The

exploration logs included in Appendix A are based on the field logs, drilling action, and inspection of the samples obtained during drilling.

Disturbed but representative samples were obtained by using the Standard Penetration Test (SPT) procedure in accordance with *ASTM International* (ASTM) D-1586. This test and sampling method consists of driving a standard 2-inch, outside-diameter, split-barrel sampler a distance of 18 inches into the soil with a 140-pound hammer free-falling a distance of 30 inches. The number of blows for each 6-inch interval is recorded, and the number of blows required to drive the sampler the final 12 inches is known as the Standard Penetration Resistance ("N") or blow count. If a total of 50 blows is recorded within one 6-inch interval, the blow count is recorded as 50 blows for the corresponding number of inches of penetration. The resistance, or N-value, provides a measure of the relative density of granular soils or the relative consistency of cohesive soils; these values are plotted on the attached boring logs.

The samples obtained from the split-barrel sampler were classified in the field and representative portions placed in watertight containers. The samples were then transported to our laboratory for further visual classification and laboratory testing.

Stratigraphy

Sediments encountered in our borings generally consisted of fill of variable thickness overlying native sediments interpreted to be mass wasting deposits, pre-Fraser non-glacial deposits, and pre-Fraser till. The following section presents more detailed subsurface information on the sediment types encountered at the site. Detailed descriptions of the sediments encountered in our explorations are included on the boring logs in Appendix A.

Fill

Fill soils (those not naturally placed), were observed in all three borings. The fill extended to depths ranging from 2 feet (EB-2) to 6.5 feet (EB-1). The fill generally consisted of loose to medium dense, moist, light brown to dark blue-gray, fine to medium sand with variable silt and gravel content. Portions of the fill in boring EB-3W consisted of gravelly fine sand and silt. Organic debris and faint organic odors were observed in the fill in borings EB-1 and EB-2.

Mass Wasting Deposits

Sediments encountered below the fill in boring EB-1 generally consisted of medium dense to dense, fine sand with minor to moderate silt content and interbeds of sandy silt. These sediments, which exhibited a blocky, chaotic texture, are interpreted to consist of Holocene-aged mass wasting deposits. Mass wasting deposits consist of sediments that have undergone downslope movement. At the location of boring EB-1, the mass wasting deposits extended to a depth of approximately 17.5 feet. It is important to note that the mass wasting deposits observed in EB-1 are not related to a small landslide that was reported to have occurred on the

adjacent bluff in 1994. Due to the lack of large-scale geomorphic indications of a landslide associated with the mass wasting deposits, and their moderately high to high relative density, it is our opinion that slope movement associated with these deposits occurred prior to recent times (i.e., more than 100 years ago).

Pre-Fraser Non-Glacial Deposits

Sediments encountered below the mass wasting deposits in EB-1, and below the existing fill in the other two borings (EB-2 and EB-3W), generally consisted of medium dense to very dense fine sand with variable silt and gravel content and interbeds of stiff to hard silt with variable quantities of fine sand. Portions of these sediments contained scattered organic debris, including small pieces of wood, fine, black organics, and glacially consolidated peat. We interpret these sediments to be representative of sediments deposited in a freshwater, non-glacial environment prior to the most recent glaciation of the Puget Lowland, known as the Fraser Glaciation. The observed depth to the top of the pre-Fraser, non-glacial sediments ranged between 2 feet (EB-2) and 17.5 feet (EB-1). At the location of boring EB-2, these sediments extended to a depth of approximately 22.5 feet. At the locations of borings EB-1 and EB-3W, the pre-Fraser non-glacial deposits extended beyond the maximum depths explored of approximately 21.5 to 22 feet.

Pre-Fraser Till

Sediments encountered below the pre-Fraser non-glacial deposits in boring EB-2, below a depth of approximately 22.5 feet, generally consisted of dense to very dense, unsorted, silty, fine sand with varying amounts of gravel. We interpret these sediments to be representative of lodgement till deposited by basal, debris-laden glacial ice prior to the Fraser Glaciation. Due to its high relative density and high silt content, the pre-Fraser till exhibits a low permeability which acts as an aquitard, limiting vertical migration of groundwater present in the overlying, younger deposits. At the location of boring EB-2, the pre-Fraser till extended beyond the maximum depth explored of approximately 26.5 feet.

Pre-Fraser Gravel Deposits

Sediments consisting of dense to very dense, stratified gravel within a silty matrix were observed on the lower portion of the marine bluff west of the site. We interpret these sediments to consist of pre-Fraser gravel deposits. The pre-Fraser gravel deposits were not encountered in our borings.

Regional Geologic Mapping

Review of regional geologic mapping of the area by Logan et al. (2003) indicates that the site is underlain by a relatively thin deposit of Vashon (Fraser-aged) lodgement till with exposures of pre-Fraser sandy deposits overlying pre-Fraser-aged gravel deposits mapped on the adjacent

marine bluff. The map also depicts Holocene landslide deposits overlying the older Pleistocene deposits on the portion of the bluff directly west of the site. The map describes the pre-Fraser sandy deposits as consisting of thin to thick-bedded to cross-bedded sand interbedded with laminated silt and minor peat, diatomite, and gravel, and states that these deposits are generally non-glacial. Although no Vashon lodgement till was observed at the site, the mapped location and description of the pre-Fraser sandy deposits is consistent with the pre-Fraser non-glacial deposits encountered in our borings.

Groundwater

During drilling groundwater seepage was observed in borings EB-1, EB-2, and EB-3W at depths of approximately 12 feet (EB-1), 2 feet and 20 feet (EB-2), and 18 feet (EB-3). Groundwater seepage in boring EB-1 was limited to a relatively thin, perched zone within the mass wasting deposits. Groundwater encountered in borings EB-2 and EB-3W was present within the coarser-grained, sandy interbeds within the pre-Fraser non-glacial deposits and also appeared to be perched near the contact between the fill and pre-Fraser non-glacial deposits in EB-2.

It should be noted that groundwater levels below the site may fluctuate in response to changes in season, precipitation, site use, and other factors. Borings EB-1 and EB-2 were drilled in mid-April, when groundwater levels in shallow unconfined aquifers are typically near their seasonal high. Boring EB-3W was drilled in late June, when groundwater levels are typically declining from their seasonal high.

Because it can take time for water to flow into an open boring, groundwater levels observed during drilling may not be representative of actual static groundwater levels. For this reason, boring EB-3W was completed as a 2-inch-diameter monitoring well. Monitoring well construction details are shown on the EB-3W exploration log in Appendix A.

Subsequent to its completion, monitoring well EB-3W was developed using a surge block and bailer to enhance the hydraulic connection between the well screen and the surrounding aquifer. An electronic data logger was then installed in the well to allow monitoring of the groundwater level. Groundwater monitoring conducted over the period from June 23, 2025 to November 11, 2025 indicates that the groundwater level in the well varied by 1.79 feet during this time, ranging from a low of elevation 60.53 feet on October 3rd to a high of 62.32 feet on November 8th. A hydrograph of the groundwater level in boring EB-3W during the period of monitoring is included in Appendix B.

The plans for the existing sewage treatment plant show a footing drain at the base of the aeration basin (Figure 2). The aeration basin footing drain shown on the plan has been estimated by Gray and Osborne, Inc. to be at approximately elevation 63 feet. Based on the existing groundwater level data, this would place the elevation of the footing drain at the east end of the aeration basin close to the groundwater surface. The location of the discharge for the footing drain is unknown and it is not known if the drain is still functioning. Although

demolition plans for the existing sewage treatment plant do not include removal of the footing drain, it is possible that demolition of other components of the sewage treatment plant could inadvertently eliminate the discharge piping from the drain. If this were to occur, and the aeration basin footing drain is currently still functioning, it would have the potential to affect groundwater levels below the site.

CONSTRUCTION DEWATERING FLOW ESTIMATE

Hydraulic Conductivity Testing and Analysis

Hydraulic conductivity is a measure of the ability for water to flow through a porous medium, such as soil or rock. Slug testing is a type of test used to estimate the horizontal hydraulic conductivity of the saturated sediments surrounding the screened zone of a well. It involves quickly adding or removing a "slug" of water from a well and monitoring the resulting hydraulic response (water level rise or fall) in the well. Typically, this is conducted using a weighted cylinder of known volume to displace the water in the well. Slug testing was conducted on monitoring well EB-3W to obtain an estimate of the hydraulic conductivity for the purpose of estimating pumping rates during dewatering of the process tank and pump station excavations. The hydraulic response in the well was recorded using an electronic data logger. Analysis of the slug testing data was conducted in accordance with the Kansas Geological Survey (KGS) model (Hyder et al., 1994) using the computer program AQTESOLV (HydroSOLVE, Inc., 2020).

Slug test results are primarily influenced by the characteristics of the saturated sediments immediately surrounding the screened zone of a well. For this reason, the results may not be representative of the larger aquifer system, which is often heterogeneous. This is particularly true for a stratified deposit such as the pre-Fraser non-glacial deposits in which EB-3W is completed, which contains frequently interbedded fine- and coarse-grained strata which may be of non-uniform thickness and limited lateral extent. Additional inaccuracies can be caused by wellbore storage effects or poor hydraulic connection between the well and the aquifer, although the latter may be mitigated by good well development. For this reason, slug testing was repeated multiple times to obtain a range of estimated hydraulic conductivities. Hydraulic conductivity values ranging from 13 to 35 feet per day were estimated from the slug test data. The results of the slug tests are included in Appendix C.

Although hydraulic conductivity can be estimated from sieve data, it is generally considered to be a less reliable method than slug testing, particularly for sediments like the pre-Fraser non-glacial deposits, which have been glacially consolidated. Sieve analyses were conducted on two sediment samples collected from the water-bearing zone (aquifer) in monitoring well EB-3W. As a check on the accuracy of the hydraulic conductivity estimates obtained from the slug tests, the sieve data was compared to our in-house sieve database for sediments with measured hydraulic conductivity values. The sieve-based hydraulic conductivity estimates for

EB-3W were found to be generally consistent with the hydraulic conductivity values obtained from the slug tests. Copies of the sieve testing results are included in Appendix D.

Estimated Construction Dewatering Pumping Rates

Dewatering pumping rates for the process tank and pump station excavations were estimated using the range of hydraulic conductivity values obtained from the slug tests. The following values were used for our analysis:

Pump Station Excavation

- Excavation Area: 18 feet x 10 feet = 180 square feet
- Bottom of Excavation Elevation: 62.5 feet
- Dewatering Target Elevation: 60.5 feet

Process Tanks Excavation

- Excavation Area: 51 feet x 27 feet = 1,377 square feet
- Bottom of Excavation Elevation: 64.5 feet
- Dewatering Target Elevation: 62.5 feet

Aquifer Characteristics

- Static Groundwater Elevation (Summer): 62.0 feet
- Static Groundwater Elevation (Wet Season High): 67.0 feet (assumed)
- Hydraulic Conductivity: 13 to 35 feet/day
- Bottom of Aquifer: 5 feet below the bottom of EB-3W (assumed)

The static summer dry season groundwater elevation of 62.0 feet is based on groundwater monitoring data from EB-3W, rounded up to the nearest foot. This elevation is also based on a ground surface elevation of 76 feet at the location of EB-3W, which was estimated from the topographic contours shown on Figure 2. The wet season high groundwater level elevation was assumed to be 5 feet above the summer groundwater level elevation. At the time of this report, wet season monitoring of the groundwater level in EB-3W is ongoing.

Due to aquifer storage losses, initial dewatering pumping rates will exceed long-term pumping rates. For this reason, dewatering pumping rates were estimated for the short term (14-day pumping) and longer term (180-day, and 365-day pumping) dewatering cases. Summaries of the results are shown below in Tables 2 through 4.

Table 2. Estimated 14-Day Dewatering Pumping Rates

Excavation	Estimated Flow Rate (GPM)			
	Dry Season		Wet Season	
	K = 13 feet/day	K = 35 feet/day	K = 13 feet/day	K = 35 feet/day
Process Tanks	0*	0*	10	45
Pump Station	<5	15	10	45

Notes: K = Hydraulic Conductivity
GPM = Gallons Per Minute
***The dry season groundwater elevation is below the elevation of the bottom of the process tank excavation.**

Table 3. Estimated 180-Day Dewatering Pumping Rates

Excavation	Estimated Flow Rate (GPM)			
	Dry Season		Wet Season	
	K = 13 feet/day	K = 35 feet/day	K = 13 feet/day	K = 35 feet/day
Process Tanks	0*	0*	10	30
Pump Station	<5	10	10	40

Notes: K = Hydraulic Conductivity
GPM = Gallons Per Minute
***The dry season groundwater elevation is below the elevation of the bottom of the process tank excavation.**

Table 4. Estimated 365-Day Dewatering Pumping Rates

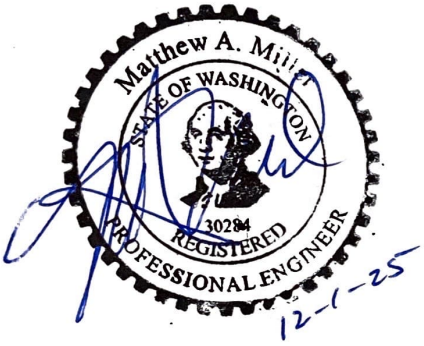
Excavation	Estimated Flow Rate (GPM)			
	Dry Season		Wet Season	
	K = 13.3 feet/day	K = 35.1 feet/day	K = 13.3 feet/day	K = 35.1 feet/day
Process Tanks	0*	0*	10	30
Pump Station	<5	10	10	40

Notes: K = Hydraulic Conductivity
GPM = Gallons Per Minute
***The dry season groundwater elevation is below the elevation of the bottom of the process tank excavation.**

Upon your request, we are available to reassess wet season estimated pumping rates if the ongoing groundwater level monitoring indicates that the wet season high groundwater level in EB-3W differs from the value assumed for our estimates.

We appreciate this opportunity to be of service to Gray and Osborne, Inc. If you have any questions regarding this report, please do not hesitate to call.

Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington



Timothy J. Peter, L.E.G., L.Hg.
Senior Engineering Geologist

Matthew A. Miller, P.E.
Principal Geotechnical Engineer

References:

Hyder, Z., Butler, J.J., McElwee, C.D., and Liu, W., 1994, Slug tests in partially penetrating wells: Water Resources Research, Vol. 30, No. 11, pp 2945-2957.

HydroSOLV, Inc., 2020, AQTESOLV® for Windows® 95/98/Me/NT/2000/XP/Vista, Version 4.50 – PROFESSIONAL, Copyright 1996-2007.

Logan, R.L., Walsh, T.J., and Polenz, M., 2003, Geologic map of the Longbranch 7.5-minute quadrangle, Thurston, Pierce, and Mason Counties, Washington: Washington Division of Geology and Earth Resources, Open File Report 2003-21, 2003.

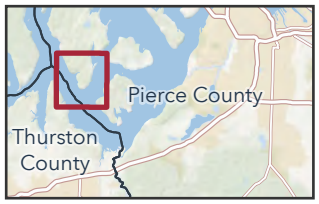
Attachments:

Figure 1. Vicinity Map
Figure 2. Site and Exploration Plan

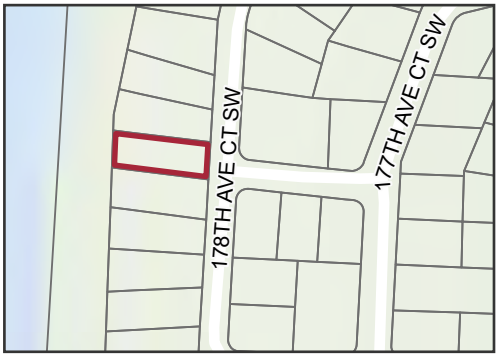
Appendix A. Exploration Logs
Appendix B. EB-3W Hydrograph
Appendix C. Slug Testing Data
Appendix D. Sieve Testing Results



COUNTY LOCALE



LOCATION



ESRI, USGS, NATIONAL GEOGRAPHIC, DELORME, NATURALVUE, I-CUBED, GEBCO: ARCGIS ONLINE BASEMAP. WADOT STATE ROUTES 24K (12/20). PIERCE CO: PARCELS, ROADS (8/25).

NOTE: LOCATION AND DISTANCES SHOWN ARE APPROXIMATE. BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION.

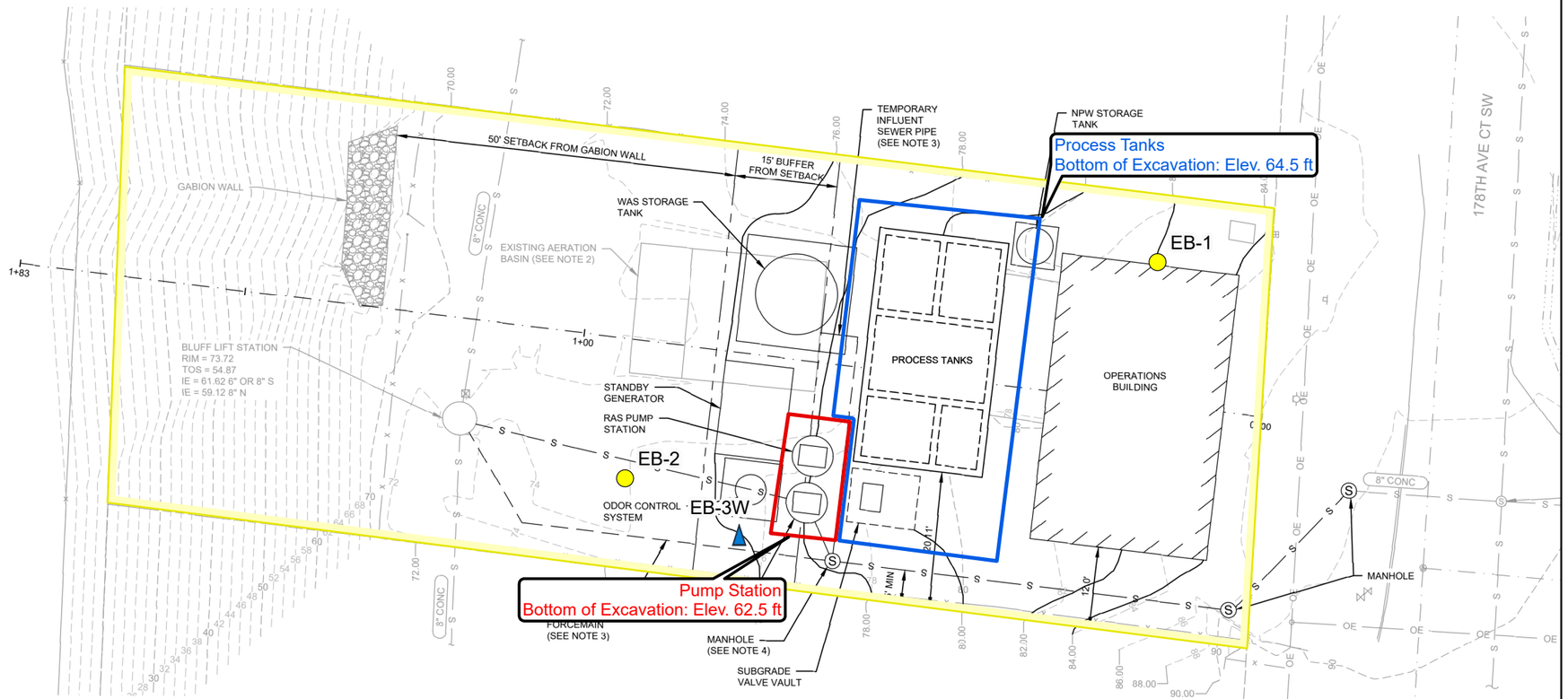
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VICINITY MAP

TAYLOR BAY SEWAGE TREATMENT PLANT
PIERCE COUNTY, WASHINGTON

PROJECT NO.	DATE	FIGURE
20200440E002	10/25	1

G:\GIS_Projects\aa\2020\200440 Taylor Bay Sewage Treatment Plant_aprx\E002\Ltr1025\20200440E002 F1 VM_TaylorBay_1025.aprx | 20200440E002 F1 VM_Taylor Bay | 2025-10-17 | mtrop



LEGEND

- SITE
- EXPLORATION BORING
- MONITORING WELL
- PROCESS TANKS APPROXIMATE EXCAVATION LIMIT
- PUMP STATION APPROXIMATE EXCAVATION LIMIT

N

0 20

FEET

DATA SOURCES/REFERENCES:
GRAY AND OSBORNE, INC. CONSULTING ENGINEERS, TAYLOR BAY BEACH CLUB HOA, FIGURE 5-1, 4/5/2024.

BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION. LOCATION AND DISTANCES SHOWN ARE APPROXIMATE.

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SITE AND EXPLORATION PLAN

TAYLOR BAY SEWAGE TREATMENT PLANT
PIERCE COUNTY, WASHINGTON

PROJECT NO.	DATE	FIGURE
20200440E002	10/25	2

G:\GIS_Projects\aaY2020\200440_Taylor Bay Sewage Treatment Plant_aprx\E002\Ltr1025\20200440E002 F2 SP_TaylorBay_1025.aprx | 20200440E002 F2 SP_Taylor Bay_1025 | 2025-10-20 | mtrop

APPENDIX A

Exploration Logs

Coarse-Grained Soils - More than 50%[1] Retained on No. 200 Sieve	Gravels - More than 50%[1] of Coarse Fraction Retained on No. 4 Sieve	≤5% Fines[2]	GW	Well-graded gravel and gravel with sand, little to no fines
			GP	Poorly-graded gravel and gravel with sand, little to no fines
		≥12% Fines[2]	GM	Silty gravel and silty gravel with sand
			GC	Clayey gravel and clayey gravel with sand
	Sands - 50%[1] or More of Coarse Fraction Passes No. 4 Sieve	≤5% Fines[2]	SW	Well-graded sand and sand with gravel, little to no fines
			SP	Poorly-graded sand and sand with gravel, little to no fines
		≥12% Fines[2]	SM	Silty sand and silty sand with gravel
			SC	Clayey sand and clayey sand with gravel
Fine-Grained Soils - 50%[1] or More Passes No. 200 Sieve	Silts and Clays Liquid Limit Less than 50		ML	Silt, sandy silt, gravelly silt, silt with sand or gravel
			CL	Clay of low to medium plasticity; silty, sandy, or gravelly clay, lean clay
			OL	Organic clay or silt of low plasticity
	Silts and Clays Liquid Limit 50 or More		MH	Elastic silt, clayey silt, silt with micaceous or diatomaceous fine sand or silt
			CH	Clay of high plasticity, sandy or gravelly clay, fat clay with sand or gravel
			OH	Organic clay or silt of medium to high plasticity
Highly Organic Soils			PT	Peat, muck and other highly organic soils

Terms Describing Relative Density and Consistency

Coarse-Grained Soils	Density	SPT[3] blows/foot
	Very Loose	0 to 4
	Loose	4 to 10
	Medium Dense	10 to 30
	Dense	30 to 50
	Very Dense	>50

Fine-Grained Soils	Consistency	SPT[3] blows/foot
	Very Soft	0 to 2
	Soft	2 to 4
	Medium Stiff	4 to 8
	Stiff	8 to 15
	Very Stiff	15 to 30
	Hard	>30

Test Symbols

G = Grain Size
M = Moisture Content
A = Atterberg Limits
C = Chemical
DD = Dry Density
K = Permeability

Component Definitions

Descriptive Term	Size Range and Sieve Number
Boulders	Larger than 12"
Cobbles	3" to 12"
Gravel	3" to No. 4 (4.75 mm)
Coarse Gravel	3" to 3/4"
Fine Gravel	3/4" to No. 4 (4.75 mm)
Sand	No. 4 (4.75 mm) to No. 200 (0.075 mm)
Coarse Sand	No. 4 (4.75 mm) to No. 10 (2.00 mm)
Medium Sand	No. 10 (2.00 mm) to No. 40 (0.425 mm)
Fine Sand	No. 40 (0.425 mm) to No. 200 (0.075 mm)
Silt and Clay	Smaller than No. 200 (0.075 mm)

[4] Estimated Percentage

Component	Percentage by Weight
Trace	<5
Some	5 to <12
Modifier (silty, sandy, gravelly)	12 to <30
Very *modifier* (silty, sandy, gravelly)	30 to <50

Moisture Content

Dry - Absence of moisture, dusty, dry to the touch
Slightly Moist - Perceptible moisture
Moist - Damp but no visible water
Very Moist - Water visible but not free draining
Wet - Visible free water, usually from below water table

Symbols

Sampler Type and Description

- Blows/6" or portion of 6"
- Split-Spoon Sampler (SPT)
- California Sampler
- Ring Sampler
- Continuous Sampling
- Grab Sample
- Portion not recovered

Groundwater depth

- ATD At time of drilling
- Static water level (date)

- Cement grout surface seal
- Bentonite seal
- Filter pack with blank casing section
- Screened casing or Hydrotip with filter pack
- End cap

Classifications of soils in this report are based on visual field and/or laboratory observations, which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field or laboratory testing unless presented herein. Visual-manual and/or laboratory classification methods of ASTM D-2487 and D-2488 were used as an identification guide for the Unified Soil Classification System.

