Operation & Maintenance Manual

and

Maintenance Log

FOR

HEEIA KEA SMALL BOAT HARBOR WASTEWATER TREATMENT PLANT

Compiled and Prepared by:
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BILLS ENGINEERING INC.
Civil/Environmental Engineering

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APPENDIX

PART 1

Consultant (Bills Engineering, Inc.) Operation and Maintenance Program Including Monitoring Requirements and Sample Operator Log

SYSTEM INFORMATION

Wastewater System: HEEIA KEA SMALL BOAT HARBOR WWTP

Permit # DOH File No. 245-B

Street Address: 46-499 Kamehameha Highway

City, State, Zip: Kaneohe, HI 96744

Phone: Bydon Burdett 808-590-1745
Tany Borabora 808-233-3603. **Fax:** N/A

Contact: Tanya Borabora, (Harbor Master) Bydon Burdett (Operator Aqua Engineers)

E-mail: bburdett@aquaengineers.com

County: CITY AND COUNTY OF HONOLULU, OAHU, HAWAII

Ownership: State of Hawaii Department of Land and Natural Resources
Division of Boating and Ocean Recreation

Date: January 2023

The O&M Manual should be a quick reference for successful daily operation and include anything from trouble shooting to emergency procedures. The rule requires the O&M Manual to contain:

- ✓ Bound and Indexed Equipment Manufacturer Manuals (you can download most of these manuals off of the web or get them from equipment manufacturers)
- ✓ Operation and Control Procedures
- ✓ Preventive Maintenance and Repair Procedures

We recommend that you make at least **two copies** of the O&M Manual and store one in a safe place in case the plant copy gets lost or damaged by normal use.

The Preventative Maintenance Logs show the date and type of all maintenance performed. We recommend that you include the Preventative Maintenance Logs in your O&M Manual Binder.

DOH REQUIREMENTS

Operation and Maintenance Manual

“In accordance with Title 11- Chapter 62 Hawaii Administrative Rules, each domestic wastewater treatment and effluent disposal or reuse facility must maintain up-to date operation and maintenance manual(s). The report should indicate whether up-to date operation and maintenance manual(s) for the treatment and effluent disposal or reuse facilities are available to the operator at a convenient location. The report should provide the name and address of the location.

The report should include the date the last up-date was done to the operation and maintenance manual(s)and indicate whether the manual(s) are revised on a periodic basis to reflect any facility alterations performed or to reflect experience resulting from facility operation. A good time to revise the operation and maintenance manual would be during preparation of the operation and maintenance performance report.

The details of the manual should be consistent with the complexity of the system. The manual should have been developed in accordance with the unique requirements of the individual wastewater facility. The report should indicate whether the manual(s)provide the operator with adequate information and description regarding the design, operation, and maintenance features of the facility involved.

The report should indicate whether the manual(s) include the information required by Title 11-Chapter 62. In accordance with this rule, "The manual shall include basic hydraulic and engineering design criteria for the facility, as well as information and procedures required for normal control and distribution of wastewater, residuals, and effluent within the facility. In addition, information concerning process control and performance evaluation for the facility, as well as equipment and procedural descriptions (including any notification/reporting requirements of appropriate agencies) for emergency operating conditions and listing 11 of spare parts to have on hand shall be included. Regular maintenance and repair instructions for all equipment; laboratory testing equipment and monitoring procedures; safety and personnel requirements; and a "trouble shooting" problem guide shall be included in the manual."

CONTACTS

Emergency

On Oahu, sewage spills should be reported to the City and County of Honolulu at (808) 768-7272.

Chemical spills should be reported to the Department of Health, Hazard Evaluation & Emergency Response Office at (808) 586-4249 during normal business hours and (808)247-2191 after normal business hours.

Repair/Service

COMPANY OR ORGANIZATION	TELEPHONE	EMAIL
Department of Health	808-586-4294	
Consultant:Bills Engineering, Inc.	808-792-2022	dbills@bowersand kubota.com
Operations Bydon Burdett	808-590-1745	bburdett@aquaengineers.com
Laboratory		
Sludge Hauler (ABC Plumbing Randy Miguel)	808-887-0766	sweetwatertoo@yahoo.com
Equipment Vendor (WWW)	808-841-0033	mack@hiengineering.com
Equipment Vendor (Flygt)	808-841-0033	mack@hiengineering.com
Chemical Supplier		
Equipment Vendor (Trojan UV)	808-841-0033	mack@hiengineering.com
Equipment Vendor (Effluent Flow Meter)	808-841-0033	mack@hiengineering.com

NOTE: Items not filled in should be completed by Operator

BOUND & INDEXED
EQUIPMENT MANUFACTURER MANUALS

Manufacturers O&M Manuals are attached to this document in Parts 2, 3, 4, 5 & 6

FACILITY DESCRIPTION & MAJOR EQUIPMENT

Preliminary Treatment Equipment

Sewage Pump Station
(See Part 2 for Flygt SPS Operation and Maintenance Manual)

Flow Equalization/Surge Tanks
Part of World Water Works WWTP
(See Part 3 for manufacturers Operation and Maintenance Manual)

Screens
The WWTP is equipped with a World Water Works Sidehill Screen which separates large solids from the raw influent.
(See Part 4 for Manufacturer's Operation and Maintenance Manual)

Primary Treatment Equipment *(if applicable)*

Not Applicable.