(1) Percentage by dry weight
(2) Combined USCS symbols used for fines between 5% and 12%
(3) (SPT) Standard Penetration Test (ASTM D-1586)
(4) In General Accordance with Standard Practice for Description and Identification of Soils (ASTM D-2488)

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EXPLORATION LOG KEY

FIGURE: A1

Blocks\ dwg \ log_key 2022.dwg LAYOUT: Layout 5 - 2022 Logdraft

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Exploration Boring EB-1

Taylor Bay Sewage Treatment Plant — Sheet: 1 of 1

Pierce County, WA	Start Date: 4/12/23	Logged By: ART
20200440E001	Ending Date: 4/12/23	Approved By: JHS

Driller/Equipment: Geologic / Mini Track
Hammer Weight/Drop: 140#/30"
Hole Diameter (in): 4.25
▼ Groundwater Depth ATD (ft): 12

Total Depth (ft): 21.5
Ground Surface Elevation (ft): ≈80
Datum: NAVD88
▽ Groundwater Depth Post Drilling (ft) (Date): ()

Depth (ft)	Sample Type	Sample	% Recovery	Graphic Symbol	Description	Water Level	Blows/6"	Blows/Foot (10 20 30 40 50+)	Other Tests
0					**Fill**				
		1			Moist, brown to dark brown with iron oxide mottling, silty, fine SAND, some gravel; organics; unsorted (SM).		2 3 2	5	
5		2			No recovery.		2 4 8	12	
					Mass Wasting				
		3			Moist, brownish gray, fine SAND, some silt; unsorted; poor recovery, less than 1 inch (SP-SM).		10 15 17	32	
10		4			Wet, gray to brownish gray, fine SAND, trace silt, trace gravel; massive (SP).	▼	9 13 18	31	
15		5			Moist, gray to dark, gray, non-cohesive sandy, SILT; massive; disturbed texture (ML).		11 14 17	31	
					Pre-Fraser Nonglacial Deposits				
20		6			Moist, light gray, silty, fine SAND to SILT, some fine sand; organic inclusions; stratified (SM-ML).		30 40 50/3"	50/3"	
					Perched groundwater at 12 feet ATD.				
25									
30									
35									

8/13/2025

20200440E001

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Exploration Boring EB-2

Taylor Bay Sewage Treatment Plant — Sheet: 1 of 1

Pierce County, WA	Start Date: 4/12/23	Logged By: ART
20200440E001	Ending Date: 4/12/23	Approved By: JHS

Driller/Equipment: Geologic / Mini Track
Hammer Weight/Drop: 140#/30"
Hole Diameter (in): 4.25
Groundwater Depth ATD (ft): 2 20

Total Depth (ft): 26.5
Ground Surface Elevation (ft): ≈73
Datum: NAVD88
Groundwater Depth Post Drilling (ft) (Date): ()

Depth (ft)	Sample Type	Sample	% Recovery	Graphic Symbol	Description	Water Level	Blows/6"	Blows/Foot (10 20 30 40 50+)	Other Tests
0		1			**Fill** Wet, brownish gray, fine SAND, some silt, some gravel; unsorted (SP-SM).	▼	3 7 7	14	
					Pre-Fraser Nonglacial Deposits				
5		2			Moist, brownish gray to light gray with iron oxide mottling, SILT to fine sandy, SILT; massive (ML).		7 20 31	51	
10		3			Moist, purple gray, SILT; massive; organics; interbeds of peat; organics odor (ML).		10 17 23	40	
15		4			Moist, brownish dark gray, silty, fine SAND; massive (SM).		14 20 25	45	
20		5			Wet, dark gray, fine SAND, trace silt, trace coarse sand; red sand grains (SP).	▼	21 50/6"	50/6"	
					Pre-Fraser Till				
25		6			Moist, brownish gray, SILT, some gravel; unsorted (ML). Driller calls refusal at 25 feet due to hard drilling conditions.		13 42 50/5"	50/5"	
					Perched groundwater at 2 feet and 20 feet ATD.				
30									
35									

8/13/2025

20200440E001

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Monitoring Well — EB-3W

Taylor Bay Sewage Treatment Plant — Sheet: 1 of 2

Longbranch, WA	Start Date: 6/23/2025	Logged By: LBK/SMS
20200440E002	Ending Date: 6/23/2025	Approved By: JHS

Driller/Equipment: Geologic Drill Part./tracked-HSA
Hammer Weight/Drop: 140#/30"
Hole Diameter (in): 8
Ground Surface Elevation (ft): 76
Water Level Elevation (ft): 62.9
Groundwater Depth ATD (ft): 19

Total Depth (ft): 22
Well Completion Depth (ft): 22
Well Tag No.: BQN 167
Top of Well Casing Elevation (ft): 75.7
Datum: NAVD88
Groundwater Depth Post Drilling (ft) (Date): 15.00 (7/9/2025)

Depth (ft)	Sample Type	Sample No.	Graphic Symbol	Description	Water Level	Blows/6"	Blows/Foot (10 20 30 40 50+)	Well Construction
0		1		**Fill - Access Road** Dry, brown, gravelly, fine SAND, some silt; abundant broken gravels (SP-SM).		6 12 9	21	Monument: Flush-mounted with 12-inch steel skirt Concrete 0 to 2 feet
2.5		2		**Fill** Slightly moist, dark blue-grey with orange (Fe-ox) staining, SILT, some fine sand to silty, fine SAND, trace gravel; unsorted (ML/SM).		18 5 7	12	Well Casing: 2-inch-diameter (nom) sch 40 PVC, threaded connections, J-plug cap, 0.3 to 20 feet Bentonite Seal: 3/8-inch bentonite chips, 2 to 19 feet
5		3		**Pre-Fraser Non-Glacial Deposits** Slightly moist, lavender brown, SILT, some to trace clay; massive (ML). Thin layer (≈1 to 2 inches) very moist, dark orange, silty, fine to medium SAND (SM). Moist, lavender brown, SILT, some to trace clay; massive (ML).		8 7 5	12	
7.5		4		As above.		2 7 12	19	
10		5		Moist, dark orangish brown, very silty, very fine SAND, trace gravel (SM). Very moist, dark purple grey, silty, very fine SAND; massive; mica present (SM). Abundant black, fine organics and thin wood pieces. Becomes very silty.		5 5 6	11	
12.5		6		Moist to very moist, dark purple brown to purple grey, SILT, some fine sand; abundant black, fine organics (ML). Occasional gravel (mudflow?)		6 5 7	12	
15		7		Very moist, dark purple brown to purple grey, very silty, very fine SAND; black, fine organics present; mica present (SM). Very moist, dark purple grey, fine sandy, SILT; black, fine organics present; mica present (ML).	▽	5 9 13	22	
17.5		8		As above.		11 27	60	

10/22/2025

20200440E002

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Monitoring Well — EB-3W

Taylor Bay Sewage Treatment Plant — Sheet: 2 of 2

Longbranch, WA	Start Date: 6/23/2025	Logged By: LBK/SMS
20200440E002	Ending Date: 6/23/2025	Approved By: JHS

Driller/Equipment: Geologic Drill Part./tracked-HSA
Hammer Weight/Drop: 140#/30"
Hole Diameter (in): 8
Ground Surface Elevation (ft): 76
Water Level Elevation (ft): 62.9
Groundwater Depth ATD (ft): 19

Total Depth (ft): 22
Well Completion Depth (ft): 22
Well Tag No.: BQN 167
Top of Well Casing Elevation (ft): 75.7
Datum: NAVD88
Groundwater Depth Post Drilling (ft) (Date): 15.00 (7/9/2025)

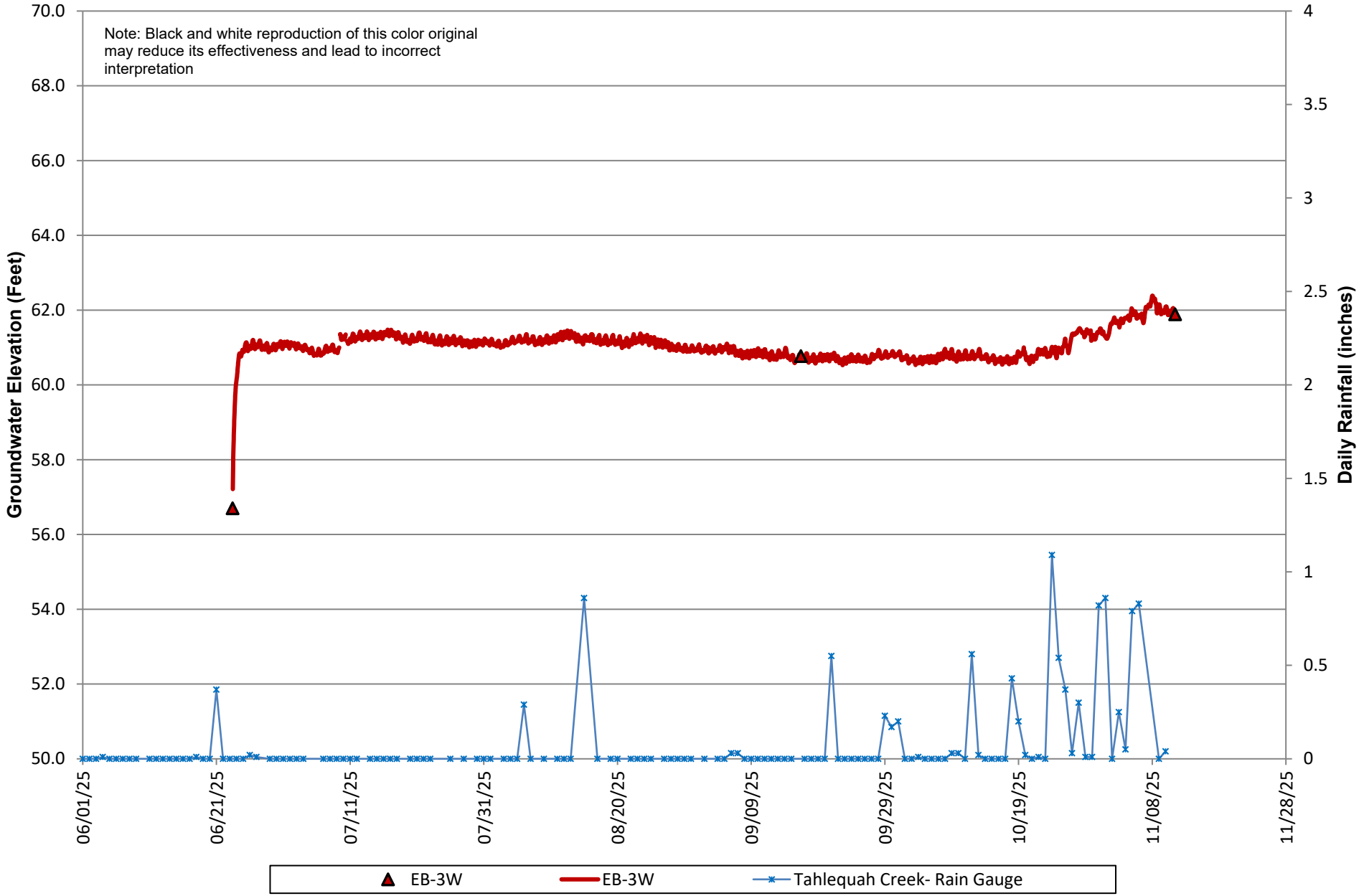
Depth (ft)	Sample Type	Sample No.	Graphic Symbol	Description	Water Level	Blows/6"	Blows/Foot (10 20 30 40 50+)	Well Construction
20		9		Very moist to wet, dark purple grey, silty, fine to medium SAND, trace gravel; fine laminae (SM).	▼	33		Sand Pack: 12/20 silica sand, 19 to 22 feet.
				Very moist to wet, dark purple grey, fine sandy, SILT, trace clay (ML). Wet, dark purple grey, fine to medium SAND, some silt; occasional fine laminae; otherwise massive (SP-SM).		8 17 28	45 ▲	Well Screen: 2-inch-diameter (nom) sch 40 PVC, 0.020-inch slot width, thread connections and end cap, 20 to 22 feet
22.5				Groundwater encountered at 18.73 feet after well installation. Well was developed about an hour after installation with a surge block and bailer. Water level immediately after development was 18.70 ft.				
25								
27.5								
30								
32.5								
35								

10/22/2025

20200440E002

APPENDIX B

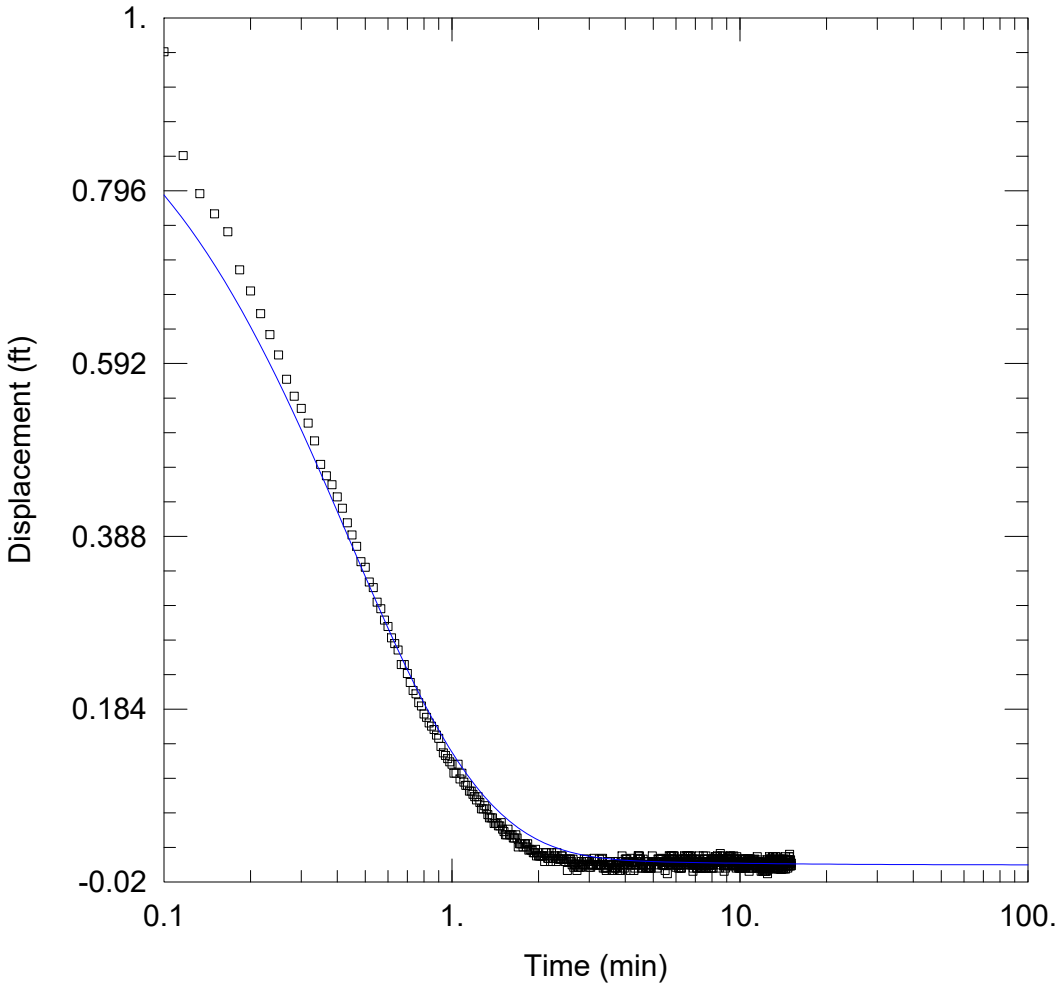
EB-3W Hydrograph



Groundwater Hydrograph
Taylor Bay Sewage Treatment Plant
Longbranch, Washington

APPENDIX C

Slug Testing Data



WELL TEST ANALYSIS

Data Set: C:\...\EB-3W_1.0ft_SlugOut_ady_lowS.aqt
Date: 08/19/25 Time: 12:39:29

PROJECT INFORMATION

Company: AESI
Client: Taylor STP
Project: 20200440
Location: EB-3W
Test Well: EB-3W
Test Date: 07/10/2025

AQUIFER DATA

Saturated Thickness: 4. ft

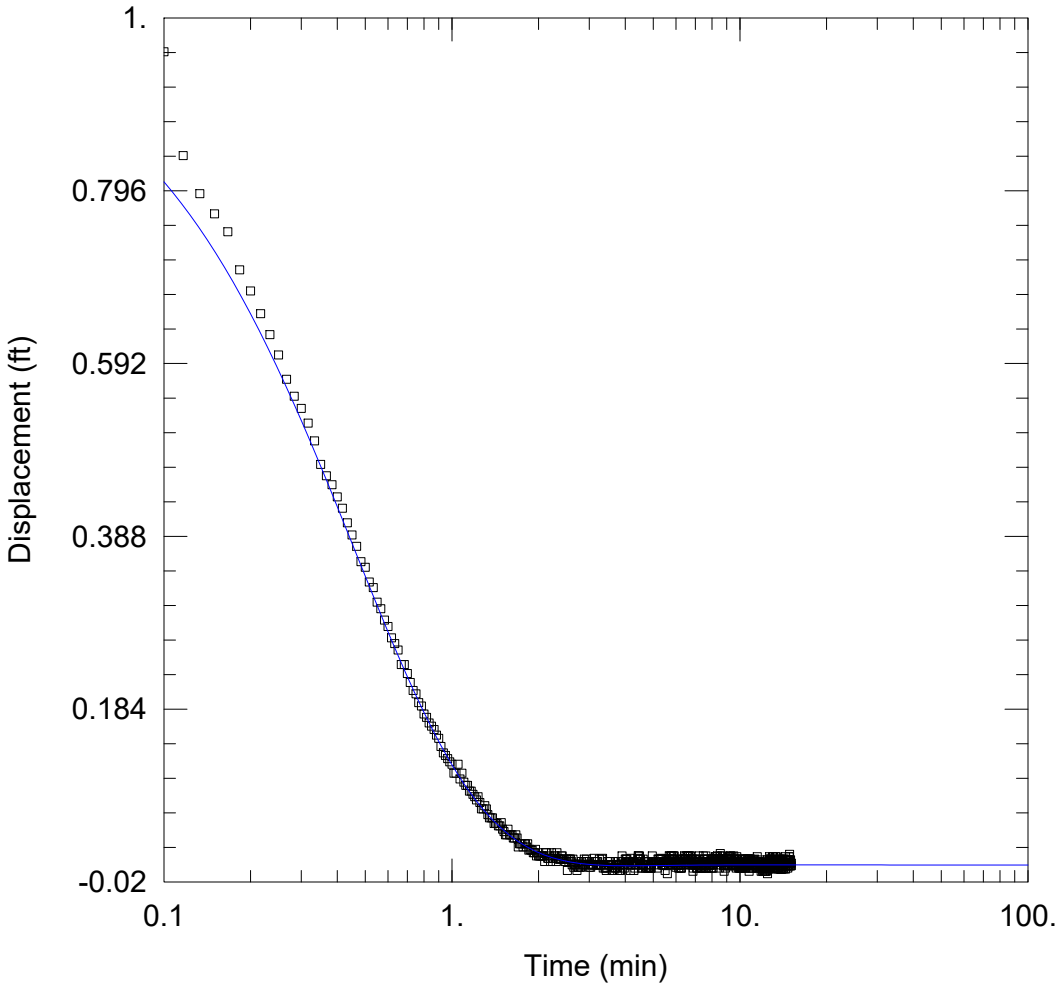
WELL DATA (EB-3W)

Initial Displacement: 1. ft
Total Well Penetration Depth: 3. ft
Casing Radius: 0.083 ft
Static Water Column Height: 9.04 ft
Screen Length: 2. ft
Well Radius: 0.33 ft

SOLUTION

Aquifer Model: Confined
Solution Method: KGS Model

Kr = 35.1 ft/day
Kz/Kr = 0.1
Ss = 2.5E-11 ft^{-1}



WELL TEST ANALYSIS

Data Set: C:\...\EB-3W_1.0ft_SlugOut_unconfined.aqt
Date: 08/19/25 Time: 12:39:58

PROJECT INFORMATION

Company: AESI
Client: Taylor STP
Project: 20200440
Location: EB-3W
Test Well: EB-3W
Test Date: 07/10/2025

AQUIFER DATA

Saturated Thickness: 12. ft

WELL DATA (EB-3W)

Initial Displacement: 1. ft
Total Well Penetration Depth: 3. ft
Casing Radius: 0.083 ft
Static Water Column Height: 12. ft
Screen Length: 2. ft
Well Radius: 0.33 ft

SOLUTION

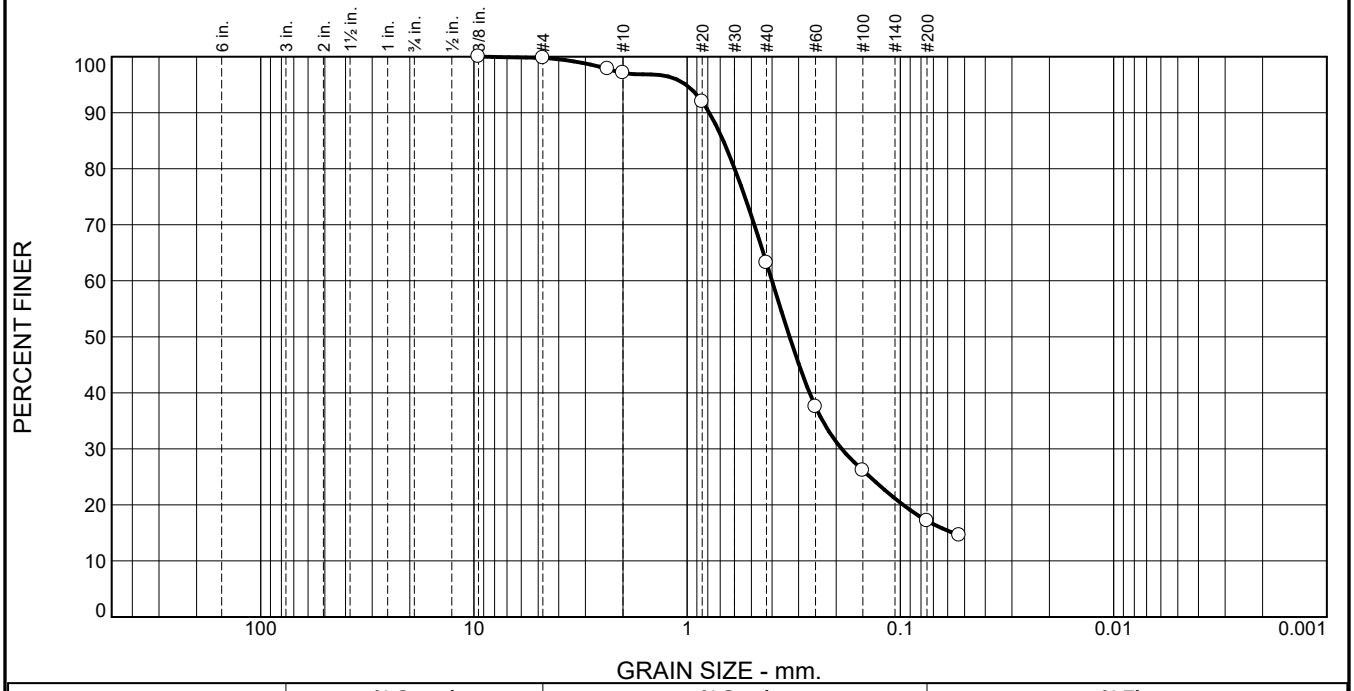
Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 13.26 ft/day
Kz/Kr = 0.1
Ss = 2.443E-10 ft^{-1}

APPENDIX D

Sieve Testing Results

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.2	2.7	33.9	46.0	17.2	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3/8"	100.0		
#4	99.8		
#8	97.8		
#10	97.1		
#20	92.0		
#40	63.2		
#60	37.5		
#100	26.2		
#200	17.2		
#270	14.6		

* (no specification provided)

Material Description

silty SAND trace gravel

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 0.7874 D_{85}= 0.6769 D_{60}= 0.4000
D_{50}= 0.3309 D_{30}= 0.1886 D_{15}= 0.0566
D_{10}= C_u= C_c=

Remarks

Date Received: 6-26-2025 **Date Tested:** 6-30-2025

Tested By: FEW

Checked By: LBK/TP

Title:

Location: Onsite
Sample Number: EB-3W **Depth:** 19'-19.5'

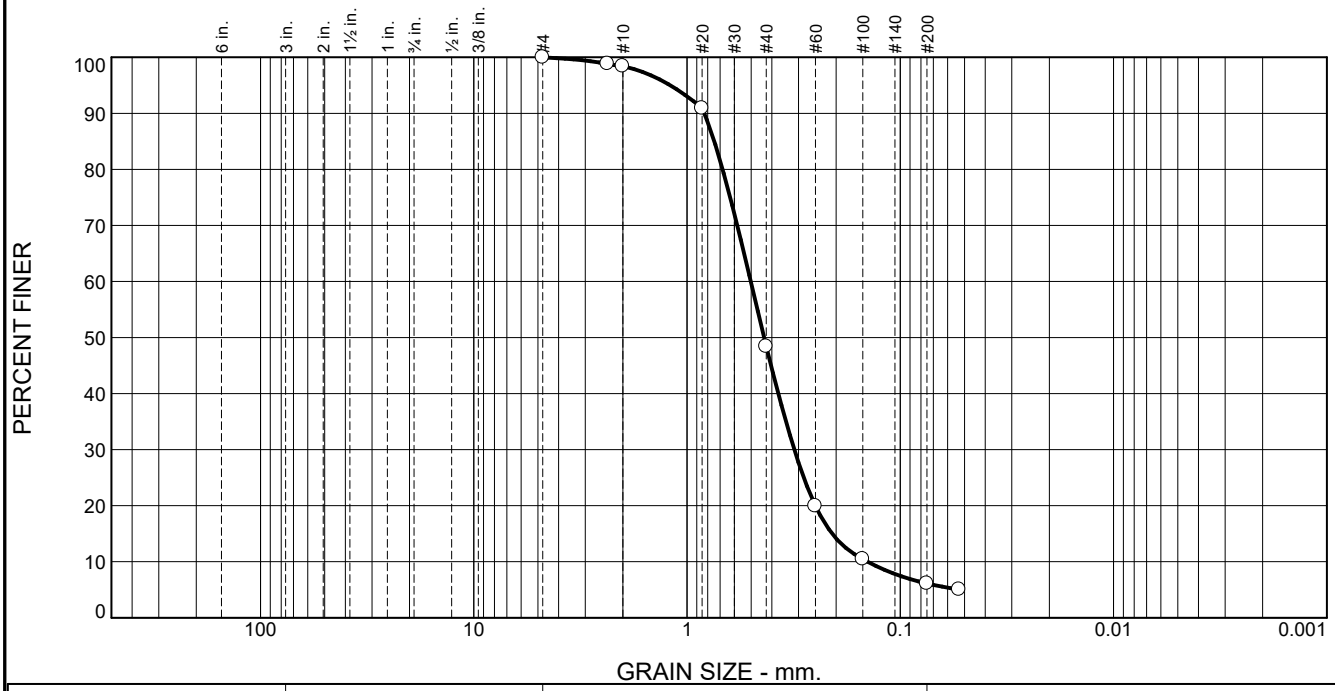
Date Sampled: 6-23-2025

associated earth sciences incorporated

Client: Gray and Osborne, Inc.
Project: Taylor Bay Sewage Treatment Plant

Project No: 20200440 E002 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	1.6	50.0	42.3	6.1	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100.0		
#8	98.8		
#10	98.4		
#20	90.9		
#40	48.4		
#60	19.9		
#100	10.5		
#200	6.1		
#270	5.0		

* (no specification provided)

Material Description

SAND some silt

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=**

Classification

USCS (D 2487)= SP-SM **AASHTO (M 145)=** A-1-b

Coefficients

D_{90}= 0.8304 D_{85}= 0.7453 D_{60}= 0.5026
D_{50}= 0.4351 D_{30}= 0.3140 D_{15}= 0.2089
D_{10}= 0.1426 C_u= 3.52 C_c= 1.38

Remarks

Date Received: 6-26-2025 **Date Tested:** 6-30-2025

Tested By: FEW

Checked By: LBK/TP

Title:

Location: Onsite
Sample Number: EB-3W **Depth:** 20.5'-22' **Date Sampled:** 6-23-2025

associated earth sciences incorporated

Client: Gray and Osborne, Inc.
Project: Taylor Bay Sewage Treatment Plant

Project No: 20200440 E002 **Figure**

OUTFALL GEOTECHNICAL REPORT

GEOTECHNICAL REPORT
TAYLOR BAY WWTF
OUTFALL REPLACEMENT
8220 – 178th Avenue Court Southwest
Pierce County, Washington

PROJECT NO. 24-274
October 2024

Prepared for:

Gray & Osborne, Inc.
CONSULTING ENGINEERS

PanGEO INCORPORATED

Geotechnical & Earthquake Engineering Consultants

PanGEO INCORPORATED
Geotechnical & Earthquake Engineering Consultants

October 31, 2024
PanGEO File No. 24-274

Peter Burgoon
Gray & Osborne, Inc.
11 Spokane Street, Suite 105
Wenatchee, Washington 98801

Subject: Geotechnical Report (Revised)
Taylor Bay WWTF Outfall Replacement
8220 – 178th Avenue Court Southwest, Pierce County, Washington
G&O IPN #22848.01

Dear Mr. Burgoon:

PanGEO Inc. is pleased to present this report to support the design and construction of the proposed outfall replacement for the Taylor Bay Wastewater Treatment Facility (WWTF) in unincorporated Pierce County, Washington.

In preparing this report, we completed a subsurface exploration program and, based on the subsurface data collected, it appears that the proposed outfall replacement can be completed as planned. The proposed outfall pipe should be secured/anchored with a manhole located sufficiently away from the bluff, and the pipe should be directed over the bluff where the slope has been improved by the existing gabion wall.

For the pipe trench excavation in the intertidal area, the on-site soils may be used as trench backfill. Within the WWTF, it is our opinion that the excavated materials may be used as trench backfill provided the soils can be properly compacted, otherwise imported structural fill should be used as trench backfill.

3213 Eastlake Avenue East, Suite B
Seattle, WA 98102
Tel (206) 262-0370
www.pangeoinc.com

We appreciate the opportunity to assist you with this project. Please call if you have any questions.

Sincerely,



Siew L. Tan, P.E.
Principal Geotechnical Engineer

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Figure A-4 Test Boring PG-3

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Test borings EB-1 and EB-2

GEOTECHNICAL REPORT
TAYLOR BAY WWTF OUTFALL REPLACEMENT
PIERCE COUNTY, WASHINGTON

1.0 GENERAL

PanGEO completed a geotechnical study for the Taylor Bay Wastewater Treatment Facility (WWTF) Outfall Replacement project in Pierce County. The objective of our study was to evaluate subsurface conditions at the site and provide geotechnical design parameters to assist you with the proposed outfall replacement at the site.

Our work was performed in accordance with our proposal dated June 28, 2024, which was approved on July 2, 2024. Our scope of work included reviewing readily available geologic and geotechnical data, a site reconnaissance, drilling and logging three test borings, and developing the conclusions and recommendations presented in this report.

2.0 SITE AND PROJECT DESCRIPTION

The subject site is located at the Taylor Bay Wastewater Treatment Facility (WWTF) at 8220 – 178th Avenue Court Southwest in unincorporated Pierce County, Washington. The approximate site location is shown on the attached Figure 1, Vicinity Map. The facility is located on an approximately 0.25-acre parcel at the top of an approximately 60-foot-tall bluff overlooking Taylor Bay. The existing site conditions are shown in Plates 1 and 2 on the following pages.

We understand that following a landslide on the slope below the northwest corner of the WWTF in 1994, the community came together to build a gabion wall along the affected area of the slope. Based on documentation provided by Gray & Osborne, including a Figure 1-3 Existing Site Plan, receipts for the gabion baskets and quarry spalls, and verbal information provided by a local resident and facility manager (Steve Stemhagen), the wall is approximately 30 to 40 feet long, 3 to 4 feet wide, and 15 to 20 feet tall. According to Steve Stemhagen, the wall was founded on native “hardpan,” and the bottom row is two baskets wide. Based on receipts provided for the gabion baskets, each basket was 3-feet wide, making the base of the wall approximately 6-feet wide. No other information, such as design drawings or an as-built was provided. We also understand

that, based on verbal discussions, this area has been stable since the gabion wall was constructed, with no signs of slope instabilities.



Plate 1: *Aerial view of the site.*

North is at the top of the image.

The site is outlined in a yellow dashed line.



Plate 2: *Looking southwest along the proposed outfall alignment.*

An existing outfall pipe descends from the top of the bluff along the south side of the gabion wall, as shown in Figures 2A and 2B. The proposed improvements involve replacing the outfall pipe with an 8-inch diameter HDPE gravity sewer pipe. Based on preliminary drawings dated August 2024, a manhole will be installed on the north end of the site, approximately 60 feet east of the gabion wall with an approximate invert elevation of 71.8 feet. The proposed outfall pipe will then be directed westward at about 3 feet below existing grade and daylight into the gabion wall. From the gabion wall, the pipe will be directed along the surface of the slope down to the intertidal zone where it will be directed approximately 3 feet below grade towards its discharge point and daylighting at approximately Elevation -10 feet. We understand driftwood will be secured in front of the outfall pipe at the bottom of the bluff to protect the pipe from storm damage, similar to the existing outfall pipe.

The conclusions and recommendations outlined in this report are based on our understanding of the proposed project, which is in turn based on the project information provided. If the above project description is substantially different from the proposed improvements or if the project scope changes, PanGEO should be consulted to review the recommendations contained in this report and make modifications, if needed.

3.0 SUBSURFACE EXPLORATIONS

3.1 TEST BORINGS

Three test borings (PG-1, PG-2, and PG-3) were completed at the site on July 24, 2024, at the approximate locations indicated on Figures 2A and 2B. The test borings were drilled to about 5 to 28½ feet below existing grade.

Soil samples were obtained from the borings at 2½- and 5-foot depth intervals in conjunction with Standard Penetration Test (SPT) sampling methods in general accordance with ASTM test method ASTM D-1586, Standard Test Method for Penetration Test and Split Spoon Barrel of Soils, in which the samples are obtained using a 2-inch outside diameter split-spoon sampler. The sampler was driven into the soil a distance of 18 inches using a 140-pound weight falling a distance of 30 inches. The

number of blows required for each 6-inch increment of sampler penetration was recorded. The number of blows required to achieve the last 12 inches of sampler penetration is defined as the SPT N-value. The N-value provides an empirical measure of the relative density of cohesionless soil, or the relative consistency of fine-grained soils.

A geologist from PanGEO was present throughout the field exploration program to observe the drilling, assist in sampling, and to document the soil samples obtained from the borings. The borings were backfilled with bentonite chips upon completion. The soil samples retrieved from the borings were described using the system outlined on Figure A-1 of Appendix A. The summary boring logs are included as Figures A-2 and A-4.

3.2 PREVIOUS TEST BORINGS

Associated Earth Sciences (AESI) previously completed a geotechnical study at the WWTF in 2024, which included two test borings at the site. The approximate locations of these previous test borings, designated as EB-1 and EB-2, are shown on the attached Figures 2A and 2B. The summary test boring logs are included in Appendix B. The previous test borings were advanced to approximately 21½ and 26½ feet below grade.

4.0 SUBSURFACE CONDITIONS

4.1 SITE GEOLOGY

Based on our review of the *Geologic Map of the Longbranch 7.5-Minute Quadrangle, Thurston, Pierce, and Mason Counties, Washington* (Logan et al., 2003), the geologic units in the area of the site consist of Landslide Deposits (Geologic Map Unit Qls), Pre-Vashon Sandy Deposits (Geologic Map Unit Qps), Pre-Vashon Gravel Deposits (Geologic Map Unit Qpg) and Beach Deposits (Geologic Map Unit Qb). The principal characteristics of these soil units are described below:

- **Beach Deposits (Qb):** Beach deposits typically consist of sand and gravel deposited in the intertidal zone.

- **Landslide Deposits (Qls):** This deposit consists of clay, silt, sand, and gravel transported downslope as landslides, earth flows, and slumps. Material ranges from blocks to intermixed debris.
- **Pre-Vashon Sandy Deposits (Qps):** This deposit consists primarily of sand interbedded with laminated silt and is generally considered to be nonglacial but may include glacial-stage deposits.
- **Pre-Vashon Gravel Deposits (Qpg):** This deposit consists primarily of gravel and sand most commonly exposed below the Pre-Vashon Sandy Deposits and is generally considered to be glacial in origin.

4.2 SOIL CONDITIONS

The following is a generalized description of the soils encountered in our explorations. For additional details, please refer to the test boring logs included in Appendices A and B. In addition to the boring logs, a generalized subsurface profile (see Figure 3) was developed based on the results of the test borings and our observations of the site conditions.

Our subsurface descriptions are based on the conditions encountered at the time of our exploration. It should be noted that the stratigraphic contacts indicated on the boring logs represent the approximate depth to boundaries between soil units. Actual transitions between soil units may be more gradual or occur at different elevations. Soil and rock conditions between our exploration locations may vary from those encountered. The nature and extent of variations between our exploratory locations may not become evident until construction. If variations do appear, PanGEO should be requested to reevaluate the recommendations in this report and to modify or verify them in writing prior to proceeding with earthwork and construction.

4.2.1 Upland Area

A summary of the generalized soil units encountered in the test borings within the WWTF are presented below:

Fill – Test boring PG-1 was completed near the top of the bluff, behind the existing gabion wall. The boring encountered approximately 9½ feet of loose to medium dense silty sand to occasionally sandy silt, with varying amounts of gravel. Scattered to numerous organic debris (roots and rootlets) were observed in this unit. We interpret this unit as fill that was placed as gabion wall backfill.

Previous test borings EB-1 and EB-2 noted the upper approximately 6½ to 2 feet, respectively, consisted of fill. The fill was generally described as loose to medium dense silty sand with some gravel and organic debris.

Landslide Deposits (Qls) – In the previous boring EB-1, located at the east end of the site, the soils below the fill are described as a mass wasting deposit consisting of dense sand with silt to hard sandy silt. We interpret this unit to be the Landslide Deposits mapped at the site. This unit was logged in EB-1 at about 6½ to 17½ feet deep, overlying the Pre-Fraser Nonglacial Deposits that we interpret as the mapped Pre-Vashon Sandy Deposits. Landslide Deposits were not observed in test borings PG-1 through PG-3 or described in previous boring EB-2.

Pre-Vashon Sandy Deposits (Qps) – Below the fill in PG-1, we encountered medium dense to dense sand with varying amounts of silt with interbedded sandy silt. This unit was observed to about 19 feet deep in PG-1 and was not encountered in PG-2 or PG-3. This soil unit appears consistent with the Pre-Vashon Sandy Deposits mapped in the vicinity of the site. This unit also appears generally consistent with soils described in previous borings EB-1 and EB-2, referred to as Pre-Fraser Nonglacial Deposits

Pre-Vashon Gravel Deposits (Qpg) – Below the Pre-Vashon Sandy Deposits in PG-1, the soil consisted of a very dense sandy silt to silty sand with trace gravel. This unit was observed to the maximum exploration depth of about 28½ feet in

PG-1. This soil unit appears generally consistent with the Pre-Vashon Gravel Deposits mapped in the vicinity of the site and is generally consistent with the soil described in the previous boring EB-2, referred to as Pre-Fraser Till.

4.2.2 Intertidal Zone

Test borings PG-2 and PG-3 were completed in the intertidal zone and encountered medium dense sand with gravel. Additionally, numerous cobbles were observed on the beach but were too large to be observed in the soil samples. This unit was observed to about 2 feet deep in PG-2 located at the bottom of the bluff and to the maximum exploration depth of about 5 feet deep in PG-3 located closer to the low-tide zone. This soil unit appears consistent with the Beach Deposits mapped near the site.

In PG-2, below the beach deposits, we encountered a unit of medium dense to very dense sandy silt to sand with silt, which we interpreted as Pre-Vashon undifferentiated sediments.

4.3 GROUNDWATER

Where the planned manhole is intended, east of the existing WWTF lab, perched groundwater was noted in previous borings EB-1 at about 12 feet deep and EB-2 at about 2 and 20 feet deep.

Where the outfall pipe trench is planned behind the existing gabion wall, perched groundwater was encountered in boring PG-1 between approximately 6 to 9 feet and 15 to 19 feet below the existing grade.

Where the outfall pipe trench is planned in the intertidal zone, borings PG-2 and PG-3 effectively encountered groundwater near the ground surface. PG-2, located at the bottom of the bluff, encountered perched water at about 1 to 2 feet deep and saturated soil conditions at about 7 feet deep.

The design team and earthwork contractor should be aware that groundwater levels and seepage rates are not static. There will likely be fluctuations in the groundwater levels and seepage rates depending on the season, amount of rainfall, surface water runoff, tidal

influence (for the intertidal zone), and other factors. Generally, the water level is higher and seepage rates are greater in the wetter, winter months (typically October through May).

5.0 CRITICAL AREA REVIEW

According to our review of the Pierce County parcel information, the site is mapped as a landslide and erosion hazard. Based on review of the Department of Ecology Shoreline Photo Viewer (see Plate 3 below), landslides have occurred along the bluff to the north and south of the site.

The documented landslides appear to be relatively shallow and are common on steep slopes in Puget Sound. This types of slides are in part caused by weathering and loosening of surficial soils (such as by tree roots), and triggered by groundwater and/or precipitations.



Plate 3: *Oblique aerial view of the site, facing northeast. Photo taken 6/27/2016.*

The site is outlined in a yellow dashed line. Nearby landslides along the bluff circled in red.

We understand a landslide occurred near the northwest corner of the property in 1994. We understand the landslide was remediated by constructing a gabion wall along the affected bluff.

It is our opinion that the area south of the gabion wall is likely more at-risk because of its steeper slope gradient, and potential presence of weathered/disturbed surficial soils. Hence, it is our opinion that the area where the existing gabion wall is located is a better option.

Based on our understanding of subsurface conditions and the proposed improvement concept, it is our opinion that the current design will not adversely impact the stability of the site and its vicinity.

6.0 GEOTECHNICAL RECOMMENDATIONS

6.1 LIQUEFACTION POTENTIAL

Liquefaction is a process that can occur when soil loses shear strength for short periods of time during a seismic event. Ground shaking of sufficient strength and duration results in the loss of grain-to-grain contact and an increase in pore water pressure, causing the soil to behave as a fluid. Soils with a potential for liquefaction are typically cohesionless, predominately silt and sand sized, must be loose, and be below the groundwater table.

In the intertidal zone, the submerged soils are relatively coarse grained and are considered low risk for soil liquefaction. Within the WWTF, the risk of liquefaction is considered negligible because of the presence of very dense soils within shallow depths. As such, it is opinion that design considerations associated with liquefaction are not needed for this project.

6.2 LATERAL RESISTANCE FOR MANHOLE

As currently envisaged, a manhole will be installed about 60 feet from the top of the bluff to anchor the outfall pipe. Lateral forces on the manhole can be resisted by passive resistance of soil backfill against the manhole. We recommend that an allowable passive pressure of 300 pcf be used for design, applied over two time the diameter of the manhole. The passive pressure within the uppermost one foot of the ground surface should be ignored for design.

The recommended value is based on the assumption that properly compacted fill will be placed against the manhole and level ground surface.

If the manhole will be subjected to the influence of surcharge loading within a horizontal distance equal to or less than the height of the walls, the walls should be designed for the additional horizontal pressure calculated using a lateral pressure coefficient of 0.4.

Surcharge from vehicle traffic within 5 feet of the manhole may be calculated using a uniform lateral pressure of 100 psf.

6.3 Pipe Installation through the Gabian Wall

We recommend removing one gabion basket on the top row and directing the pipe through the gap. The removed basket can be replaced by installing custom-sized gabion baskets on either side of the pipe.

The pipe invert should be located about 3 feet below the top of the existing gabion wall, so that the lower row of gabion baskets can remain as is. The pipe should sit freely on the gabion basket and should not be directly anchored to the gabion wall. The gabion wall should not be used as an anchor for the outfall pipe.

6.4 Pipe Anchoring on the Slope

Pipe anchors should consist of minimum #9 rebars driven by hand (i.e., sledgehammer) to at least 3 feet or refusal. In our opinion, due to the density of the site soils and gradient of the bluff, driving galvanized iron anchors such as 2-inch diameter pipe piles may be difficult. One concept for pipe anchors is shown in Plate 4 on the following page.

Based on boring PG-1 located behind the gabion wall, we anticipate the soil conditions of the slope to consist of medium dense to very dense sand with silt to silty sand to sandy silt with trace gravel (Pre-Vashon Deposits). However, in our experience, loose surficial soils (i.e., colluvium) may be present at the surface along steep slopes.

The pipe anchor collars should be over-sized relative to the pipe diameter to accommodate the thermal expansion of the HDPE pipe. Anchors should have an

approximate spacing of 5 to 10 feet along the pipe. However, actual spacing should be determined in the field based on the observed topography and soil conditions.

In our experience, the pipe can likely be directed along the slope to the bottom of the bluff by relying on the curvature of the pipe without the need for a thrust block at the base of the bluff. The topography depicted in our generalized subsurface profile (Figure 3) is based on Pierce County, WA LiDAR from 2020. Field conditions may vary based on the pipe trajectory relative to the location of the subsurface profile as shown on the site and exploration plans (Figures 2A and 2B). Additionally, site conditions may have changed since the LiDAR scan (2020) due to natural erosion of the bluff.

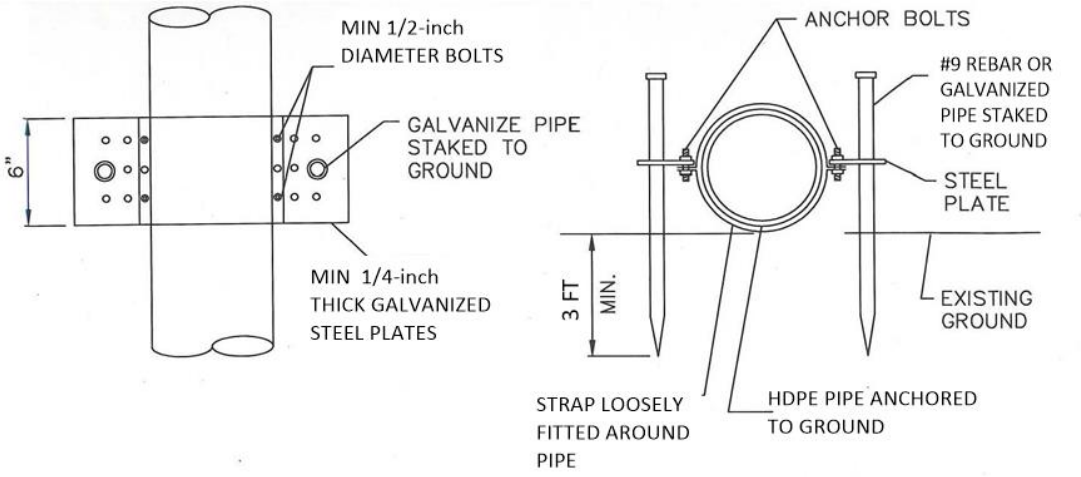


Plate 4. Concept for Pipe Anchors

6.5 EROSION CONTROL CONSIDERATIONS

Care should be taken to limit the area of clearing and grading of the bluff prior to pipe installation to minimize the amount and duration of bare soil exposed. The temporary removal of vegetation on the slope may increase the risk of surficial sloughing on the slope, and should be limited to the pipe alignment. The root balls of the removed trees, if any, should remain in place if feasible. We also recommend that any disturbed ground exposed on the slope due to tree removal be revegetated or covered with mulch. If the

slope cannot be immediately revegetated due to weather, the disturbed slope area should be covered with plastic sheets for temporary protection until the area can be revegetated.

In our opinion, the potential for erosion at the site can be adequately mitigated by employing best management practices (BMPs). During construction, erosion control should include measures for reducing concentrated surface runoff and for reducing the potential of off-site sediment transport by protecting disturbed or exposed surfaces. The construction stormwater control plan (CSC) should include the following:

- Where practical, maintain vegetation buffers around cleared areas.
- The ground surface within the construction area should be graded to prevent ponding of water and to prevent runoff from reaching site slopes
- Adequately cover soil stockpiles with plastic sheeting.
- Place hydroseed, mulch, or straw in areas where grading is completed.
- Divert water away from the top of slopes.
- Use silt fences and/or straw bales around the site perimeter.
- If possible, stage construction such that the amount of exposed soil and exposure time is minimized.

The erosion control measures should be inspected on a regular basis to verify they are functioning as intended.

Adequate drainage provisions are imperative to improve the performance of the site slope. We recommend both short-term and long-term drainage measures be incorporated into the project design and construction. Surface runoff can be controlled during construction by careful grading practices and BMPs, as described above. All collected water should be directed under control to a positive and permanent discharge system.

Permanent control of surface water should be incorporated in the final grading design. Adequate surface gradients and drainage systems should be incorporated into the design such that surface runoff is directed away from structures and away from site slopes. Collected water from the surface runoff should be routed into an appropriate discharge

point and should *not* be discharged onto the site slopes or into the gabion wall. For post-construction, long-term erosion can be mitigated by revegetating disturbed areas and controlling surface water runoff.

Following restoration, in our opinion, the restored area will protect the slope integrity by vegetating bare soil and providing suitable drainage to mitigate soil erosion. Provided restoration is completed and erosion is mitigated as described above, it is our opinion that the proposed work will not adversely impact the steep slope area.

6.6 BUOYANCY

The outfall pipe within the intertidal zone may be subjected to buoyancy force if it is empty or partially full. The buoyancy force may be partially resisted by the weight of the trench backfill above the pipe. The weight of the trench backfill may be computed using an effective soil unit weight of 50 pounds per cubic foot for submerged soils. A unit weight of 115 pcf may be used for soils located above water level.

6.7 TRENCHING

We understand that the below grade portions of the planned outfall pipe will be approximately 3 feet deep with a slightly deeper excavation anticipated for the manhole.

Within the WWTF property near the planned manhole, dense to very dense silt to sandy silt is anticipated at about 2 feet deep. Based on PG-1 located between the gabion wall and existing lab, fill consisting of loose to medium dense silty sand to sandy silt is anticipated to extend to about 10 feet deep. Fill thickness may increase towards the gabion wall. In the intertidal zone, the soil consists of a medium dense to very dense silty sand to sandy silt with gravel and cobbles.

In the intertidal zone, water is expected to be present within the trench excavation, even during low tides. Because of the relatively coarse-grained nature of the site soils, seepage rate into the excavation is anticipated to be quite high and the efforts to maintain a dry excavation are anticipated to be quite extensive. However, because of the flexible nature

of the proposed pipe material (HDPE) and the relatively shallow invert depth, it is our opinion that it is feasible to install the outfall pipe in wet conditions.

The excavated trench in the intertidal zone should be backfilled the same day. As a result, the pipe will likely need to be installed in multiple stages, and mechanical connections will be needed to splice the pipe sections together. We envisage that, at each stage, a portion of the trench will be excavated or dredged in the wet soil to the proposed pipe invert elevation. The excavated materials will be stockpiled adjacent to the trench or on a barge. Once the pipe section is secured in place, the excavated materials will then be used as trench backfill.

All temporary excavations should be performed in accordance with Part N of WAC (Washington Administrative Code) 296-155. The contractor is responsible for maintaining safe excavation slopes and/or shoring. Any temporary excavation greater than 4 feet deep should be properly sloped or shored. For planning purposes, it is our opinion that temporary excavations may be sloped as steep as 1H:1V (Horizontal:Vertical). Alternatively, conventional trench boxes are considered appropriate for this project.

6.8 SUBGRADE PREPARATION

Based on the test borings, we anticipate the pipe subgrade within the WWTF to consist of native soils (medium dense to very dense silty sand to silt), and undocumented fill near the gabion wall. In the intertidal zone, the pipe subgrade is anticipated to consist of beach deposits that generally consist of loose sand, gravel and cobble with silt. The on-site soils are considered adequate for supporting the proposed HDPE pipe.

Loose or soft soils, if present, should be compacted to a dense and unyielding condition with a jumping jack or a hoe-pack before pipe installation. If the loose soils cannot be compacted, it should be over-excavated at least one foot below the pipe and backfilled with a compacted Crushed Surfacing Base Course (CSBC) per Section 9-03.9(3) of Standard Specifications (WSDOT, 2024) to provide a stable base beneath the pipes. A layer of geotextile should be placed below the CSBC to improve subgrade stability.

The stability of the trench subgrade may be affected by groundwater seepage, precipitation, repetitive construction traffic or other factors. The trench subgrade should be observed and verified by experienced personnel before placing pipes.

6.9 PIPE BEDDING

The on-site soils are considered adequate for supporting HDPE pipe and the use of pipe bedding is optional. If bedding materials will be used to level and smooth surface, it should consist of Gravel Backfill for Pipe Zone Bedding in Section 9-03.12(3) of WSDOT's *Standard Specifications*.

6.10 TRENCH BACKFILL

In the intertidal zone, the excavated on-site soils may be used as trench backfill. Compaction of the trench backfill is likely not practical. Hence, the trench backfill within the intertidal zone can be loosely placed.

Within the WWTF, the on-site soils may be used as trench backfill and backfill around the manhole, provided that the on-site soils can be properly compacted to meet the project specifications. If imported soils are needed to backfill the trench and manhole, the imported soils should consist of Gravel Borrow (Section 9-03.14 (1) of the 2024 WSDOT *Standard Specifications*), or approved equivalent.

The first zone of backfill extending from the bedding material to at least 6 inches above the crown of the pipe should consist of select free-draining granular material to reduce the compaction effort required and resulting stresses on the pipe.

During placement of the initial lifts, the trench backfill should not be bulldozed into the trench or dropped directly on the pipe. Furthermore, heavy vibratory equipment should not be permitted to operate directly over the pipe until a minimum of 2 feet of backfill has been placed above the crown. The trench backfill material should be placed in 8- to 12-inch, loose lifts and compacted to at least 95 percent maximum density, determined using ASTM D 1557 (Modified Proctor) in the uppermost 2 feet, and to at least 90% below the uppermost 2 feet.

6.11 WET WEATHER EARTHWORK

In our opinion, the proposed construction may be accomplished during wet weather. However, it is likely more economical to perform the earthwork construction during the drier summer months. Winter/spring construction will require the implementation of best management erosion and sedimentation control practices to reduce the chance of off-site sediment transport. The on-site subgrade soils may become saturated and spongy, and difficult to compact due to rain in the wet season. Soft subgrade soil due to inclement weather, disturbance, and poor drainage will require removal and replacement with well-compacted structural fill. Additionally, groundwater levels are typically higher in the winter/spring seasons than in the summer.

General recommendations related to earthwork performed in wet weather or in wet conditions are presented below. These recommendations should be incorporated into the contract specifications.

- Earthwork should be performed in small areas to minimize exposure to wet weather. Excavation or the removal of unsuitable soil should be followed promptly by the placement and compaction of clean structural fill. The size and type of construction equipment used may have to be limited to prevent soil disturbance. Under some circumstances, it may be necessary to excavate soils with a backhoe to minimize subgrade disturbance caused by equipment traffic.

- During wet weather conditions, the allowable fines content of the gravel borrow should be reduced to no more than 5 percent by weight based on the portion passing ¾-inch sieve. The fines should be non-plastic.

- The ground surface within the construction area should be graded to promote run-off of surface water and to prevent the ponding of water.

- The ground surface within the construction area should be sealed by a smooth drum vibratory roller, or equivalent, and under no circumstances should soil be left uncompacted and exposed to moisture.

- Geotextile silt fences or hay bales should be strategically located to control erosion and the movement of soil.

7.0 LIMITATIONS

We have prepared this report for Gray & Osborne, Inc., and the project design team. Recommendations contained in this report are based on a site reconnaissance, a subsurface exploration program, review of pertinent subsurface information, and our understanding of the project. The study was performed using a mutually agreed-upon scope of work.

Variations in soil conditions may exist between the locations of the explorations and the actual conditions underlying the site. The nature and extent of soil variations may not be evident until construction occurs. If any soil conditions are encountered at the site that are different from those described in this report, we should be notified immediately to review the applicability of our recommendations. Additionally, we should also be notified to review the applicability of our recommendations if there are any changes in the project scope.

The scope of our work does not include services related to construction safety precautions. Our recommendations are not intended to direct the contractors' methods, techniques, sequences or procedures, except as specifically described in our report for consideration in design. Additionally, the scope of our work specifically excludes the assessment of environmental characteristics, particularly those involving hazardous substances.

This report has been prepared for planning and design purposes for specific application to the proposed project in accordance with the generally accepted standards of local practice at the time this report was written. No warranty, express or implied, is made.

This report may be used only by the client and for the purposes stated, within a reasonable time from its issuance. Land use, site conditions (both off and on-site), or other factors including advances in our understanding of applied science, may change over time and could materially affect our findings. Therefore, this report should not be

relied upon after 24 months from its issuance. PanGEO should be notified if the project is delayed by more than 24 months from the date of this report so that we may review the applicability of our conclusions considering the time lapse.

It is the client's responsibility to see that all parties to this project, including the designer, contractor, subcontractors, etc., are made aware of this report in its entirety. The use of information contained in this report for bidding purposes should be done at the contractor's option and risk. Any party other than the client who wishes to use this report shall notify PanGEO of such intended use and for permission to copy this report. Based on the intended use of the report, PanGEO may require that additional work be performed and that an updated report be reissued. Noncompliance with any of these requirements will release PanGEO from any liability resulting from the use of this report.

We appreciate the opportunity to be of service.

Sincerely,

PanGEO, Inc.





Mary V. Green, LEG, CEG
Project Engineering Geologist

Siew L. Tan, P.E.
Principal Geotechnical Engineer

8.0 LIST OF REFERENCES

Associated Earth Sciences Incorporated (AESI), 2024, *Subsurface Exploration, Geologic Hazard, and Geotechnical Engineering Report, Taylor Bay Sewage Treatment Plant, Longbranch, Washington,* Prepared for Gray and Osborne, Inc.

International Code Council (IBC), 2018. *International Building Code 2018*. Country Club Hills, IL: International Code Council, Inc.

International Code Council (IBC), 2021. *International Building Code 2021*. Country Club Hills, IL: International Code Council, Inc.

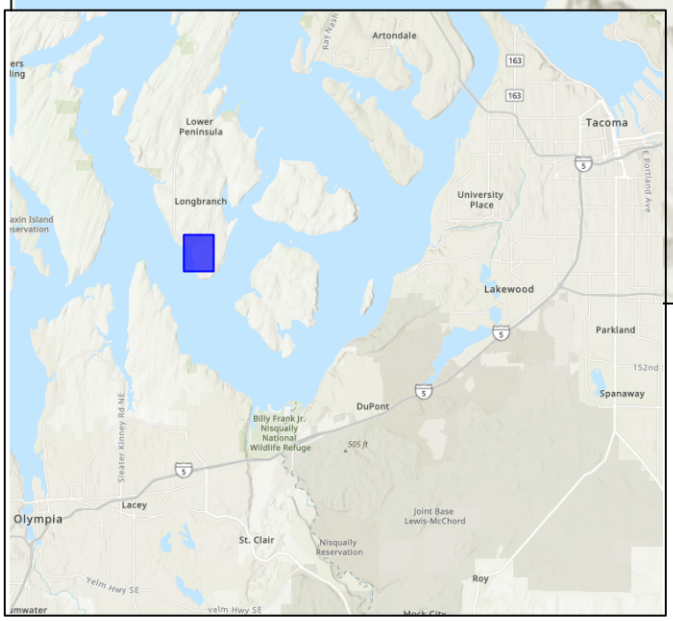
Logan, R.L., Walsh, T.J., and Polenz, M., 2003, *Geologic Map of the Longbranch 7.5-Minute Quadrangle, Thurston, Pierce, and Mason Counties, Washington*, Washington Division of Geology and Earth Resources, Open File Report 2003-21, scale 1:24,000.

Pierce County, *Public GIS*, accessed August 10, 2024 via https://matterhornwab.co.pierce.wa.us/publicgis/

Washington Administration Code (WAC), 2023, *Part N – Excavation, Trenching, and Shoring.*

WSDOT, 2024, *Standard Specifications for Road, Bridge and Municipal Construction*, M 41-10, Washington State Department of Transportation.





Base Map: ESRI Topographic

NORTH

Not to Scale

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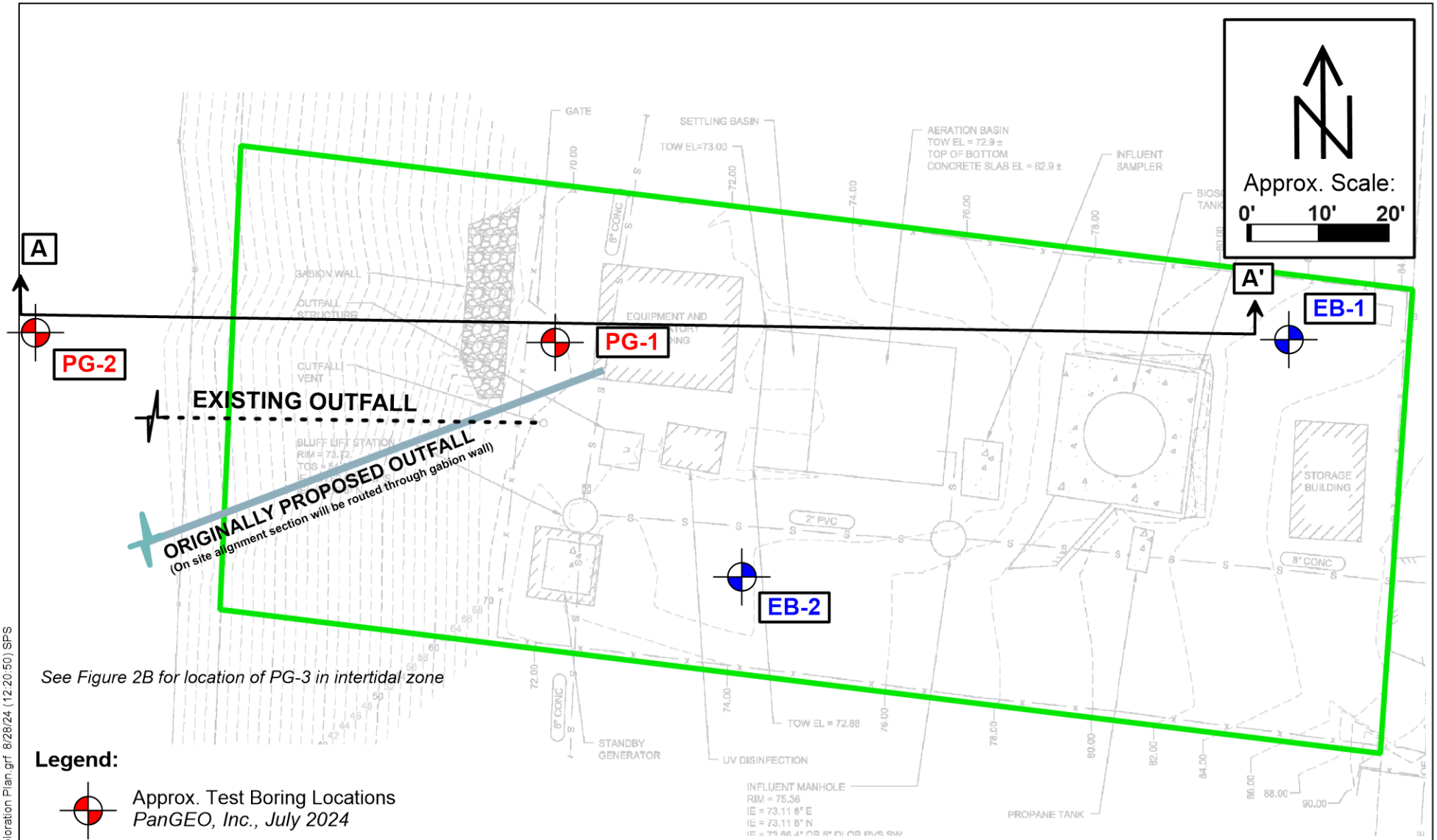
Taylor Bay WWTF
Outfall Replacement
8220 - 178th Avenue Court SW
Pierce County, Washington

VICINITY MAP

Project No. **24-274**

Figure No. **1**

24-274 Fig 1 - Vicinity Map.grf 7/18/24 (2:36:08) MVG



See Figure 2B for location of PG-3 in intertidal zone

Legend:

- Approx. Test Boring Locations *PanGEO, Inc., July 2024*
- Approx. Test Boring Locations *AESI, Inc., May 2024*
- Parcel Boundary
- Subsurface Profile

Base map modified from 2024 Site Survey provided by Gray & Osborne, dated May 15, 2024

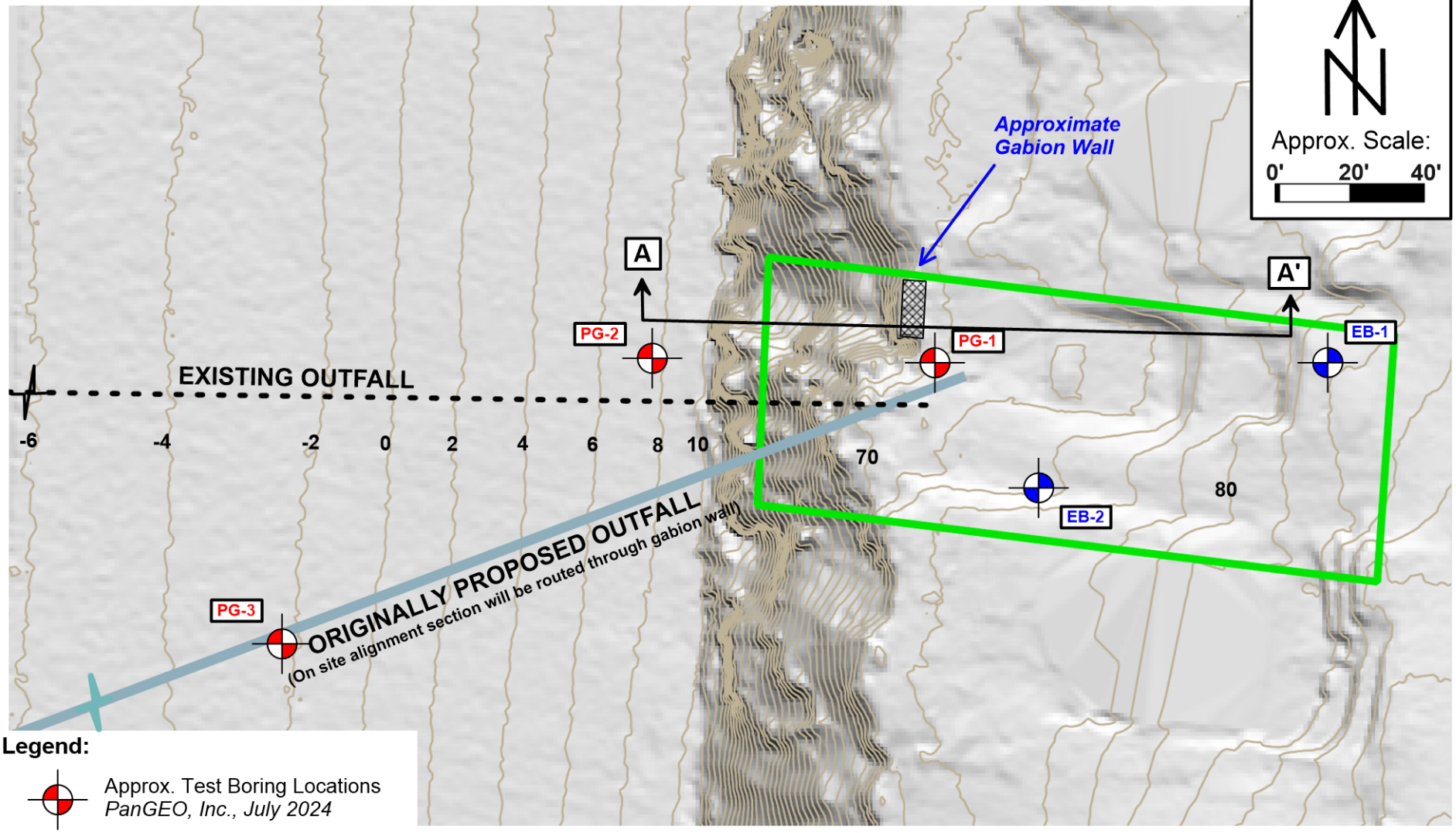
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Taylor Bay WWTF
Outfall Replacement
8220 - 178th Avenue Court SW
Pierce County, Washington

SITE AND EXPLORATION PLAN
- SURVEY EXHIBIT -

Project No. **24-274** | Figure No. **2A**

24-274 Fig 2A - Site Exploration Plan.grf 8/28/24 (12:20:50) SPS



Legend:

- Approx. Test Boring Locations *PanGEO, Inc., July 2024*
- Approx. Test Boring Locations *AESI, Inc., May 2024*
- Parcel Boundary
- Subsurface Profile

Base map modified from 2020 Pierce County LiDAR Dataset

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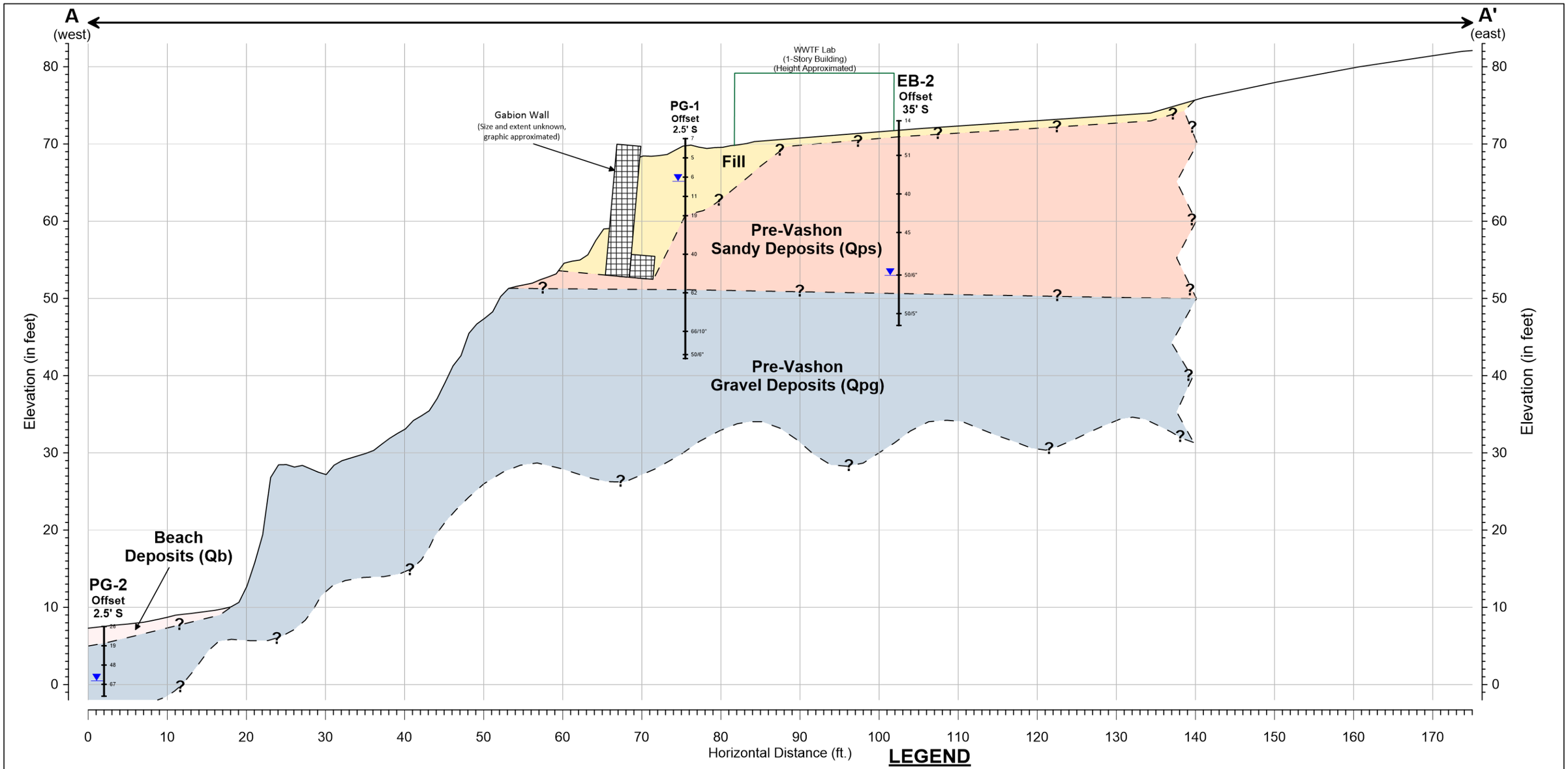
Taylor Bay WWTF
Outfall Replacement
8220 - 178th Avenue Court SW
Pierce County, Washington

SITE AND EXPLORATION PLAN
- LIDAR EXHIBIT -

Project No. **24-274**

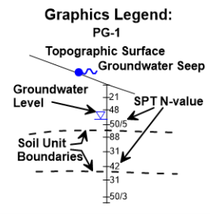
Figure No. **2B**

24-274 Fig 2B - Site Exploration Plan.grf 8/28/24 (12:17:22) SPS



Notes:

1. Existing ground profile estimated based on Figure 1-3 Existing Site Plan, provided by Gray & Osborne, Inc., and Pierce County, WA LiDAR, 2020 by Sanborn
2. Transitions between soil units and in between explorations are best estimates and may vary from the actual soil conditions. The shape of the fill-native contact behind PG-1 is unknown and estimated. In our experience, colluvium may be present at the surface along steep slopes.
3. See report text for detailed descriptions of subsurface conditions across site.
4. See Appendices A and B for detailed exploration logs.
5. See Figures 2A and 2B for Site Plan view of the site with approximate profile location.
6. Gabion wall size and extent unknown and approximated based on Figure 1-3 Existing Site Plan, provided by Gray & Osborne, Inc., receipts provided for cages and quarry spalls, and word of mouth by neighborhood residents.



LEGEND

- **Fill:** Loose to medium dense, silty SAND with gravel to sandy SILT, with scattered organics
- **Pre-Vashon Sandy Deposits (Qps):** Medium dense to dense, sandy SILT to silty SAND to SAND with silt, interbedded
- **Pre-Vashon Gravel Deposits (Qpg):** Very dense sandy SILT to silty SAND, trace gravel
- **Beach Deposits (Qb):** Loose to medium dense, silty to gravelly SAND, scattered shells

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Taylor Bay WWTF
Outfall Replacement
8220 - 178th Avenue Court SW
Pierce County, Washington

GENERALIZED SUBSURFACE PROFILE
SECTION A-A'

Project No.	Figure No.
24-274	3

APPENDIX A

SUMMARY TEST BORING LOGS

RELATIVE DENSITY / CONSISTENCY

SAND / GRAVEL			SILT / CLAY		
Density	SPT N-values	Approx. Relative Density (%)	Consistency	SPT N-values	Approx. Undrained Shear Strength (psf)
Very Loose	<4	<15	Very Soft	<2	<250
Loose	4 to 10	15 - 35	Soft	2 to 4	250 - 500
Med. Dense	10 to 30	35 - 65	Med. Stiff	4 to 8	500 - 1000
Dense	30 to 50	65 - 85	Stiff	8 to 15	1000 - 2000
Very Dense	>50	85 - 100	Very Stiff	15 to 30	2000 - 4000
			Hard	>30	>4000

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS		GROUP DESCRIPTIONS	
Gravel 50% or more of the coarse fraction retained on the #4 sieve. Use dual symbols (eg. GP-GM) for 5% to 12% fines.	GRAVEL (<5% fines)	GW	Well-graded GRAVEL
		GP	Poorly-graded GRAVEL
	GRAVEL (>12% fines)	GM	Silty GRAVEL
		GC	Clayey GRAVEL
Sand 50% or more of the coarse fraction passing the #4 sieve. Use dual symbols (eg. SP-SM) for 5% to 12% fines.	SAND (<5% fines)	SW	Well-graded SAND
		SP	Poorly-graded SAND
	SAND (>12% fines)	SM	Silty SAND
		SC	Clayey SAND
Silt and Clay 50%or more passing #200 sieve	Liquid Limit < 50	ML	SILT
		CL	Lean CLAY
		OL	Organic SILT or CLAY
	Liquid Limit > 50	MH	Elastic SILT
		CH	Fat CLAY
		OH	Organic SILT or CLAY
Highly Organic Soils		PT	PEAT

Notes: 1. Soil exploration logs contain material descriptions based on visual observation and field tests using a system modified from the Uniform Soil Classification System (USCS). Where necessary laboratory tests have been conducted (as noted in the "Other Tests" column), unit descriptions may include a classification. Please refer to the discussions in the report text for a more complete description of the subsurface conditions.

2. The graphic symbols given above are not inclusive of all symbols that may appear on the borehole logs. Other symbols may be used where field observations indicated mixed soil constituents or dual constituent materials.

DESCRIPTIONS OF SOIL STRUCTURES

Layered: Units of material distinguished by color and/or composition from material units above and below

Laminated: Layers of soil typically 0.05 to 1mm thick, max. 1 cm

Lens: Layer of soil that pinches out laterally

Interlayered: Alternating layers of differing soil material

Pocket: Erratic, discontinuous deposit of limited extent

Homogeneous: Soil with uniform color and composition throughout

Fissured: Breaks along defined planes

Slickensided: Fracture planes that are polished or glossy

Blocky: Angular soil lumps that resist breakdown

Disrupted: Soil that is broken and mixed

Scattered: Less than one per foot

Numerous: More than one per foot

BCN: Angle between bedding plane and a plane normal to core axis

COMPONENT DEFINITIONS

COMPONENT	SIZE / SIEVE RANGE	COMPONENT	SIZE / SIEVE RANGE
Boulder:	> 12 inches	Sand	
Cobbles:	3 to 12 inches	Coarse Sand:	#4 to #10 sieve (4.5 to 2.0 mm)
Gravel		Medium Sand:	#10 to #40 sieve (2.0 to 0.42 mm)
Coarse Gravel:	3 to 3/4 inches	Fine Sand:	#40 to #200 sieve (0.42 to 0.074 mm)
Fine Gravel:	3/4 inches to #4 sieve	Silt	0.074 to 0.002 mm
		Clay	<0.002 mm

TEST SYMBOLS

for In Situ and Laboratory Tests listed in "Other Tests" column.

ATT	Atterberg Limit Test
Comp	Compaction Tests
Con	Consolidation
DD	Dry Density
DS	Direct Shear
%F	Fines Content
GS	Grain Size
Perm	Permeability
PP	Pocket Penetrometer
R	R-value
SG	Specific Gravity
TV	Torvane
TXC	Triaxial Compression
UCC	Unconfined Compression

SYMBOLS

Sample/In Situ test types and intervals

- 2-inch OD Split Spoon, SPT (140-lb. hammer, 30" drop)
- 3.25-inch OD Spilt Spoon (300-lb hammer, 30" drop)
- Non-standard penetration test (see boring log for details)
- Thin wall (Shelby) tube
- Grab
- Rock core
- Vane Shear

MONITORING WELL

- Groundwater Level at time of drilling (ATD)
- Static Groundwater Level
- Cement / Concrete Seal
- Bentonite grout / seal
- Silica sand backfill
- Slotted tip
- Slough
- Bottom of Boring

MOISTURE CONTENT

Dry	Dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water

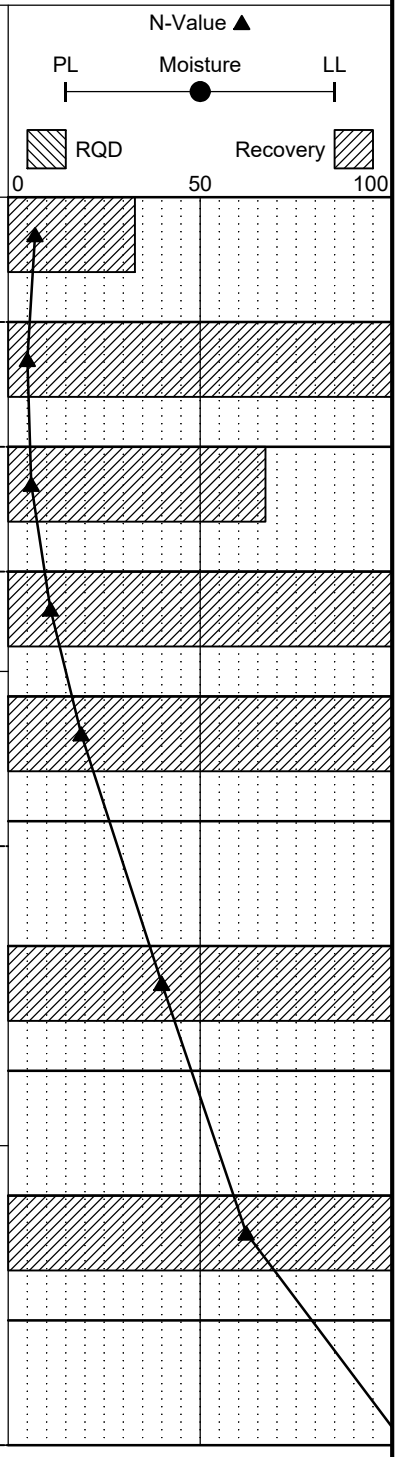
PanGEO INCORPORATED
Phone: 206.262.0370

Terms and Symbols for Boring and Test Pit Logs

Figure A-1

Project:	Taylor Bay WWTF Outfall Replacement	Surface Elevation:	~70.7 ft
Job Number:	24-274	Top of Casing Elev.:	N/A
Location:	8220 178th Ave Court SW, Longbranch, Pierce County, WA	Drilling Method:	Hollow Stem Auger
Coordinates:	Northing: 682472, Easting: 1074396	Sampling Method:	SPT

Depth, (ft)	Sample No.	Sample Type	Blows / 6 in.	Other Tests	Symbol	MATERIAL DESCRIPTION
0.0	S-1		3 3 4			**FILL** Loose, gray-brown, silty SAND with gravel, disturbed soil structure, roots and rootlets, dry to moist. *--Rocky drill action between approximately 2 to 4 feet bgs.*
2.5	S-2		2 2 3			Loose, orange-brown to brown, silty SAND, trace gravel, scattered rootlets and burnt wood debris, iron-oxide staining, disturbed soil structure, moist.
5.0	S-3		1 1 5			Loose, gray-brown, silty SAND to sandy SILT, trace gravel, scattered rootlets, disturbed soil structure, moist to wet. --Perched groundwater observed from approximately 6 to 9 feet bgs.
7.5	S-4		3 4 7			Medium dense, gray, silty fine SAND, scattered rootlets, disturbed soil structure, moist to wet. *--Slower drill action at approximately 8 feet bgs.*
10.0	S-5		6 8 11			**PRE-VASHON SANDY DEPOSITS - Qps** Medium dense, gray to gray-brown, sandy SILT to silty SAND, scattered burnt wood fragments, non-plastic, diamict (till-like) in parts, moist. *--Driller noted drilling through rock at approximately 12.5 feet bgs.*
12.5						Dense, gray-brown, SAND with silt, fine to medium-grained, scattered interbedded silt lenses, moist to wet.
15.0	S-6		12 17 23			--Perched groundwater observed from approximately 15 to 19 feet bgs.
17.5						**PRE-VASHON GRAVEL DEPOSITS - Qpg** Very dense, gray to brown, SILT to sandy SILT, trace gravel, thinly bedded, scattered organics, laminated to slightly diamict (till-like), non-plastic, moist.
20.0	S-7		8 26 36			
22.5						*(continued on next page).*
25.0						



Completion Depth:	28.5ft
Date Borehole Started:	7/23/24
Date Borehole Completed:	7/23/24
Logged By:	S. Scott
Drilling Company:	CN Drilling

Remarks: Standard penetration test (SPT) sampler driven with a 140 lb. safety hammer w/ 30" drop. Hammer operated with a rope and cathead mechanism with portable acker drill rig. Coordinates and elevation are based on Figure 1-3 Existing Site Plan, provided by Gray & Osborne, Inc., Pierce County, WA LiDAR, 2020 by Sanborn, and known site features. This information is provided for relative information only and is not a substitution for field survey. **Datum: Washington State Plane - South | NAVD88**

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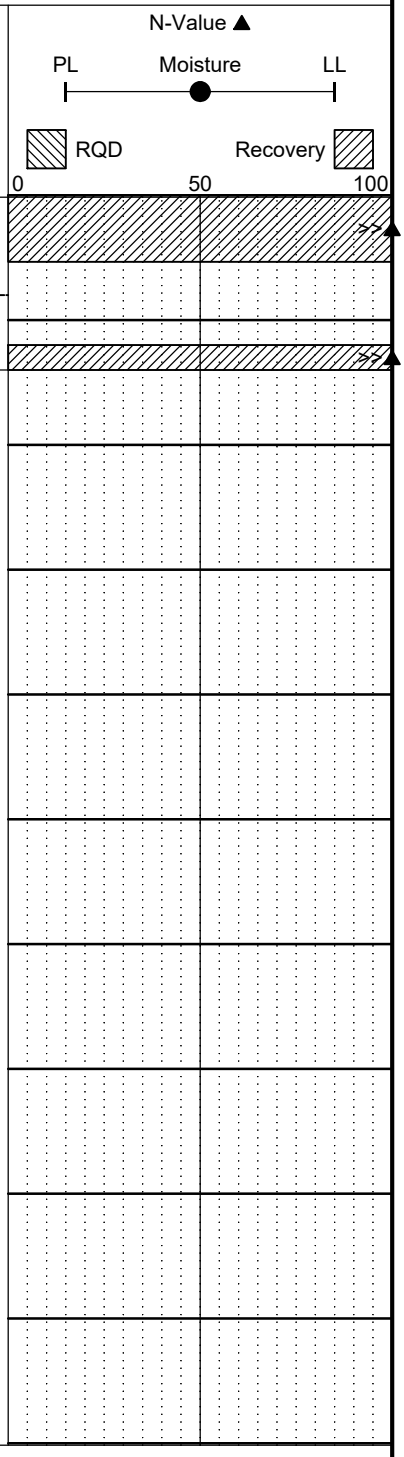
LOG OF TEST BORING PG-1

Figure A-2

The stratification lines represent approximate boundaries. The transition may be gradual.

Project:	Taylor Bay WWTF Outfall Replacement	Surface Elevation:	~70.7 ft
Job Number:	24-274	Top of Casing Elev.:	N/A
Location:	8220 178th Ave Court SW, Longbranch, Pierce County, WA	Drilling Method:	Hollow Stem Auger
Coordinates:	Northing: 682472, Easting: 1074396	Sampling Method:	SPT

Depth, (ft)	Sample No.	Sample Type	Blows / 6 in.	Other Tests	Symbol	MATERIAL DESCRIPTION
25.0	S-8		11 16 50/4			**PRE-VASHON GRAVEL DEPOSITS - Qpg *(continued)***
						Very dense, brown, silty SAND, trace gravel, diamict (till-like), moist.
27.5	S-9		50/6			Very dense, orange-brown, SAND with silt, trace gravel, iron-oxide staining, moist.
						Boring terminated at about 28.5 feet below existing ground surface due to practical refusal in gravel-cobble unit.
30.0						Perched groundwater was observed between about 6 to 9 feet and 15 to 19 feet bgs at the time of drilling.
32.5						
35.0						
37.5						
40.0						
42.5						
45.0						
47.5						
50.0						



Completion Depth:	28.5ft
Date Borehole Started:	7/23/24
Date Borehole Completed:	7/23/24
Logged By:	S. Scott
Drilling Company:	CN Drilling

Remarks: Standard penetration test (SPT) sampler driven with a 140 lb. safety hammer w/ 30" drop. Hammer operated with a rope and cathead mechanism with portable acker drill rig. Coordinates and elevation are based on Figure 1-3 Existing Site Plan, provided by Gray & Osborne, Inc., Pierce County, WA LiDAR, 2020 by Sanborn, and known site features. This information is provided for relative information only and is not a substitution for field survey. **Datum: Washington State Plane - South | NAVD88**

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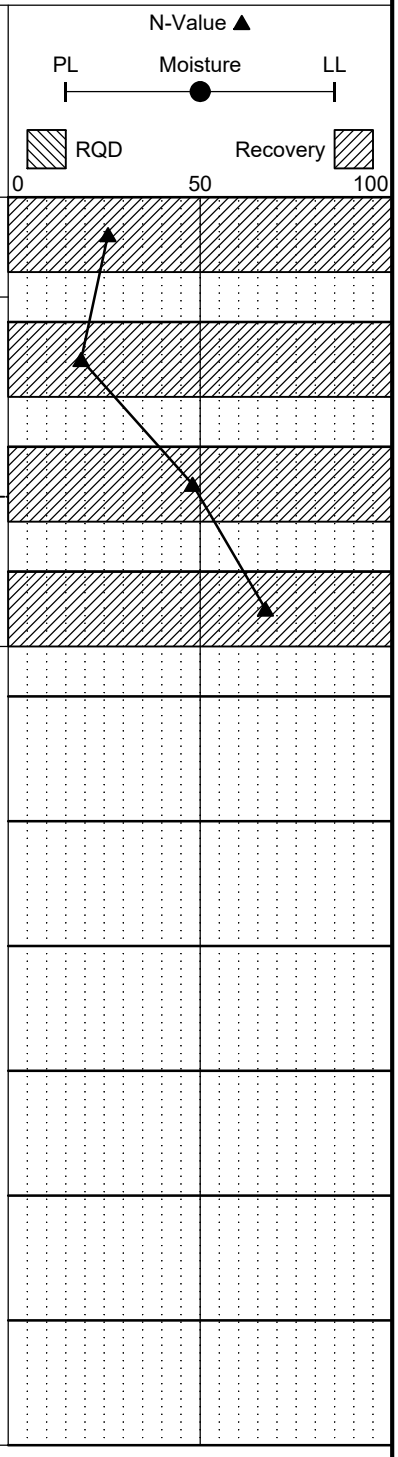
LOG OF TEST BORING PG-1

Figure A-2

The stratification lines represent approximate boundaries. The transition may be gradual.

Project:	Taylor Bay WWTF Outfall Replacement	Surface Elevation:	~7.5 ft
Job Number:	24-274	Top of Casing Elev.:	N/A
Location:	8220 178th Ave Court SW, Longbranch, Pierce County, WA	Drilling Method:	Hollow Stem Auger
Coordinates:	Northing: 682476, Easting: 1074331	Sampling Method:	SPT

Depth, (ft)	Sample No.	Sample Type	Blows / 6 in.	Other Tests	Symbol	MATERIAL DESCRIPTION
0.0	S-1		6 11 15			**BEACH DEPOSITS - Qb** Medium dense, orange-brown, silty to gravelly SAND, moist to wet. --Perched groundwater observed from approximately 1 to 2 feet bgs.
2.5	S-2		3 8 11			**PRE-VASHON UNDIFFERENTIATED SEDIMENTS - Qu** Medium dense, gray to orange-brown, SILT to sandy SILT, massive, trace iron-oxide staining, non-plastic, moist.
5.0	S-3		8 18 30			Very dense, brown to gray-brown, SAND with silt, fine to medium-grained, moist to wet (saturated). --Groundwater observed beginning at approximately 7 feet bgs.
7.5	S-4		20 31 36			
10.0						Boring terminated at about 9 feet below ground surface (bgs) due to practical refusal in heaving sands beginning at about 7 feet bgs. Perched groundwater was observed between about 1 to 2 feet. Saturated groundwater conditions observed beginning at approximately 7 feet bgs at the time of drilling.
12.5						
15.0						
17.5						
20.0						
22.5						
25.0						



Completion Depth:	9.0ft
Date Borehole Started:	7/23/24
Date Borehole Completed:	7/23/24
Logged By:	S. Scott
Drilling Company:	CN Drilling

Remarks: Standard penetration test (SPT) sampler driven with a 140 lb. safety hammer w/ 30" drop. Hammer operated with a rope and cathead mechanism with portable acker drill rig. Coordinates and elevation are based on Figure 1-3 Existing Site Plan, provided by Gray & Osborne, Inc., Pierce County, WA LiDAR, 2020 by Sanborn, and known site features. This information is provided for relative information only and is not a substitution for field survey. **Datum: Washington State Plane - South | NAVD88**

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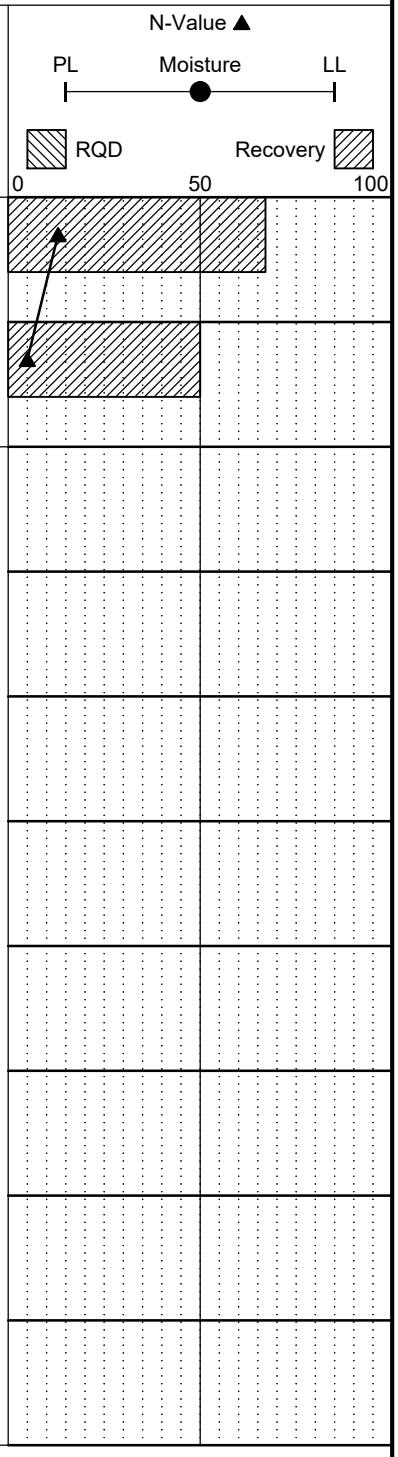
LOG OF TEST BORING PG-2

Figure A-3

The stratification lines represent approximate boundaries. The transition may be gradual.

Project:	Taylor Bay WWTF Outfall Replacement	Surface Elevation:	~-2.9 ft
Job Number:	24-274	Top of Casing Elev.:	N/A
Location:	8220 178th Ave Court SW, Longbranch, Pierce County, WA	Drilling Method:	Hollow Stem Auger
Coordinates:	Northing: 682381, Easting: 1074228	Sampling Method:	SPT

Depth, (ft)	Sample No.	Sample Type	Blows / 6 in.	Other Tests	Symbol	MATERIAL DESCRIPTION
0.0	S-1		4 6 7			**BEACH DEPOSITS - Qb** Loose to medium dense, gray-brown, gravelly SAND, fine to coarse-grained, 1- to 2-inch subround to round gravels, scattered shell fragments, wet (saturated).
2.5	S-2		2 1 4			*Driller noted heaving sands with rising tide; unable to sample.*
5.0						Boring terminated at about 5 feet below existing ground surface due to heaving sands. Boring drilled in intertidal zone with groundwater effectively encountered at surface grade.
7.5						
10.0						
12.5						
15.0						
17.5						
20.0						
22.5						
25.0						



Completion Depth:	5.0ft
Date Borehole Started:	7/23/24
Date Borehole Completed:	7/23/24
Logged By:	S. Scott
Drilling Company:	CN Drilling

Remarks: Standard penetration test (SPT) sampler driven with a 140 lb. safety hammer w/ 30" drop. Hammer operated with a rope and cathead mechanism with portable acker drill rig. Coordinates and elevation are based on Figure 1-3 Existing Site Plan, provided by Gray & Osborne, Inc., Pierce County, WA LiDAR, 2020 by Sanborn, and known site features. This information is provided for relative information only and is not a substitution for field survey. **Datum: Washington State Plane - South | NAVD88**

PanGEO INCORPORATED

LOG OF TEST BORING PG-3

Figure A-4

The stratification lines represent approximate boundaries. The transition may be gradual.

APPENDIX B

PREVIOUS TEST BORING LOGS

associated earth sciences incorporated

Exploration Boring — EB-1

Taylor Bay Sewage Treatment Plant — Sheet: 1 of 1

Pierce County, WA	Start Date: 4/12/23	Logged By: ART
20200440E001	Ending Date: 4/12/23	Approved By: JHS

Driller/Equipment: Geologic / Mini Track
Hammer Weight/Drop: 140#/30"
Hole Diameter (in): 4.25
Groundwater Depth ATD (ft): 12

Total Depth (ft): 21.5
Ground Surface Elevation (ft): ≈80
Datum: NAVD88
Groundwater Depth Post Drilling (ft) (Date): ()

Depth (ft)	Sample Type	Sample	% Recovery	Graphic Symbol	Description	Water Level	Blows/6"	Blows/Foot (10 20 30 40 50+)	Other Tests
0					**Fill**				
		1			Moist, brown to dark brown with iron oxide mottling, silty, fine SAND, some gravel; organics; unsorted (SM).		2 3 2	5	
5		2			No recovery.		2 4 8	12	
					Mass Wasting				
		3			Moist, brownish gray, fine SAND, some silt; unsorted; poor recovery, less than 1 inch (SP-SM).		10 15 17	32	
10		4			Wet, gray to brownish gray, fine SAND, trace silt, trace gravel; massive (SP).	▼	9 13 18	31	
15		5			Moist, gray to dark, gray, non-cohesive sandy, SILT; massive; disturbed texture (ML).		11 14 17	31	
					Pre-Fraser Nonglacial Deposits				
20		6			Moist, light gray, silty, fine SAND to SILT, some fine sand; organic inclusions; stratified (SM-ML).		30 40 50/3"	50/3"	
					Perched groundwater at 12 feet ATD.				
25									
30									
35									

6/5/2023

20200440E001

associated earth sciences incorporated

Exploration Boring — EB-2

Taylor Bay Sewage Treatment Plant — Sheet: 1 of 1

Pierce County, WA	Start Date: 4/12/23	Logged By: ART
20200440E001	Ending Date: 4/12/23	Approved By: JHS

Driller/Equipment: Geologic / Mini Track
Hammer Weight/Drop: 140#/30"
Hole Diameter (in): 4.25
Groundwater Depth ATD (ft): 2 20

Total Depth (ft): 26.5
Ground Surface Elevation (ft): ≈73
Datum: NAVD88
Groundwater Depth Post Drilling (ft) (Date): ()

Depth (ft)	Sample Type	Sample	% Recovery	Graphic Symbol	Description	Water Level	Blows/6"	Blows/Foot (10 20 30 40 50+)	Other Tests
0		1			**Fill** Wet, brownish gray, fine SAND, some silt, some gravel; unsorted (SP-SM).	▼	3 7 7	14	
					Pre-Fraser Nonglacial Deposits				
5		2			Moist, brownish gray to light gray with iron oxide mottling, SILT to fine sandy, SILT; massive (ML).		7 20 31	51	
10		3			Moist, purple gray, SILT; massive; organics; interbeds of peat; organics odor (ML).		10 17 23	40	
15		4			Moist, brownish dark gray, silty, fine SAND; massive (SM).		14 20 25	45	
20		5			Wet, dark gray, fine SAND, trace silt, trace coarse sand; red sand grains (SP).	▼	21 50/6"	50/6"	
					Pre-Fraser Till				
25		6			Moist, brownish gray, SILT, some gravel; unsorted (ML). Driller calls refusal at 25 feet due to hard drilling conditions.		13 42 50/5"	50/5"	
					Perched groundwater at 2 feet and 20 feet ATD.				
30									
35									

6/5/2023

20200440E001

APPENDIX E

SUPPLEMENTAL BIDDER RESPONSIBILITY CRITERIA

APPENDIX E

SUPPLEMENTAL BIDDER RESPONSIBILITY CRITERIA FORMS
WASTEWATER TREATMENT FACILITY UPGRADE

These forms shall be completed in their entirety and submitted by the apparent two lowest Bidders to the Taylor Bay Beach Club HOA by 12:00 p.m. (noon) of the second business day following the bid submittal deadline.

Failure to submit and meet the requirements as stated in Article 3 of the Instructions to Bidders shall be grounds for rejection of the bid. The Taylor Bay Beach Club HOA will be the sole judge in determining if the prospective contractor meets the minimum experience requirements.

Contractor:

Name: _____

Address: _____

Phone: _____

Contact Person: _____

2. Delinquent State Taxes

Instructions to Bidders: Check the appropriate box

☐ The Bidder does not owe delinquent taxes to the Washington State Department of Revenue.

☐ Alternatively, the Bidder does owe delinquent taxes to the Washington State Department of Revenue.

If the Bidder owes delinquent taxes, they must submit a written payment plan approved by the Department of Revenue, to the Contracting Agency.

_____ _____

(Date) (Signature)

_____

(Print Name)

_____

(Title)

3. Subcontractor Responsibility:

Instructions to Bidders: Check all boxes that apply

☐ The Bidder's standard subcontract form includes the subcontractor responsibility language required by RCW 39.06.020.

☐ The Bidder has a procedure for validating the responsibility of subcontractors with which the Bidder contracts.

☐ The Bidder's subcontract form includes a requirement that each of its subcontractors shall have and document a similar procedure to determine whether the sub-tier subcontractors with whom it contracts are also "responsible" subcontractors as defined by RCW 39.06.020.

If the Bidder is unable to check all of the above boxes, provide an explanation as to how the bidder will comply with RCW 39.06.020.

_____ _____

(Date) (Signature)

_____

(Print Name)

_____

(Title)

4. Claims Against Retainage and Bonds:

Instructions to Bidders: Check the appropriate box

☐ The Bidder has not had claims against retainage and bonds in the 3 years prior to the bid submittal date.

☐ Alternatively, the Bidder has had claims against retainage and bonds in the 3 years prior to the bid submittal date.

If the Bidder has had claims against retainage and bonds in the 3 years prior to the bid submittal date, submit a list of public works projects completed during this period that have had claims against retainage and bonds and include name of Project, contact information for the Owner, a list of claims filed against retainage and/or payment bond for any of the projects listed; and a written explanation of circumstances surrounding each claim and the ultimate resolution of the claim.

_____ _____

(Date) (Signature)

_____

(Print Name)

_____

(Title)

5. Public Bidding Crime:

Instructions to Bidders: Check the appropriate box

☐ The undersigned certifies that the Bidder and/or its Owners have not been convicted of a crime involving bidding on a public works contract in the 5 years prior to the bid submittal date.

☐ Alternatively, the undersigned confirms that the Bidder and/or its Owners have been convicted of a crime involving bidding on a public works contract in the 5 years prior to the bid submittal date.

If the Bidder and/or its Owners have been convicted of a crime involving bidding on a public works contract, provide a written explanation identifying the date of the conviction and a description of the circumstances surrounding the conviction.

_____ _____

(Date) (Signature)

_____

(Print Name)

_____

(Title)

6. Termination for Cause/Termination for Default

Instructions to Bidders: Check the appropriate box

☐ The undersigned certifies that the Bidder has not had any public works contracts terminated for cause or terminated for default by a government agency in the 5 years prior to the bid submittal date.

☐ Alternatively, the undersigned confirms that the Bidder has had public works contracts terminated for cause or terminated for default by a government agency in the 5 years prior to the bid submittal date.

If the Bidder has had any public works contracts terminated for cause or terminated for default in the 5 years prior to the bid submittal date, provide a written explanation for all contracts terminated for cause or terminated for default by identifying the project contract that was terminated, the government agency which terminated the Contract, the date of the termination, and a description of the circumstances surrounding the termination.

_____ _____

(Date) (Signature)

_____

(Print Name)

_____

(Title)

7. Lawsuits

Instructions to Bidders: Check the appropriate box

☐ The undersigned certifies that the Bidder has not had any lawsuits with judgments entered against the Bidder in the 5 years prior to the bid submittal date that demonstrate a pattern of failing to meet the terms of contracts.

☐ Alternatively, the undersigned confirms that the Bidder has had any lawsuits with judgments entered against the Bidder in the 5 years prior to the bid submittal date that demonstrate a pattern of failing to meet the terms of contracts.

If the Bidder has had any lawsuits with judgments entered against the Bidder in the 5 years prior to the bid submittal date that demonstrate a pattern of failing to meet the terms of contracts, submit a list of lawsuits along with a written explanation of the circumstances surrounding each lawsuit. The Contracting Agency shall evaluate these explanations to determine whether the lawsuits demonstrate a pattern of failing to meet the terms of contracts.

_____ _____

(Date) (Signature)

_____

(Print Name)

_____

(Title)

8. Contract Time (Liquidated Damages)

Instructions to Bidders: Check the appropriate box

☐ The undersigned certifies that the Bidder has not had liquidated damages assessed on any project it has completed in the 5 years prior to the bid submittal date.

☐ Alternatively, the undersigned confirms that the Bidder has had liquidated damages assessed on projects in the 5 years prior to the bid submittal date.

If the Bidder has had liquidated damages assessed against projects in the 5 years prior to the bid submittal dated, submit a list of projects along with Owner contact information, and number of days assessed liquidated damages. The Contracting Agency shall determine whether the Contractor has a pattern of failing to complete projects within Contract Time.

_____ _____

(Date) (Signature)

_____

(Print Name)

_____

(Title)

9. Capacity and Experience

The Bidder shall have sufficient current capacity and the Project Superintendent assigned to the Project shall have experience to meet the requirements of this Project. The Bidder and Project Superintendent shall have successfully completed at least two projects as the prime contractor, of a similar size and scope, during the 5-year period immediately preceding the bid submittal deadline for this project. Similar size is defined as a minimum of 70 percent of the bid amount submitted by the Bidder and similar scope is defined as a wastewater treatment improvements project completed at an active wastewater treatment facility.

A. Capacity

i. Gross dollar amount of work currently under contract:

_____

ii. Gross dollar amount of contracts currently not completed:

_____

iii. List five major pieces of equipment which are anticipated to be used on this project by the Contractor and note which items are owned by the Contractor and which are to be leased or rented from others:

_____

_____

_____

_____

_____

iv. Number of superintendents on Bidder's staff:

_____

B. Experience

i. General character of work performed by firm:

_____

_____

_____

_____

ii. Identify who will be the superintendent on this project and years of experience. Also, list the number of years this person has been with your firm.

_____

_____

iii. Similar Size and Scope Projects Completed in the Past 5 Years

#1 Owner's Name and Contact Information: _____
_____
_____
Owner is a Government Agency? ___ Yes ____ No
Superintendent's Name: _____
Project Name: _____
Awarded Contract Amount: _____
Final Contract Amount: _____
Completion Date: _____
Project Description: _____
_____
_____
_____

#2 Owner's Name and Contact Information: _____

_____

_____

Owner is a Government Agency? ___ Yes ____ No
Superintendent's Name: _____
Project Name: _____
Awarded Contract Amount: _____
Final Contract Amount: _____
Completion Date: _____
Project Description: _____

_____

_____

_____

#3 Owner's Name and Contact Information: _____

_____

_____

Owner is a Government Agency? ___ Yes ____ No
Superintendent's Name: _____
Project Name: _____
Awarded Contract Amount: _____
Final Contract Amount: _____
Completion Date: _____
Project Description: _____

_____

_____

_____

APPENDIX F

INADVERTENT DISCOVERY PLAN

INADVERTENT DISCOVERY PLAN

PLAN AND PROCEDURES FOR THE DISCOVERY OF CULTURAL RESOURCES AND HUMAN SKELETAL REMAINS

To request ADA accommodation, including materials in a format for the visually impaired, call Ecology at 360-407-6000 or visit https://ecology.wa.gov/accessibility. People with impaired hearing may call Washington Relay Service at 711. People with a speech disability may call TTY at 877-833-6341.

Site Name(s): Taylor Bay Beach Club, Inc Location: Longbranch, WA

Project Lead/Organization: Gray and Osborne, Inc. County: Pierce

If this Inadvertent Discovery Plan (IDP) is for multiple (batched) projects, ensure the location information covers all project areas.

1. INTRODUCTION

The IDP outlines procedures to perform in the event of a discovery of archaeological materials or human remains, in accordance with applicable state and federal laws. An IDP is required, as part of Agency Terms and Conditions for all grants and loans, for any project that creates disturbance above or below the ground. An IDP is not a substitute for a formal cultural resource review (Executive 21-02 or Section 106).

Once completed, **the IDP should always be kept at the project site** during all project activities. All staff, contractors, and volunteers should be familiar with its contents and know where to find it.

2. CULTURAL RESOURCE DISCOVERIES

A cultural resource discovery could be prehistoric or historic. Examples include (see images for further examples):

- An accumulation of shell, burned rocks, or other food related materials.
- Bones, intact or in small pieces.
- An area of charcoal or very dark stained soil with artifacts.
- Stone tools or waste flakes (for example, an arrowhead or stone chips).
- Modified or stripped trees, often cedar or aspen, or other modified natural features, such as rock drawings.
- Agricultural or logging materials that appear older than 50 years. These could include equipment, fencing, canals, spillways, chutes, derelict sawmills, tools, and many other items.
- Clusters of tin cans or bottles, or other debris that appear older than 50 years.
- Old munitions casings. ***Always assume these are live and never touch or move.***
- Buried railroad tracks, decking, foundations, or other industrial materials.
- Remnants of homesteading. These could include bricks, nails, household items, toys, food containers, and other items associated with homes or farming sites.

The above list does not cover every possible cultural resource. When in doubt, assume the material is a cultural resource.

3. ON-SITE RESPONSIBILITIES

If any employee, contractor, or subcontractor believes that they have uncovered cultural resources or human remains at any point in the project, take the following steps to ***Stop-Protect-Notify***. **If you suspect that the discovery includes human remains, also follow Sections 5 and 6.**

STEP A: Stop Work.

All work must stop immediately in the vicinity of the discovery.

STEP B: Protect the Discovery.

Leave the discovery and the surrounding area untouched and create a clear, identifiable, and wide boundary (30 feet or larger) with temporary fencing, flagging, stakes, or other clear markings. Provide protection and ensure integrity of the discovery until cleared by the Department of Archaeological and Historical Preservation (DAHP) or a licensed, professional archaeologist.

Do not permit vehicles, equipment, or unauthorized personnel to traverse the discovery site. Do not allow work to resume within the boundary until the requirements of this IDP are met.

STEP C: Notify Project Archaeologist (if applicable).

If the project has an archaeologist, notify that person. If there is a monitoring plan in place, the archaeologist will follow the outlined procedure.

STEP D: Notify Project and Washington Department of Ecology (Ecology) contacts.

Project Lead Contacts

Primary Contact		Alternate Contact	
Name:	Peter Burgoon	Name:	Mitzi McCart
Organization:	Gray and Osborne, Inc	Organization:	Taylor Bay Beach Club
Phone:	509-853-2460	Phone:	(253) 970-1116
Email:	pburgoon@g-o.com	Email:	mitzimccart@gmail.com

Ecology Contacts (completed by Ecology Project Manager)

Ecology Project Manager		Alternate or Cultural Resource Contact	
Name:	Sydney Kahn	Name:	Shawn McKone
Program:	Water Quality	Program:	Water Quality
Phone:	206-594-0000	Phone:	206-594-0158
Email:	skah@ecy.wa.gov	Email:	shmc461@ecy.wa.gov

STEP E: Ecology will notify DAHP.

Once notified, the Ecology Cultural Resource Contact or the Ecology Project Manager will contact DAHP to report and confirm the discovery. To avoid delay, the Project Lead/Organization will contact DAHP if they are not able to reach Ecology.

DAHP will provide the steps to assist with identification. DAHP, Ecology, and Tribal representatives may coordinate a site visit following any necessary safety protocols. DAHP may also inform the Project Lead/Organization and Ecology of additional steps to further protect the site.

Do not continue work until DAHP has issued an approval for work to proceed in the area of, or near, the discovery.

DAHP Contacts:

Name: Rob Whitlam, PhD
Title: State Archaeologist
Cell: 360-890-2615
Email: Rob.Whitlam@dahp.wa.gov
Main Office: 360-586-3065

Human Remains/Bones:

Name: Guy Tasa, PhD
Title: State Anthropologist
Cell: 360-790-1633 (24/7)
Email: Guy.Tasa@dahp.wa.gov

4. TRIBAL CONTACTS

In the event cultural resources are discovered, the following tribes will be contacted. See Section 10 for Additional Resources.

Tribe:	Squaxin Island Tribe	Tribe:	Skokomish Tribe
Name:	Rhonda Foster	Name:	Kris Miller
Title:	Cultural Resources Director & THPO	Title:	THPO Cultural Resources
Phone:	360-432-3850	Phone:	360-426-2280 x215
Email:	RFoster@squaxin.us	Email:	shlanay1@skokomish.org
Tribe:	Squaxin Island Tribe	Tribe:	Skokomish Tribe
Name:	Shaun Dinubilo	Name:	Joseph Pavel
Title:	Cultural Resources	Title:	Natural Resources
Phone:	360-432-3998	Phone:	360-877-5213 x2206
Email:	SDinubilo@squaxin.us	Email:	jpavel@skokomish.org

Please provide contact information for additional tribes within your project area, if needed, in Section 11.

5. FURTHER CONTACTS (if applicable)

If the discovery is confirmed by DAHP as a cultural or archaeological resource, or as human remains, and there is a partnering federal or state agency, Ecology or the Project Lead/Organization will ensure the partnering agency is immediately notified.

Federal Agency:		State Agency:	
Agency:	USDA RD	Agency:	
Name:	Ambrea Cormier	Name:	
Title:	State Loan Specialist	Title:	
Phone:	360-704-7705	Phone:	
Email:	ambrea.cormier@usda.gov	Email:	

6. SPECIAL PROCEDURES FOR THE DISCOVERY OF HUMAN SKELETAL MATERIAL

Any human skeletal remains, regardless of antiquity or ethnic origin, will at all times be treated with dignity and respect. Follow the steps under ***Stop-Protect-Notify.*** For specific instructions on how to handle a human remains discovery, see: *RCW 68.50.645: Skeletal human remains—Duty to notify—Ground disturbing activities—Coroner determination—Definitions*.

Suggestion: If you are unsure whether the discovery is human bone or not, contact Guy Tasa with DAHP, for identification and next steps. Do not pick up the discovery.

Guy Tasa, PhD State Physical Anthropologist
Guy.Tasa@dahp.wa.gov
(360) 790-1633 (Cell/Office)

For discoveries that are confirmed or suspected human remains, follow these steps:

1. Notify law enforcement and the Medical Examiner/Coroner using the contacts below. **Do not call 911** unless it is the only number available to you.

   Enter contact information below (required):
   - Local Medical Examiner or Coroner name and phone: Karen Cline-Parhamovich, D.O. (253)798-6494
   - Local Law Enforcement main name and phone: Sheriff Keith Swank (253)798-7530
   - Local Non-Emergency phone number (911 if without a non-emergency number): (253)287-4455
2. The Medical Examiner/Coroner (with assistance of law enforcement personnel) will determine if the remains are human or if the discovery site constitutes a crime scene and will notify DAHP.
3. **DO NOT speak with the media, allow photography or disturbance of the remains, or release any information about the discovery on social media.**
4. If the remains are determined to be non-forensic, Cover the remains with a tarp or other materials (not soil or rocks) for temporary protection and to shield them from being photographed by others or disturbed.

Further activities:

- Per RCW 27.44.055, RCW 68.50, and RCW 68.60, DAHP will have jurisdiction over non-forensic human remains. Ecology staff will participate in consultation. Organizations may also participate in consultation.
- Documentation of human skeletal remains and funerary objects will be agreed upon through the consultation process described in RCW 27.44.055, RCW 68.50, and RCW 68.60.
- When consultation and documentation activities are complete, work in the discovery area may resume as described in Section 8.

If the project occurs on federal lands (such as a national forest or park or a military reservation) the provisions of the Native American Graves Protection and Repatriation Act of 1990 (NAGPRA) apply and the responsible federal agency will follow its provisions. Note that state highways that cross federal lands are on an easement and are not owned by the state.

If the project occurs on non-federal lands, the Project Lead/Organization will comply with applicable state and federal laws, and the above protocol.

7. DOCUMENTATION OF ARCHAEOLOGICAL MATERIALS

Archaeological resources discovered during construction are protected by state law RCW 27.53 and assumed eligible for inclusion in the National Register of Historic Places under Criterion D until a formal Determination of Eligibility is made.

The Project Lead/Organization must ensure that proper documentation and field assessment are made of all discovered cultural resources in cooperation with all parties: the federal agencies (if any), DAHP, Ecology, affected tribes, and the archaeologist.

The archaeologist will record all prehistoric and historic cultural material discovered during project construction on a standard DAHP archaeological site or isolate inventory form. They will photograph site overviews, features, and artifacts and prepare stratigraphic profiles and soil/sediment descriptions for minimal subsurface exposures. They will document discovery locations on scaled site plans and site location maps.

Cultural features, horizons, and artifacts detected in buried sediments may require the archaeologist to conduct further evaluation using hand-dug test units. They will excavate units in a controlled fashion to expose features, collect samples from undisturbed contexts, or to interpret complex stratigraphy. They may also use a test unit or trench excavation to determine if an intact occupation surface is present. They will only use test units when necessary to gather information on the nature, extent, and integrity of subsurface cultural deposits to evaluate the site's significance. They will conduct excavations using standard archaeological techniques to precisely document the location of cultural deposits, artifacts, and features.

The archaeologist will record spatial information, depth of excavation levels, natural and cultural stratigraphy, presence or absence of cultural material, and depth to sterile soil, regolith, or bedrock for each unit on a standard form. They will complete test excavation unit level forms, which will include plan maps for each excavation level and artifact counts and material types, number, and vertical provenience (depth below

surface and stratum association where applicable) for all recovered artifacts. They will draw a stratigraphic profile for at least one wall of each test excavation unit.

The archaeologist will screen sediments excavated for purposes of cultural resources investigation through 1/8-inch mesh, unless soil conditions warrant 1/4-inch mesh.

The archaeologist will analyze, catalogue, and temporarily curate all prehistoric and historic artifacts collected from the surface and from probes and excavation units. The ultimate disposition of cultural materials will be determined in consultation with the federal agencies (if any), DAHP, Ecology, and the affected tribe(s).

Within 90 days of concluding fieldwork, the archaeologist will provide a technical report describing any and all monitoring and resultant archaeological excavations to the Project Lead/Organization, who will forward the report to Ecology, the federal agencies (if any), DAHP, and the affected tribe(s) for review and comment.

If assessment activities expose human remains (burials, isolated teeth, or bones), the archaeologist and Project Lead/Organization will follow the process described in **Section 6**.

8. PROCEEDING WITH WORK

The Project Lead/Organization shall work with the archaeologist, DAHP, and affected tribe(s) to determine the appropriate discovery boundary and where work can continue.

Work may continue at the discovery location only after the process outlined in this plan is followed and the Project Lead/Organization, DAHP, any affected tribe(s), Ecology, and the federal agencies (if any) determine that compliance with state and federal laws is complete.

9. ORGANIZATION RESPONSIBILITY

The Project Lead/Organization is responsible for ensuring:

- This IDP has complete and accurate information.
- This IDP is immediately available to all field staff at the sites and available by request to any party.
- This IDP is implemented to address any discovery at the site.
- That all field staff, contractors, and volunteers are instructed on how to implement this IDP.

10. ADDITIONAL RESOURCES

Informative Video

Ecology recommends that all project staff, contractors, and volunteers view this informative video explaining the value of IDP protocol and what to do in the event of a discovery. The target audience is anyone working on the project who could unexpectedly find cultural resources or human remains while excavating or digging. The video is also posted on DAHP's inadvertent discovery language website.

Ecology's IDP Video (https://www.youtube.com/watch?v=ioX-4cXfbDY)

Informational Resources

DAHP (https://dahp.wa.gov)

Washington State Archeology (DAHP 2003)
(https://dahp.wa.gov/sites/default/files/Field%20Guide%20to%20WA%20Arch_0.pdf)

Association of Washington Archaeologists (https://www.archaeologyinwashington.com)

Potentially Interested Tribes

Interactive Map of Tribes by Area
(https://dahp.wa.gov/archaeology/tribal-consultation-information)

WSDOT Tribal Contact Website
(https://wsdot.wa.gov/tribal/TribalContacts.htm)

11. ADDITIONAL INFORMATION

Please add any additional contact information or other information needed within this IDP.

Implement the IDP if you see…

Chipped stone artifacts.

Examples are:

- Glass-like material.
- Angular material.
- “Unusual” material or shape for the area.
- Regularity of flaking.
- Variability of size.



Stone artifacts from Oregon.



Stone artifacts from Washington.



Biface-knife, scraper, or pre-form found in NE Washington. Thought to be a well knapped object of great antiquity. Courtesy of Methow Salmon Rec. Foundation.

Implement the IDP if you see…

Ground stone artifacts.

Examples are:

- Unusual or unnatural shapes or unusual stone.
- Striations or scratching.
- Etching, perforations, or pecking.
- Regularity in modifications.
- Variability of size, function, or complexity.



Above: Fishing Weight - credit CRITFC Treaty Fishing Rights website.



Artifacts from unknown locations (left and right images).



Implement the IDP if you see…

Bone or shell artifacts, tools, or beads.

Examples are:

- Smooth or carved materials.
- Unusual shape.
- Pointed as if used as a tool.
- Wedge shaped like a “shoehorn”.
- Variability of size.
- Beads from shell (dentalium) or tusk.









Upper Left:*Bone Awls from Oregon.*

Upper Center: *Bone Wedge from California.*

Upper Right: *Plateau dentalium choker and bracelet, from Nez Perce National Historical Park, 19th century, made using Antalis pretiosa shells Credit: Nez Perce - Nez Perce National Historical Park, NEPE 8762, Public Domain.*

Above: *Tooth Pendants. Right: Bone Pendants. Both from Oregon and Washington.*



Implement the IDP if you see…

Culturally modified trees, fiber, or wood artifacts.

Examples are:

- Trees with bark stripped or peeled, carvings, axe cuts, de-limbing, wood removal, and other human modifications.
- Fiber or wood artifacts in a wet environment.
- Variability of size, function, and complexity.





Left and Below: *Culturally modified tree and an old carving on an aspen (Courtesy of DAHP).*

Right, Top to Bottom: *Artifacts from Mud Bay, Olympia: Toy war club, two strand cedar rope, wet basketry*.







Implement the IDP if you see…

Strange, different, or interesting looking dirt, rocks, or shells.

Human activities leave traces in the ground that may or may not have artifacts associated with them. Examples are:

- "Unusual" accumulations of rock (especially fire-cracked rock).
- "Unusual" shaped accumulations of rock (such as a shape similar to a fire ring).
- Charcoal or charcoal-stained soils, burnt-looking soils, or soil that has a "layer cake" appearance.
- Accumulations of shell, bones, or artifacts. Shells may be crushed.
- Look for the "unusual" or out of place (for example, rock piles in areas with otherwise few rocks).



Shell Midden pocket in modern fill discovered in sewer trench.



Underground oven. Courtesy of DAHP.

Shell midden with fire cracked rock.





Hearth excavated near Hamilton, WA.

Implement the IDP if you see…

Historic period artifacts (historic archaeology considered older than 50 years).

Examples are:

- Agricultural or logging equipment. May include equipment, fencing, canals, spillways, chutes, derelict sawmills, tools, etc.
- Domestic items including square or wire nails, amethyst colored glass, or painted stoneware.





Left: Top to Bottom: *Willow pattern serving bowl and slip joint pocket knife discovered during Seattle Smith Cove shantytown (45-KI-1200) excavation.*

Right: *Collections of historic artifacts discovered during excavations in eastern Washington cities.*





Implement the IDP if you see…

Historic period artifacts (historic archaeology considered older than 50 years).

Examples are:

- Railway tokens, coins, and buttons.
- Spectacles, toys, clothing, and personal items.
- Items helping to understand a culture or identity.
- Food containers and dishware.



Main Image: *Dishes, bottles, workboot found at the North Shore Japanese bath house (ofuro) site, Courtesy Bob Muckle, Archaeologist, Capilano University, B.C. This is an example of an above ground resource.*





Right, from Top to Bottom: *Coins, token, spectacles and Montgomery Ward pitchfork toy discovered during Seattle Smith Cove shantytown (45-KI-1200) excavation.*





Implement the IDP if you see…

- Old munition casings – if you see ammunition of any type – ***always assume they are live and never touch or move!***
- Tin cans or glass bottles with an older manufacturer's technique – maker's mark, distinct colors such as turquoise, or an older method of opening the container.



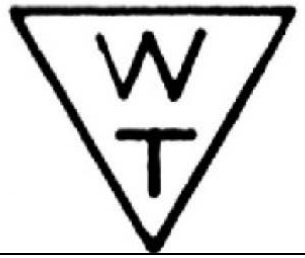


Far Left: .303 British cartridge found by a WCC planting crew on Skagit River. Don't ever touch something like this!
Left: Maker's mark on bottom of old bottle.



Right: *Old beer can found in Oregon. ACME was owned by Olympia Brewery. Courtesy of Heather Simmons.*





Logo employed by Whithall Tatum & Co. between 1924 to 1938 (Lockhart et al. 2016).



Can opening dates, courtesy of W.M. Schroeder.

Implement the IDP if you see…

You see historic foundations or buried structures.

Examples are:

- Foundations.
- Railroad and trolley tracks.
- Remnants of structures.









Counter Clockwise, Left to Right: *Historic structure 45KI924, in WSDOT right of way for SR99 tunnel. Remnants of Smith Cove shantytown (45-KI-1200) discovered during Ecology CSO excavation, City of Spokane historic trolley tracks uncovered during stormwater project, intact foundation of historic home that survived the Great Ellensburg Fire of July 4, 1889, uncovered beneath parking lot in Ellensburg.*

Implement the IDP if you see...

Potential human remains.

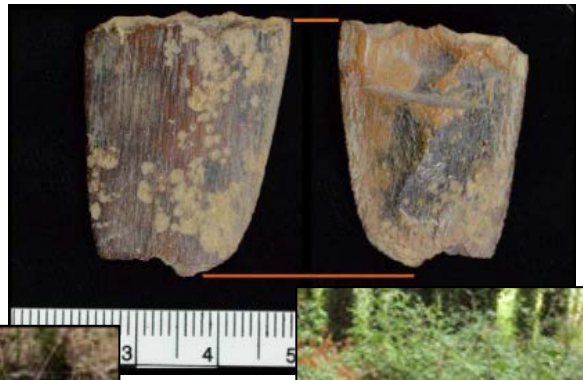
Examples are:

- Grave headstones that appear to be older than 50 years.
- Bones or bone tools--intact or in small pieces. It can be difficult to differentiate animal from human so they must be identified by an expert.
- These are all examples of animal bones and are not human.



Center: *Bone wedge tool, courtesy of Smith Cove Shantytown excavation (45KI1200).*

Other images (Top Right, Bottom Left, and Bottom) Center: Courtesy of DAHP.









Directly Above: This is a real discovery at an Ecology sewer project site.

What would you do if you found these items at a site? Who would be the first person you would call?

Hint: *Read the plan!*

APPENDIX G

NPDES PERMIT

Issuance Date: November 30, 2015
Effective Date: January 1, 2016
Expiration Date: December 31, 2020

National Pollutant Discharge Elimination System
Waste Discharge Permit No. WA0037656

State of Washington
DEPARTMENT OF ECOLOGY
Northwest Regional Office
3190 160th Avenue SE
Bellevue, WA 98008-5452

In compliance with the provisions of
The State of Washington Water Pollution Control Law
Chapter 90.48 Revised Code of Washington
and
The Federal Water Pollution Control Act
(The Clean Water Act)
Title 33 United States Code, Section 1342 et seq.

Taylor Bay Beach Club, Inc

8215 175th Avenue KP S
Longbranch, WA 98351

is authorized to discharge in accordance with the Special and General Conditions that follow.

Plant Location: 8220 178th Avenue KP S Longbranch, WA 98351	Receiving Water: Case Inlet, Puget Sound
Treatment Type: Package Plant – Activated Sludge System	

Kevin C. Fitzpatrick
Water Quality Section Manager
Northwest Regional Office
Washington State Department of Ecology

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Summary of Permit Report Submittals

Refer to the Special and General Conditions of this permit for additional submittal requirements.

Permit Section	Submittal	Frequency	First Submittal Date
S3.A	Discharge monitoring report (DMR)	Monthly	February 15, 2016
S3.A	Discharge monitoring report (DMR)	Annually	January 15, 2017
S3.F	Reporting permit violations	As necessary	
S4.B	Plans for maintaining adequate capacity	As necessary	
S4.D	Notification of new or altered sources	As necessary	
S5.F	Bypass notification	As necessary	
S5.G	Operations and maintenance manual update or review confirmation letter	1/permit cycle	December 1, 2016
S8	Outfall evaluation	1/permit cycle	June 30, 2020
S9	Engineering evaluation report	1/permit cycle	June 30, 2020
S10	Application for permit renewal	1/permit cycle	June 30, 2020
G1	Notice of change in authorization	As necessary	
G4	Reporting planned changes	As necessary	
G5	Engineering report for construction or modification activities	As necessary	
G7	Notice of permit transfer	As necessary	
G10	Duty to provide information	As necessary	
G20	Compliance schedules	As necessary	
G21	Contract submittal	As necessary	

Special Conditions

S1. Discharge limits

S1.A. Effluent limits

All discharges and activities authorized by this permit must comply with the terms and conditions of this permit. The discharge of any of the following pollutants more frequently than, or at a level in excess of, that identified and authorized by this permit violates the terms and conditions of this permit.

Beginning on the effective date of this permit, the Permittee may discharge treated domestic wastewater to Case Inlet at the permitted location subject to compliance with the following limits:

Effluent Limits: Outfall 001 **Latitude: 47.18233°N Longitude: -122.77817°**		
Parameter	**Average Monthly** [a]	**Average Weekly** [b]
Biochemical Oxygen Demand (5-day) (BOD_5)	30 milligrams/liter (mg/L) 7.0 pounds/day (lbs/day) 85% removal of influent BOD_5	45 mg/L 11 lbs/day
Total Suspended Solids (TSS)	30 mg/L 7.0 lbs/day 85% removal of influent TSS	45 mg/L 11 lbs/day
Parameter	**Minimum**	**Maximum**
pH [c]	6.0 standard units	9.0 standard units
Parameter	**Monthly Geometric Mean**	**Weekly Geometric Mean**
Fecal Coliform Bacteria [d]	200/100 milliliter (mL)	400/100 mL
Parameter	**Average Monthly**	**Maximum Daily** [e]
Total Residual Chlorine [f]	0.5 mg/L	0.75 mg/L

a	Average monthly effluent limit means the highest allowable average of daily discharges over a calendar month. To calculate the discharge value to compare to the limit, you add the value of each daily discharge measured during a calendar month and divide this sum by the total number of daily discharges measured. See footnote c for fecal coliform calculations.
b	Average weekly discharge limit means the highest allowable average of daily discharges over a calendar week, calculated as the sum of all daily discharges measured during a calendar week divided by the number of daily discharges measured during that week. See footnote c for fecal coliform calculations.
c	Indicates the range of permitted values. Do not average pH values.
d	Ecology provides directions to calculate the monthly and the weekly geometric mean in publication No. 04-10-020, Information Manual for Treatment Plant Operators available at: http://www.ecy.wa.gov/pubs/0410020.pdf
e	Maximum daily effluent limits is the highest allowable daily discharge. The daily discharge is the average discharge of a pollutant measured during a calendar day. This does not apply to pH.
f	Chlorine limits apply only during emergency periods when UV disinfection is not available and the Permittee uses chlorine for disinfection. During normal operations with UV disinfection, chlorine limits do not apply. When not using chlorine during the monitoring period, enter qualifier code “M” into the WQWebDMR form to indicate that for chlorine was conditional and not required for the monitoring period.

S1.B. Mixing zone authorization

Mixing zone for Outfall 001

The following paragraphs define the maximum boundaries of the mixing zones. Figure 1 illustrates the approximate relationship and sizes of the chronic and acute mixing zones around the diffuser:

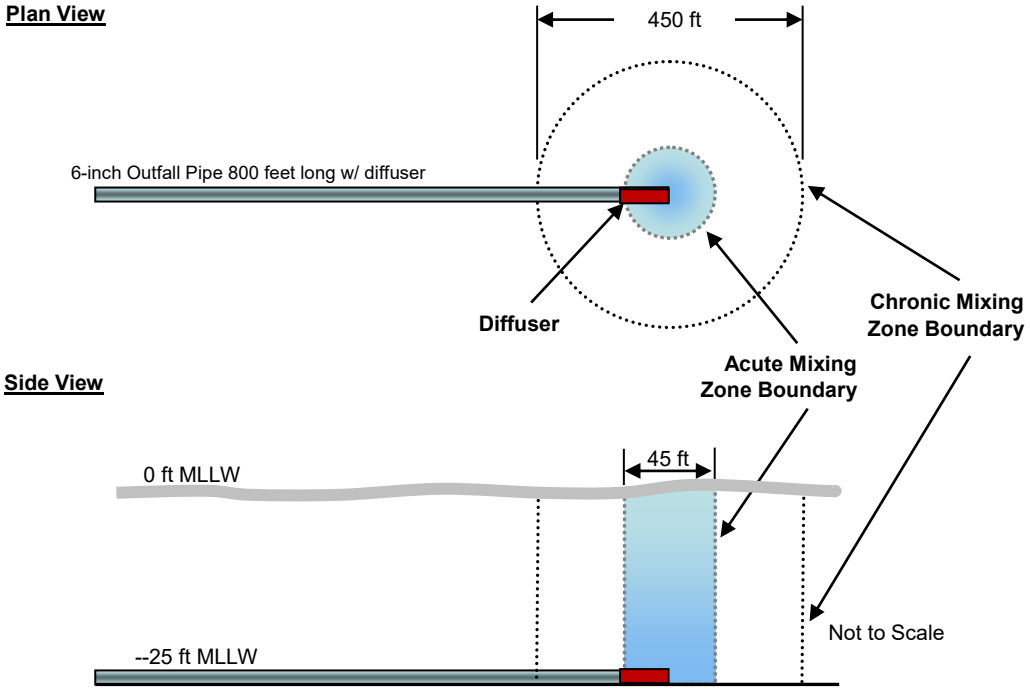


Figure 1. Outfall Mixing Zones

Chronic mixing zone

The allowable chronic mixing zone is a circle with radius of 225 feet measured from the center of the discharge port. The mixing zone extends from the bottom to the top of the water column. The concentration of pollutants at the edge of the chronic zone must meet chronic aquatic life criteria and human health criteria.

Acute mixing zone

The allowable acute mixing zone is a circle with radius of 22.5 feet measure from the center of the discharge port. The mixing zone extends from the bottom to the top of the water column. The concentration of pollutants at the edge of the acute zone must meet acute aquatic life criteria.

Available Dilution (dilution factor)	
Acute Aquatic Life Criteria	233
Chronic Aquatic Life Criteria	493
Human Health Criteria - Carcinogen	493
Human Health Criteria - Non-carcinogen	493

S2. Monitoring requirements

S2.A. Monitoring schedule

The Permittee must monitor the wastewater according to the following schedule. The Permittee must use the specified analytical methods unless the method used produces measurable results in the sample and EPA has listed it as an EPA-approved method in 40 CFR Part 136. If the Permittee uses an alternative method, not specified in the permit and as allowed above, it must report the test method, DL, and QL on the discharge monitoring report or in the required report. If the Permittee is unable to obtain the required DL and QL in its effluent due to matrix effects, the Permittee must submit a matrix-specific detection limit (MDL) and a quantitation limit (QL) to Ecology with appropriate laboratory documentation.

Parameter	Units	Laboratory Method	Minimum Sampling Frequency	Sample Type
(1) Wastewater influent				
Wastewater Influent means the raw sewage flow from the collection system into the treatment facility. Sample the wastewater entering the headworks of the treatment plant excluding any side-stream returns from inside the plant.				
Flow	GPD	NA	Continuous [a]	Metered/recorded
BOD_5	mg/L	SM 5210 B	1/week	24-hr composite [b]
BOD_5	lbs/day [c]	Not applicable (NA)	1/week	Calculated
TSS	mg/L	SM 2540 D	1/week	24-hr composite
TSS	lbs/day	NA	1/week	Calculated
(2) Final wastewater effluent				
Final Wastewater Effluent means wastewater which is exiting, or has exited, the last treatment process or operation. Typically, this is after or at the exit from the chlorine contact chamber or other disinfection process. The Permittee may take effluent samples for the BOD_5 analysis before or after the disinfection process. If taken after, dechlorinated and reseed the sample.				
BOD_5	mg/L	SM 5210 B	1/week	24-hr composite
BOD_5	lbs/day	NA	1/week	Calculated
BOD_5	% removal [d]	NA	1/month	Calculated
TSS	mg/L	SM 2540 D	1/week	24-hr composite
TSS	lbs/day	NA	1/week	Calculated
TSS	% removal	NA	1/month	Calculated
Fecal Coliform [e]	# /100 mL	SM 9222 D (MF)	1/week	Grab [f]
pH [g]	Standard Units	SM 4500-H+B	5/week	Grab
Chlorine (Total Residual)	mg/L	SM 4500 Cl G	Daily, as needed [h]	Grab
(3) Effluent characterization – final wastewater effluent				
Total ammonia	mg/L as N	SM 4500-NH3-G/H	Annually	24-hr composite
Nitrate plus Nitrite Nitrogen	mg/L as N	SM 4500-NO3- E/F/H	Annually	24-hr composite
Total Kjeldahl Nitrogen (TKN)	mg/L as N	SM 4500-N Org B/C	Annually	24-hr composite
Total Phosphorus	mg/L as P	SM 4500-PE/PF | (EPA 365.1)	Annually	24-hr composite
Soluble Reactive Phosphorus	mg/L as P	SM 4500- PE/PF	Annually	24-hr composite

Parameter	Units	Laboratory Method	Minimum Sampling Frequency	Sample Type
(4) Permit renewal application requirements – final wastewater effluent				
The Permittee must record and report the wastewater treatment plant flow discharged on the day it collects the sample for priority pollutant testing with the discharge monitoring report.				
Temperature	Degrees Celsius (°C)	SM 2550	1/month (summer months only) [i]	Grab

[a]	Continuous means uninterrupted except for brief lengths of time for calibration, power failure, or unanticipated equipment repair or maintenance. The Permittee must sample daily when continuous monitoring is not possible.
[b]	24-hour composite means a series of individual samples collected over a 24-hour period into a single container, and analyzed as one sample.
[c]	Calculated means figured concurrently with the respective sample, using the following formula: Concentration (in mg/L) X Flow (in MGD) X Conversion Factor (8.34) = lbs/day
[d]	Calculate the percent (%) removal of BOD and TSS using the following equation: $\% \text{ Removal} = \frac{(\text{Monthly Average Influent Concentration} - \text{Monthly Average Effluent Concentration}) \times 100}{\text{Monthly Average Influent Concentration}}$
[e]	Report a numerical value for fecal coliforms following the procedures in Ecology's *Information Manual for Wastewater Treatment Plant Operators*, Publication Number 04-10-020 available at: http://www.ecy.wa.gov/programs/wq/permits/guidance.html . Do not report a result as too numerous to count (TNTC).
[f]	Grab means an individual sample collected over a fifteen (15) minute, or less, period.
[g]	Report the daily pH and the minimum and maximum for the monitoring period.
[h]	The Permittee must monitor total chlorine residual concentrations only when using chlorine for disinfection purposes.
[i]	Summer months are July, August, and September. Temperature grab sampling must occur when the effluent is at or near its daily maximum temperature, which usually occurs in the late afternoon.

S2.B. Sampling and analytical procedures

Samples and measurements taken to meet the requirements of this permit must represent the volume and nature of the monitored parameters. The Permittee must conduct representative sampling of any unusual discharge or discharge condition, including bypasses, upsets, and maintenance-related conditions that may affect effluent quality.

Sampling and analytical methods used to meet the monitoring requirements specified in this permit must conform to the latest revision of the *Guidelines Establishing Test Procedures for the Analysis of Pollutants* contained in 40 CFR Part 136 (or as applicable in 40 CFR subchapters N [Parts 400–471] or O [Parts 501-503]) unless otherwise specified in this permit . Ecology may only specify alternative methods for parameters without permit limits and for those parameters without an EPA approved test method in 40 CFR Part 136.

S2.C. Flow measurement, field measurement, and continuous monitoring devices

The Permittee must:

1. Select and use appropriate flow measurement field measurement, and continuous monitoring devices and methods consistent with accepted scientific practices.
2. Install, calibrate, and maintain these devices to ensure the accuracy of the measurements is consistent with the accepted industry standard, the manufacturer's recommendation, and approved O&M manual procedures for the device and the wastestream.
3. Calibrate continuous monitoring instruments weekly unless it can demonstrate a longer period is sufficient based on monitoring records. The Permittee:
    a. May calibrate apparatus for continuous monitoring of dissolved oxygen by air calibration.
    b. Must calibrate continuous pH measurement instruments using a grab sample analyzed in the lab with a pH meter calibrated with standard buffers and analyzed within 15 minutes of sampling.
    c. Must calibrate continuous chlorine measurement instruments using a grab sample analyzed in the laboratory within 15 minutes of sampling.
4. Use field measurement devices as directed by the manufacturer and do not use reagents beyond their expiration dates.
5. Establish a calibration frequency for each device or instrument in the O&M manual that conforms to the frequency recommended by the manufacturer.
6. Calibrate flow-monitoring devices at a minimum frequency of at least one calibration per year.
7. Maintain calibration records for at least three years.

S2.D. Laboratory accreditation

The Permittee must ensure that all monitoring data required by Ecology for permit specified parameters is prepared by a laboratory registered or accredited under the provisions of chapter 173-50 WAC, *Accreditation of Environmental Laboratories*. Flow, temperature, settleable solids, conductivity, pH, and internal process control parameters are exempt from this requirement. The Permittee must obtain accreditation for conductivity and pH if it must receive accreditation or registration for other parameters.

S3. Reporting and recording requirements

The Permittee must monitor and report in accordance with the following conditions. Falsification of information submitted to Ecology is a violation of the terms and conditions of this permit.

S3.A. Discharge monitoring reports

The first monitoring period begins on the effective date of the permit (unless otherwise specified). The Permittee must:

1. Submit monitoring results for parameters shown in S2.A(1) and (2) each month.
2. Summarize, report, and submit monitoring data obtained during each monitoring period on the electronic Discharge Monitoring Report (DMR) form provided by Ecology within the WQWebDMR. Include data for each of the parameters tabulated in Special Condition S2 and as required by the form. Report a value for each day sampling occurred (unless specifically exempted in the permit) and for the summary values (when applicable) included on the electronic form.
3. Enter the "No Discharge" reporting code for an entire DMR, for a specific monitoring point, or for a specific parameter as appropriate, if the Permittee did not discharge wastewater or a specific pollutant during a given monitoring period.
4. Report single analytical values below detection as "less than the detection level (DL)" by entering < followed by the numeric value of the detection level (e.g. < 2.0) on the DMR. If the method used did not meet the minimum DL and quantitation level (QL) identified in the permit, report the actual QL and DL in the comments or in the location provided.
5. Not report zero for bacteria monitoring. Report as required by the laboratory method.
6. Calculate and report an arithmetic average value for each day for bacteria if multiple samples were taken in one day.
7. Calculate the geometric mean values for bacteria (unless otherwise specified in the permit) using:
    a. The reported numeric value for all bacteria samples measured above the detection value except when it took multiple samples in one day. If the Permittee takes multiple samples in one day it must use the arithmetic average for the day in the geometric mean calculation.
    b. The detection value for those samples measured below detection.
8. Report the test method used for analysis in the comments if the laboratory used an alternative method not specified in the permit and as allowed in monitoring schedule S2.A.
9. Calculate average values and calculated total values (unless otherwise specified in the permit) using:
    a. The reported numeric value for all parameters measured between the agency-required detection value and the agency-required quantitation value.

b. One-half the detection value (for values reported below detection) if the lab detected the parameter in another sample from the same monitoring point for the reporting period.

c. Zero (for values reported below detection) if the lab did not detect the parameter in another sample for the reporting period.

10. The contract laboratory reports must also include information on the chain of custody, QA/QC results, and documentation of accreditation for the parameter.

11. Ensure that DMRs are electronically submitted no later than the dates specified below, unless otherwise specified in this permit.

    If the Permittee has obtained a waiver, it must ensure that paper forms are postmarked or received by Ecology no later than the dates specified below, unless otherwise specified in this permit.

12. Submit DMRs for parameters with the monitoring frequencies specified in S2 (monthly, quarterly, annual, etc.) at the reporting schedule identified below. The Permittee must:

    a. Submit **monthly** DMRs by the 15th day of the following month. The first permit submittal is February 15, 2016.

    b. Submit **annual DMRs**, unless otherwise specified in the permit, by January 15 for the previous calendar year. The annual sampling period is the calendar year. The Permittee must submit the first annual DMR on January 15, 2017.

    c. Submit permit renewal application monitoring data required in Special Condition S2.A(4) annually in WQWebDMR by January 15th of the year following the monitoring period.

S3.B. Permit submittals and schedules

The Permittee must use the Water Quality Permitting Portal – Permit Submittals application (unless otherwise specified in the permit) to submit all other written permit-required reports by the date specified in the permit.

When another permit condition requires submittal of a paper (hard-copy) report, the Permittee must ensure that it is postmarked or received by Ecology no later than the dates specified by this permit. Send these paper reports to Ecology at:

Water Quality Permit Coordinator
Department of Ecology
Northwest Regional Office
3190 160th Avenue SE
Bellevue, WA 98008-5452

S3.C. Records retention

The Permittee must retain records of all monitoring information for a minimum of three (3) years. Such information must include all calibration and maintenance records and all original recordings for continuous monitoring instrumentation,

copies of all reports required by this permit, and records of all data used to complete the application for this permit. The Permittee must extend this period of retention during the course of any unresolved litigation regarding the discharge of pollutants by the Permittee or when requested by Ecology.

S3.D. Recording of results

For each measurement or sample taken, the Permittee must record the following information:

1. The date, exact place, method, and time of sampling or measurement.
2. The individual who performed the sampling or measurement.
3. The dates the analyses were performed.
4. The individual who performed the analyses.
5. The analytical techniques or methods used.
6. The results of all analyses.

S3.E. Additional monitoring by the Permittee

If the Permittee monitors any pollutant more frequently than required by Special Condition S2 of this permit, then the Permittee must include the results of such monitoring in the calculation and reporting of the data submitted in the Permittee's DMR unless otherwise specified by Special Condition S2.

S3.F. Reporting permit violations

The Permittee must take the following actions when it violates or is unable to comply with any permit condition:

1. Immediately take action to stop, contain, and cleanup unauthorized discharges or otherwise stop the noncompliance and correct the problem.
2. If applicable, immediately repeat sampling and analysis. Submit the results of any repeat sampling to Ecology within thirty (30) days of sampling.

a. Immediate reporting

The Permittee must **immediately** report to Ecology, the Department of Health, Shellfish Program, and the Pierce County Health Department (at the numbers listed below), all:

- Failures of the disinfection system.
- Collection system overflows.
- Plant bypasses discharging to marine surface waters.
- Any other failures of the sewage system (pipe breaks, etc.).

Northwest Regional Office	425-649-7000
Department of Health, Shellfish Program	360-236-3330 (business hours) 360-789-8962 (after business hours)
Pierce County Health Department	253-798-6470

b. Twenty-four-hour reporting

The Permittee must report the following occurrences of noncompliance by telephone, to Ecology at the telephone numbers listed above, within 24 hours from the time the Permittee becomes aware of any of the following circumstances:

1. Any noncompliance that may endanger health or the environment, unless previously reported under immediate reporting requirements.
2. Any unanticipated bypass that causes an exceedance of an effluent limit in the permit (See Part S5.F, "Bypass Procedures").
3. Any upset that causes an exceedance of an effluent limit in the permit (See G.15, "Upset").
4. Any violation of a maximum daily or instantaneous maximum discharge limit for any of the pollutants in Section S1.A of this permit.
5. Any overflow prior to the treatment works, whether or not such overflow endangers health or the environment or exceeds any effluent limit in the permit.

c. Report within five days

The Permittee must also submit a written report within five days of the time that the Permittee becomes aware of any reportable event under subparts a or b, above. The report must contain:

1. A description of the noncompliance and its cause.
2. The period of noncompliance, including exact dates and times.
3. The estimated time the Permittee expects the noncompliance to continue if not yet corrected.
4. Steps taken or planned to reduce, eliminate, and prevent recurrence of the noncompliance.
5. If the noncompliance involves an overflow prior to the treatment works, an estimate of the quantity (in gallons) of untreated overflow.

d. Waiver of written reports

Ecology may waive the written report required in subpart c, above, on a case-by-case basis upon request if the Permittee has submitted a timely oral report.

e. All other permit violation reporting

The Permittee must report all permit violations, which do not require immediate or within 24 hours reporting, when it submits monitoring reports for S3.A ("Reporting"). The reports must contain the information listed in subpart c, above. Compliance with these requirements does not relieve the Permittee from responsibility to maintain continuous compliance with the terms and conditions of this permit or the resulting liability for failure to comply.

S3.G. Other reporting

a. Spills of oil or hazardous materials

The Permittee must report a spill of oil or hazardous materials in accordance with the requirements of RCW 90.56.280 and chapter 173-303-145. You can obtain further instructions at the following website: http://www.ecy.wa.gov/programs/spills/other/reportaspill.htm .

b. Failure to submit relevant or correct facts

Where the Permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application, or in any report to Ecology, it must submit such facts or information promptly.

S3.H. Maintaining a copy of this permit

The Permittee must keep a copy of this permit at the facility and make it available upon request to Ecology inspectors.

S4. Facility loading

S4.A. Design criteria

The flows or waste loads for the permitted facility must not exceed the following design criteria:

Maximum Month Design Flow (MMDF)	29,000 gpd
BOD_5 Influent Loading for Maximum Month	58 lb/day

S4.B. Plans for maintaining adequate capacity

a. Conditions triggering plan submittal

The Permittee must submit a plan and a schedule for continuing to maintain capacity to Ecology when:

1. The actual flow or waste load reaches 85 percent of any one of the design criteria in S4.A for three consecutive months; or
2. The projected plant flow or loading would reach design capacity within five years.

b. Plan and schedule content

The plan and schedule must identify the actions necessary to maintain adequate capacity for the expected population growth and to meet the limits and requirements of the permit. The Permittee must consider the following topics and actions in its plan.

1. Analysis of the present design and proposed process modifications.
2. Reduction or elimination of excessive infiltration and inflow of uncontaminated ground and surface water into the sewer system.

3. Limits on future sewer extensions or connections or additional waste loads.
4. Modification or expansion of facilities.
5. Reduction of industrial or commercial flows or waste loads.

Engineering documents associated with the plan must meet the requirements of WAC 173-240-060, "Engineering Report," and be approved by Ecology prior to any construction.

S4.C. Duty to mitigate

The Permittee must take all reasonable steps to minimize or prevent any discharge or sludge use or disposal in violation of this permit that has a reasonable likelihood of adversely affecting human health or the environment.

S4.D. Notification of new or altered sources

1. The Permittee must submit written notice to Ecology whenever any new discharge or a substantial change in volume or character of an existing discharge into the wastewater treatment plant is proposed which:
   a. Would interfere with the operation of, or exceed the design capacity of, any portion of the wastewater treatment plant.
   b. Is not part of an approved general sewer plan or approved plans and specifications.
   c. Is subject to pretreatment standards under 40 CFR Part 403 and Section 307(b) of the Clean Water Act.
2. This notice must include an evaluation of the wastewater treatment plant's ability to adequately transport and treat the added flow and/or waste load, the quality and volume of effluent to be discharged to the treatment plant, and the anticipated impact on the Permittee's effluent [40 CFR 122.42(b)].

S5. Operation and maintenance

The Permittee must at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances), which are installed to achieve compliance with the terms and conditions of this permit. Proper operation and maintenance also includes keeping a daily operation logbook (paper or electronic), adequate laboratory controls, and appropriate quality assurance procedures. This provision of the permit requires the Permittee to operate backup or auxiliary facilities or similar systems only when the operation is necessary to achieve compliance with the conditions of this permit.

S5.A. Certified operator

This permitted facility must be operated by an operator certified by the state of Washington for at least a Class II plant. This operator must be in responsible charge of the day-to-day operation of the wastewater treatment plant. An operator certified for at least a Class I plant must be in charge during all regularly

scheduled shifts. The Permittee must notify Ecology when the operator in charge at the facility changes. It must provide the new operator's name and certification level and provide the name of the operator leaving the facility.

S5.B. Operation and maintenance program

The Permittee must:

1. Institute an adequate operation and maintenance program for the entire sewage system.
2. Keep maintenance records on all major electrical and mechanical components of the treatment plant, as well as the sewage system and pumping stations. Such records must clearly specify the frequency and type of maintenance recommended by the manufacturer and must show the frequency and type of maintenance performed.
3. Make maintenance records available for inspection at all times.

S5.C. Short-term reduction

The Permittee must schedule any facility maintenance, which might require interruption of wastewater treatment and degrade effluent quality, during non-critical water quality periods and carry this maintenance out according to the approved O&M manual or as otherwise approved by Ecology.

If a Permittee contemplates a reduction in the level of treatment that would cause a violation of permit discharge limits on a short-term basis for any reason, and such reduction cannot be avoided, the Permittee must:

1. Give written notification to Ecology, if possible, thirty (30) days prior to such activities.
2. Detail the reasons for, length of time of, and the potential effects of the reduced level of treatment.

This notification does not relieve the Permittee of its obligations under this permit.

S5.D. Electrical power failure

The Permittee must ensure that adequate safeguards prevent the discharge of untreated wastes or wastes not treated in accordance with the requirements of this permit during electrical power failure at the treatment plant and/or sewage lift stations. Adequate safeguards include, but are not limited to, alternate power sources, standby generator(s), or retention of inadequately treated wastes.

The Permittee must maintain Reliability Class II (EPA 430-99-74-001) at the wastewater treatment plant. Reliability Class II requires a backup power source sufficient to operate all vital components and critical lighting and ventilation during peak wastewater flow conditions. Vital components used to support the secondary processes (i.e., mechanical aerators or aeration basin air compressors) need not be operable to full levels of treatment, but must be sufficient to maintain the biota.

S5.E. Prevent connection of inflow

The Permittee must strictly enforce its sewer ordinances and not allow the connection of inflow (roof drains, foundation drains, etc.) to the sanitary sewer system.

S5.F. Bypass procedures

This permit prohibits a bypass, which is the intentional diversion of waste streams from any portion of a treatment facility. Ecology may take enforcement action against a Permittee for a bypass unless one of the following circumstances (1, 2, or 3) applies.

1. Bypass for essential maintenance without the potential to cause violation of permit limits or conditions.

   This permit authorizes a bypass if it allows for essential maintenance and does not have the potential to cause violations of limits or other conditions of this permit, or adversely impact public health as determined by Ecology prior to the bypass. The Permittee must submit prior notice, if possible, at least ten (10) days before the date of the bypass.

2. Bypass which is unavoidable, unanticipated, and results in noncompliance of this permit.

   This permit authorizes such a bypass only if:

   a. Bypass is unavoidable to prevent loss of life, personal injury, or severe property damage. "Severe property damage" means substantial physical damage to property, damage to the treatment facilities which would cause them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass.

   b. No feasible alternatives to the bypass exist, such as:
      - The use of auxiliary treatment facilities.
      - Retention of untreated wastes.
      - Maintenance during normal periods of equipment downtime, but not if the Permittee should have installed adequate backup equipment in the exercise of reasonable engineering judgment to prevent a bypass.
      - Transport of untreated wastes to another treatment facility.

   c. Ecology is properly notified of the bypass as required in Special Condition S3.F of this permit.

3. If bypass is anticipated and has the potential to result in noncompliance of this permit.

   a. The Permittee must notify Ecology at least thirty (30) days before the planned date of bypass. The notice must contain:
      - A description of the bypass and its cause.

- An analysis of all known alternatives which would eliminate, reduce, or mitigate the need for bypassing.
- A cost-effectiveness analysis of alternatives including comparative resource damage assessment.
- The minimum and maximum duration of bypass under each alternative.
- A recommendation as to the preferred alternative for conducting the bypass.
- The projected date of bypass initiation.
- A statement of compliance with SEPA.
- A request for modification of water quality standards as provided for in WAC 173-201A-410, if an exceedance of any water quality standard is anticipated.
- Details of the steps taken or planned to reduce, eliminate, and prevent reoccurrence of the bypass.

b. For probable construction bypasses, the Permittee must notify Ecology of the need to bypass as early in the planning process as possible. The Permittee must consider the analysis required above during the project planning and design process. The project-specific engineering report or facilities plan as well as the plans and specifications must include details of probable construction bypasses to the extent practical. In cases where the Permittee determines the probable need to bypass early, the Permittee must continue to analyze conditions up to and including the construction period in an effort to minimize or eliminate the bypass.

c. Ecology will consider the following prior to issuing an administrative order for this type of bypass:
   - If the bypass is necessary to perform construction or maintenance-related activities essential to meet the requirements of this permit.
   - If feasible alternatives to bypass exist, such as the use of auxiliary treatment facilities, retention of untreated wastes, stopping production, maintenance during normal periods of equipment down time, or transport of untreated wastes to another treatment facility.
   - If the Permittee planned and scheduled the bypass to minimize adverse effects on the public and the environment.

After consideration of the above and the adverse effects of the proposed bypass and any other relevant factors, Ecology will approve or deny the request. Ecology will give the public an opportunity to comment on bypass incidents of significant duration, to the extent feasible. Ecology will approve a request to bypass by issuing an administrative order under RCW 90.48.120.

S5.G. Operations and maintenance (O&M) manual

a. O&M manual submittal and requirements

The Permittee must:

1. Update the operations and maintenance (O&M) manual to incorporate recent upgrades to the plant including the new aeration blower, effluent composite sampler, blower air relief valves, and influent screen. Submit the updated O&M manual to Ecology no later than December 1, 2016.
2. When treatment processes or equipment have significant changes or upgrades, the Permittee shall update the O&M manual that meets the requirements of 173-240-080 WAC and submit it to Ecology for approval. The Permittee must submit a paper copy and an electronic copy (preferably as a PDF).
3. Keep the approved O&M Manual at the permitted facility.
4. Follow the instructions and procedures of this manual.

b. O&M manual components

In addition to the requirements of WAC 173-240-080(1) through (5), the O&M Manual must be consistent with the guidance in Table G1-3 in the *Criteria for Sewage Works Design* (Orange Book), 2008. The O&M manual must include:

1. Emergency procedures for cleanup in the event of wastewater system upset or failure.
2. A review of system components which if failed could pollute surface water or could impact human health. Provide a procedure for a routine schedule of checking the function of these components.
3. Wastewater system maintenance procedures that contribute to the generation of process wastewater.
4. Reporting protocols for submitting reports to Ecology to comply with the reporting requirements in the discharge permit.
5. Any directions to maintenance staff when cleaning or maintaining other equipment or performing other tasks which are necessary to protect the operation of the wastewater system (for example, defining maximum allowable discharge rate for draining a tank, blocking all floor drains before beginning the overhaul of a stationary engine).
6. The treatment plant process control monitoring schedule.
7. Minimum staffing adequate to operate and maintain the treatment processes and carry out compliance monitoring required by the permit.

S6. Pretreatment

S6.A. General requirements

The Permittee must work with Ecology to ensure that all commercial and industrial users of the publicly owned treatment works (POTW) comply with the pretreatment regulations in 40 CFR Part 403 and any additional regulations that the Environmental Protection Agency (U.S. EPA) may promulgate under Section 307(b) (pretreatment) and 308 (reporting) of the Federal Clean Water Act.

S6.B. Duty to enforce discharge prohibitions

1. Under federal regulations (40 CFR 403.5(a) and (b)), the Permittee must not authorize or knowingly allow the discharge of any pollutants into its POTW which may be reasonably expected to cause pass through or interference, or which otherwise violate general or specific discharge prohibitions contained in 40 CFR Part 403.5 or WAC 173-216-060.
2. The Permittee must not authorize or knowingly allow the introduction of any of the following into their treatment works:
    a. Pollutants which create a fire or explosion hazard in the POTW (including, but not limited to waste streams with a closed cup flashpoint of less than 140 degrees Fahrenheit or 60 degrees Centigrade using the test methods specified in 40 CFR 261.21).
    b. Pollutants which will cause corrosive structural damage to the POTW, but in no case discharges with pH lower than 5.0, or greater than 11.0 standard units, unless the works are specifically designed to accommodate such discharges.
    c. Solid or viscous pollutants in amounts that could cause obstruction to the flow in sewers or otherwise interfere with the operation of the POTW.
    d. Any pollutant, including oxygen-demanding pollutants, (BOD_5, etc.) released in a discharge at a flow rate and/or pollutant concentration which will cause interference with the POTW.
    e. Petroleum oil, non-biodegradable cutting oil, or products of mineral origin in amounts that will cause interference or pass through.
    f. Pollutants which result in the presence of toxic gases, vapors, or fumes within the POTW in a quantity which may cause acute worker health and safety problems.
    g. Heat in amounts that will inhibit biological activity in the POTW resulting in interference but in no case heat in such quantities such that the temperature at the POTW headworks exceeds 40 degrees Centigrade (104 degrees Fahrenheit) unless Ecology, upon request of the Permittee, approves, in writing, alternate temperature limits.
    h. Any trucked or hauled pollutants, except at discharge points designated by the Permittee.

i. Wastewaters prohibited to be discharged to the POTW by the Dangerous Waste Regulations (chapter 173-303 WAC), unless authorized under the Domestic Sewage Exclusion (WAC 173-303-071).

3. The Permittee must also not allow the following discharges to the POTW unless approved in writing by Ecology:

   a. Noncontact cooling water in significant volumes.

   b. Stormwater and other direct inflow sources.

   c. Wastewaters significantly affecting system hydraulic loading, which do not require treatment, or would not be afforded a significant degree of treatment by the system.

4. The Permittee must notify Ecology if any industrial user violates the prohibitions listed in this section (S6.B), and initiate enforcement action to promptly curtail any such discharge.

S6.C. Wastewater discharge permit required

The Permittee shall not allow significant industrial users (SIUs) to discharge wastewater to the Permittee's sewerage system until such user has received a wastewater discharge permit from Ecology in accordance with Chapter 90.48 RCW and Chapter 173-216 WAC, as amended.

S6.D. Identification and reporting of existing, new, and proposed industrial users

1. The Permittee must take continuous, routine measures to identify all existing, new, and proposed SIUs and potential significant industrial users (PSIUs) discharging or proposing to discharge to the Permittee's sewer system (see *Appendix C* of the fact sheet for definitions).

2. Within 30 days of becoming aware of an unpermitted existing, new, or proposed industrial user who may be a significant industrial user (SIU), the Permittee must notify such user by registered mail that, if classified as an SIU, they must apply to Ecology and obtain a State Waste Discharge Permit. The Permittee must send a copy of this notification letter to Ecology within this same 30-day period.

3. The Permittee must also notify all Potential SIUs (PSIUs), as they are identified, that if their classification should change to an SIU, they must apply to Ecology for a State Waste Discharge Permit within 30 days of such change.

S7. Solid wastes

S7.A. Solid waste handling

The Permittee must handle and dispose of all solid waste material in such a manner as to prevent its entry into state ground or surface water.

S7.B. Leachate

The Permittee must not allow leachate from its solid waste material to enter state waters without providing all known, available, and reasonable methods of treatment, nor allow such leachate to cause violations of the State Surface Water Quality Standards, Chapter 173-201A WAC, or the State Ground Water Quality Standards, Chapter 173-200 WAC. The Permittee must apply for a permit or permit modification as may be required for such discharges to state ground or surface waters.

S8. Outfall evaluation

The Permittee must inspect the submerged portion of the outfall line and diffuser to document its integrity and continued function. If conditions allow for a photographic verification, the Permittee must include such verification in the report. The Permittee must submit the inspection report to Ecology through the Water Quality Permitting Portal – Permit Submittals application by June 30, 2020. The Permittee must submit hard-copies of any video files to Ecology as required by Permit Condition S3.B. The Portal does not support submittal of video files.

The inspector must, at a minimum:

- Assess the physical condition of the outfall pipe, diffuser, and associated couplings.
- Determine the extent of sediment accumulation in the vicinity of the diffuser.
- Ensure diffuser ports are free of obstructions and are allowing uniform flow.
- Confirm physical location (latitude/longitude) and depth (at MLLW) of the diffuser section of the outfall.
- Assess physical condition of the submarine line.
- Assess physical condition of anchors used to secure the submarine line.
- Determine the total length of the diffuser.

S9. Engineering evaluation report

The Permittee must prepare and submit an approvable engineering report to Ecology for review and approval by June 30, 2020. The report must:

1. Assess the physical condition of each treatment unit, the treatment efficiency of each treatment process, the overall treatment efficiency of the plant, and performance trends for all influent and effluent parameters.
2. Identify physical, capacity, performance, and operation and maintenance problems and deficiencies which may require corrective actions.
3. Provide technical opinion on the adequacy of the existing infrastructure to meet the Taylor Bay community's needs for future flows and loads.
4. Provide recommendations for repair and/or replacement of deteriorated equipment and/or treatment processes.

5. Identify the outcomes if problems and deficiencies are not corrected in a timely fashion.
6. Present a detailed financial plan to support any necessary treatment process improvements, with financing options.
7. Present a schedule for the completion of all recommended improvements.

S10. Application for permit renewal or modification for facility changes

The Permittee must submit an application for renewal of this permit by June 30, 2020. The Permittee must submit a paper copy and an electronic copy (preferably as a PDF).

The Permittee must also submit a new application or supplement at least one hundred eighty (180) days prior to commencement of discharges, resulting from the activities listed below, which may result in permit violations. These activities include any facility expansions, production increases, or other planned changes, such as process modifications, in the permitted facility.

General Conditions

G1. Signatory requirements

1. All applications, reports, or information submitted to Ecology must be signed and certified.

   a. In the case of corporations, by a responsible corporate officer. For the purpose of this section, a responsible corporate officer means:

      - A president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision making functions for the corporation, or
      - The manager of one or more manufacturing, production, or operating facilities, provided, the manager is authorized to make management decisions which govern the operation of the regulated facility including having the explicit or implicit duty of making major capital investment recommendations, and initiating and directing other comprehensive measures to assure long-term environmental compliance with environmental laws and regulations; the manager can ensure that the necessary systems are established or actions taken to gather complete and accurate information for permit application requirements; and where authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures.

   b. In the case of a partnership, by a general partner.

   c. In the case of sole proprietorship, by the proprietor.

   d. In the case of a municipal, state, or other public facility, by either a principal executive officer or ranking elected official.

   Applications for permits for domestic wastewater facilities that are either owned or operated by, or under contract to, a public entity shall be submitted by the public entity.

2. All reports required by this permit and other information requested by Ecology must be signed by a person described above or by a duly authorized representative of that person. A person is a duly authorized representative only if:

   a. The authorization is made in writing by a person described above and submitted to Ecology.

   b. The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility, such as the position of plant manager, superintendent, position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters. (A duly authorized representative may thus be either a named individual or any individual occupying a named position.)

3. Changes to authorization. If an authorization under paragraph G1.2, above, is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of paragraph G1.2, above, must be submitted to Ecology prior to or together with any reports, information, or applications to be signed by an authorized representative.
4. Certification. Any person signing a document under this section must make the following certification:

   "I certify under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

G2. Right of inspection and entry

The Permittee must allow an authorized representative of Ecology, upon the presentation of credentials and such other documents as may be required by law:

1. To enter upon the premises where a discharge is located or where any records must be kept under the terms and conditions of this permit.
2. To have access to and copy, at reasonable times and at reasonable cost, any records required to be kept under the terms and conditions of this permit.
3. To inspect, at reasonable times, any facilities, equipment (including monitoring and control equipment), practices, methods, or operations regulated or required under this permit.
4. To sample or monitor, at reasonable times, any substances or parameters at any location for purposes of assuring permit compliance or as otherwise authorized by the Clean Water Act.

G3. Permit actions

This permit may be modified, revoked and reissued, or terminated either at the request of any interested person (including the Permittee) or upon Ecology's initiative. However, the permit may only be modified, revoked and reissued, or terminated for the reasons specified in 40 CFR 122.62, 40 CFR 122.64 or WAC 173-220-150 according to the procedures of 40 CFR 124.5.

1. The following are causes for terminating this permit during its term, or for denying a permit renewal application:
   a. Violation of any permit term or condition.
   b. Obtaining a permit by misrepresentation or failure to disclose all relevant facts.
   c. A material change in quantity or type of waste disposal.

d. A determination that the permitted activity endangers human health or the environment, or contributes to water quality standards violations and can only be regulated to acceptable levels by permit modification or termination.

e. A change in any condition that requires either a temporary or permanent reduction, or elimination of any discharge or sludge use or disposal practice controlled by the permit.

f. Nonpayment of fees assessed pursuant to RCW 90.48.465.

g. Failure or refusal of the Permittee to allow entry as required in RCW 90.48.090.

2. The following are causes for modification but not revocation and reissuance except when the Permittee requests or agrees:

a. A material change in the condition of the waters of the state.

b. New information not available at the time of permit issuance that would have justified the application of different permit conditions.

c. Material and substantial alterations or additions to the permitted facility or activities which occurred after this permit issuance.

d. Promulgation of new or amended standards or regulations having a direct bearing upon permit conditions, or requiring permit revision.

e. The Permittee has requested a modification based on other rationale meeting the criteria of 40 CFR Part 122.62.

f. Ecology has determined that good cause exists for modification of a compliance schedule, and the modification will not violate statutory deadlines.

g. Incorporation of an approved local pretreatment program into a municipality's permit.

3. The following are causes for modification or alternatively revocation and reissuance:

a. When cause exists for termination for reasons listed in 1.a through 1.g of this section, and Ecology determines that modification or revocation and reissuance is appropriate.

b. When Ecology has received notification of a proposed transfer of the permit. A permit may also be modified to reflect a transfer after the effective date of an automatic transfer (General Condition G7) but will not be revoked and reissued after the effective date of the transfer except upon the request of the new Permittee.

G4. Reporting planned changes

The Permittee must, as soon as possible, but no later than one hundred eighty (180) days prior to the proposed changes, give notice to Ecology of planned physical alterations or additions to the permitted facility, production increases, or process modification which will result in:

1. The permitted facility being determined to be a new source pursuant to 40 CFR 122.29(b).
2. A significant change in the nature or an increase in quantity of pollutants discharged.
3. A significant change in the Permittee's sludge use or disposal practices. Following such notice, and the submittal of a new application or supplement to the existing application, along with required engineering plans and reports, this permit may be modified, or revoked and reissued pursuant to 40 CFR 122.62(a) to specify and limit any pollutants not previously limited. Until such modification is effective, any new or increased discharge in excess of permit limits or not specifically authorized by this permit constitutes a violation.

G5. Plan review required

Prior to constructing or modifying any wastewater control facilities, an engineering report and detailed plans and specifications must be submitted to Ecology for approval in accordance with chapter 173-240 WAC. Engineering reports, plans, and specifications must be submitted at least one hundred eighty (180) days prior to the planned start of construction unless a shorter time is approved by Ecology. Facilities must be constructed and operated in accordance with the approved plans.

G6. Compliance with other laws and statutes

Nothing in this permit excuses the Permittee from compliance with any applicable federal, state, or local statutes, ordinances, or regulations.

G7. Transfer of this permit

In the event of any change in control or ownership of facilities from which the authorized discharge emanate, the Permittee must notify the succeeding owner or controller of the existence of this permit by letter, a copy of which must be forwarded to Ecology.

1. Transfers by Modification

   Except as provided in paragraph (2) below, this permit may be transferred by the Permittee to a new owner or operator only if this permit has been modified or revoked and reissued under 40 CFR 122.62(b)(2), or a minor modification made under 40 CFR 122.63(d), to identify the new Permittee and incorporate such other requirements as may be necessary under the Clean Water Act.

2. Automatic Transfers

   This permit may be automatically transferred to a new Permittee if:

   a. The Permittee notifies Ecology at least thirty (30) days in advance of the proposed transfer date.

   b. The notice includes a written agreement between the existing and new Permittees containing a specific date transfer of permit responsibility, coverage, and liability between them.

c. Ecology does not notify the existing Permittee and the proposed new Permittee of its intent to modify or revoke and reissue this permit. A modification under this subparagraph may also be minor modification under 40 CFR 122.63. If this notice is not received, the transfer is effective on the date specified in the written agreement.

G8. Reduced production for compliance

The Permittee, in order to maintain compliance with its permit, must control production and/or all discharges upon reduction, loss, failure, or bypass of the treatment facility until the facility is restored or an alternative method of treatment is provided. This requirement applies in the situation where, among other things, the primary source of power of the treatment facility is reduced, lost, or fails.

G9. Removed substances

Collected screenings, grit, solids, sludges, filter backwash, or other pollutants removed in the course of treatment or control of wastewaters must not be resuspended or reintroduced to the final effluent stream for discharge to state waters.

G10. Duty to provide information

The Permittee must submit to Ecology, within a reasonable time, all information which Ecology may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit or to determine compliance with this permit. The Permittee must also submit to Ecology upon request, copies of records required to be kept by this permit.

G11. Other requirements of 40 CFR

All other requirements of 40 CFR 122.41 and 122.42 are incorporated in this permit by reference.

G12. Additional monitoring

Ecology may establish specific monitoring requirements in addition to those contained in this permit by administrative order or permit modification.

G13. Payment of fees

The Permittee must submit payment of fees associated with this permit as assessed by Ecology.

G14. Penalties for violating permit conditions

Any person who is found guilty of willfully violating the terms and conditions of this permit is deemed guilty of a crime, and upon conviction thereof shall be punished by a fine of up to ten thousand dollars ($10,000) and costs of prosecution, or by imprisonment in the discretion of the court. Each day upon which a willful violation occurs may be deemed a separate and additional violation.

Any person who violates the terms and conditions of a waste discharge permit may incur, in addition to any other penalty as provided by law, a civil penalty in the amount of up to ten thousand dollars ($10,000) for every such violation. Each and every such violation is a separate and distinct offense, and in case of a continuing violation, every day's continuance is deemed to be a separate and distinct violation.

G15. Upset

Definition – "Upset" means an exceptional incident in which there is unintentional and temporary noncompliance with technology-based permit effluent limits because of factors beyond the reasonable control of the Permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

An upset constitutes an affirmative defense to an action brought for noncompliance with such technology-based permit effluent limits if the requirements of the following paragraph are met.

A Permittee who wishes to establish the affirmative defense of upset must demonstrate, through properly signed, contemporaneous operating logs, or other relevant evidence that:

1. An upset occurred and that the Permittee can identify the cause(s) of the upset.
2. The permitted facility was being properly operated at the time of the upset.
3. The Permittee submitted notice of the upset as required in Special Condition S3.F.
4. The Permittee complied with any remedial measures required under S3.F of this permit.

In any enforcement action the Permittee seeking to establish the occurrence of an upset has the burden of proof.

G16. Property rights

This permit does not convey any property rights of any sort, or any exclusive privilege.

G17. Duty to comply

The Permittee must comply with all conditions of this permit. Any permit noncompliance constitutes a violation of the Clean Water Act and is grounds for enforcement action; for permit termination, revocation and reissuance, or modification; or denial of a permit renewal application.

G18. Toxic pollutants

The Permittee must comply with effluent standards or prohibitions established under Section 307(a) of the Clean Water Act for toxic pollutants within the time provided in the regulations that establish those standards or prohibitions, even if this permit has not yet been modified to incorporate the requirement.

G19. Penalties for tampering

The Clean Water Act provides that any person who falsifies, tampers with, or knowingly renders inaccurate any monitoring device or method required to be maintained under this permit shall, upon conviction, be punished by a fine of not more than $10,000 per violation, or by imprisonment for not more than two (2) years per violation, or by both. If a conviction of a person is for a violation committed after a first conviction of such person under this condition, punishment shall be a fine of not more than $20,000 per day of violation, or by imprisonment of not more than four (4) years, or by both.

G20. Compliance schedules

Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in any compliance schedule of this permit must be submitted no later than fourteen (14) days following each schedule date.

G21. Service agreement review

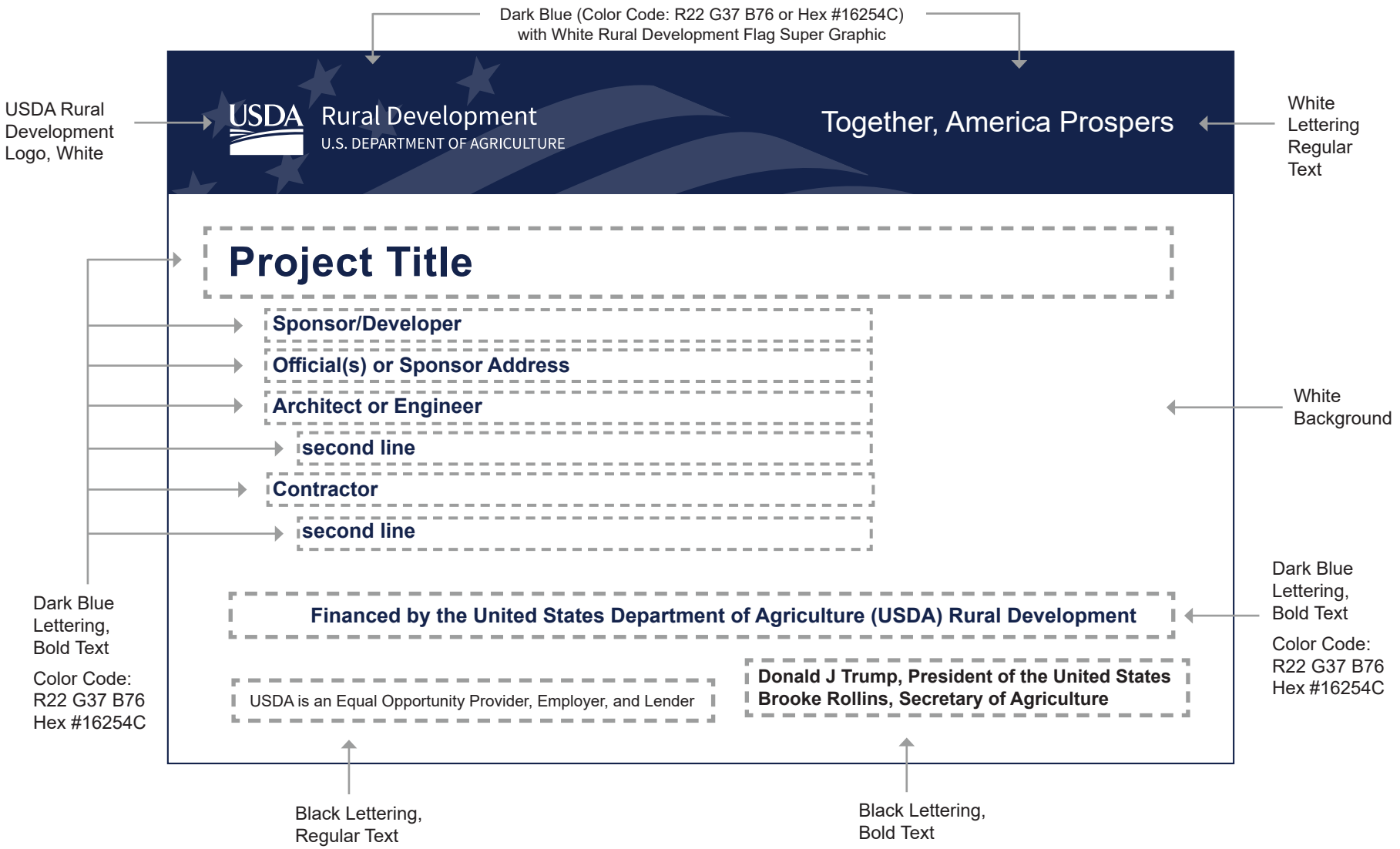
The Permittee must submit to Ecology any proposed service agreements and proposed revisions or updates to existing agreements for the operation of any wastewater treatment facility covered by this permit. The review is to ensure consistency with chapters 90.46 and 90.48 RCW as required by RCW 70.150.040(9). In the event that Ecology does not comment within a thirty-day (30) period, the Permittee may assume consistency and proceed with the service agreement or the revised/updated service agreement.

APPENDIX H

TEMPORARY CONSTRUCTION SIGN

Temporary Construction Sign for Rural Development Projects

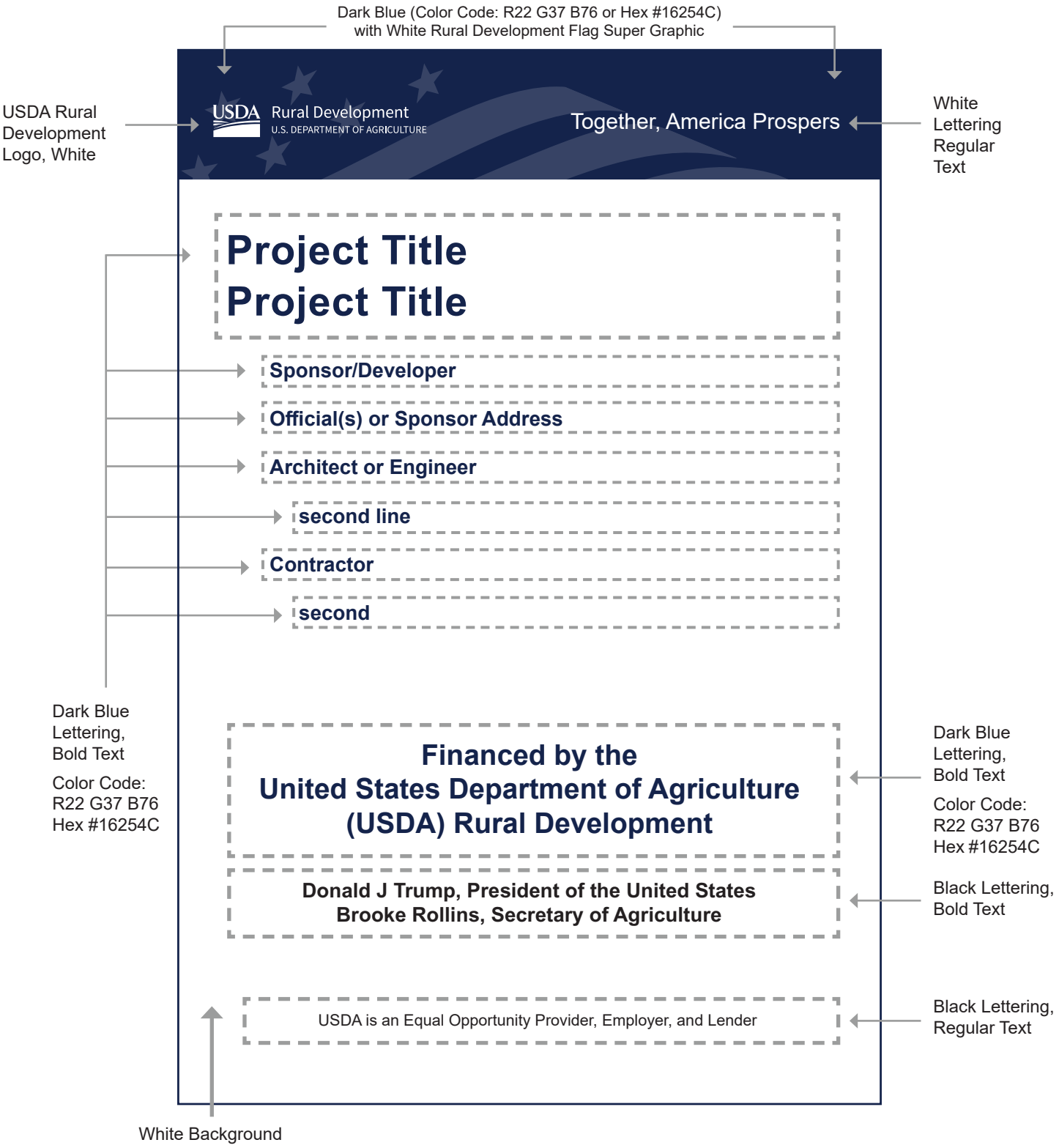
Recommended Font: Arial



SIGN DIMENSIONS: 1200mm x 2400mm x 19mm (approx.4’ x 8’ x 3/4)
PLYWOOD PANEL (APA RATED A+B GRADE-EXTERIOR)

Temporary Construction Sign for Rural Development Projects

Recommended Font: Arial



SIGN DIMENSIONS: 2400mm x 1200mm x 19mm (approx.8'x 4' x 3/4")
PLYWOOD PANEL (APA RATED A+B GRADE-EXTERIOR)