Secondary Treatment Equipment

Type of Biological Treatment (Extended Aeration, Oxidation Ditch etc.)
World Water Works Moving Bend Biofilm Reactor (MBBR)
(See Part 3 for Manufacturer's Operation and Maintenance Manual)

Return Sludge Pumping Equipment (Size, Mfr. & Model)
0.5 HP Sump Pumps supplied by World Water Works
(See part 3 for Manufacturer's Operation and Maintenance Manual)

Standby Power System

Standby Power is provided by a Catepillar (CAT) generator set. The generator set is equipped with an Automatic Transfer Switch (ATS) which identifies power losss from the main normal power provided by HECO.
(See Part 6 for Manufacturer's Operation and Maintenance Manual for the standby power source as well as ATS

Visually check water quality and water level. The effluent from the WWTP passes through a redundant UV System (two sets of banks) before entering the redundant leaching field system (two leaching fields). The UV System and effluent disposal

Leaching Fields

The effluent disposal system consists of two leaching fields using Infiltrator trenches, effluent distribution system and an inspection port in the middle of each leaching field system.

Visually check water quality and water level. The effluent from the WWTP passes through a redundant UV System (two sets of banks) before entering the redundant leaching field system (two leaching fields). The UV System and effluent disposal system are valved so that any UV bank can be used with any leaching field.

Sludge Digestion Equipment

Digester Pumping Equipment (Size, Mfr. & Model)
Aerobic Digester part of World Water Works WWTP
(See Part 3 for Manufacturer's Operation and Maintenance Manual)

Auxiliary Power Equipment

An LPG operated standby generator with auto-transfer switch and auto-dialer provide standby power to both the sewage pump station and the WWTP.
(See Part 6 for Operation and Maintenance Manual)

EQUIPMENT INVENTORY

SEE INDIVIDUAL MANUFACTURERS O&M MANUALS

(INCULDED IN THIS DOCUMENT)

SPARE PARTS/EQUIPMENT INVENTORY

SEE INDIVIDUAL MANUFACTURERS O&M MANUALS

(INCULDED IN THIS DOCUMENT)

COLLECTION SYSTEM/LIFT STATION OPERATION & MAINTENANCE

SEE PART 2 OF THIS MANUAL FOR

FLYGT PUMP STATION O & M MANUAL

MAINTENANCE PROGRAM

"A good maintenance program is essential for a wastewater treatment plant to operate continuously at peak design efficiency. A successful maintenance program will cover everything from mechanical equipment, such as pumps, valves, scrapers, and other moving equipment, to the care of the plant grounds, buildings, and structures.

Mechanical maintenance is of prime importance, as the equipment must be kept in good operating condition for the plant to maintain peak performance. Manufacturers provide information on the mechanical maintenance of their equipment. You should thoroughly read their literature on your plant equipment and understand the procedures. Contact the manufacture or the local representative if you have any questions. Follow the instructions very carefully when performing maintenance on equipment. You must also recognize tasks that may be beyond your capabilities or repair facilities, and you should request assistance when needed.

For a successful maintenance program, you or your supervisors must understand the need for and the benefits from equipment that operates continuously as intended. Disabled or improperly working equipment is a threat to the quality of the plant effluent, and repair costs for poorly maintained equipment usually exceed the cost of maintenance." [4]

There are two basic types of maintenance, preventive and corrective. Preventive maintenance is scheduled maintenance actions designed to avert equipment failure and disruption of the treatment process. Typical preventive maintenance would include equipment and tank inspections, oil changes, lubrication of motors, etc. The goal of a successful preventive maintenance program is to protect valuable equipment, promote the longevity of this equipment and to ensure adequate treatment. The second type of maintenance is corrective maintenance. This type of maintenance is conducted when a failure has taken place and is required to restore equipment to operational status. Corrective maintenance is often required at inopportune times and frequently requires a significant amount of down time.

An effective preventive maintenance program is invaluable. Preventive maintenance can be conducted at a time convenient to the one performing the maintenance and downtime is limited. The cost and time it takes to complete preventive maintenance is almost always less, than the cost and time it would take to complete corrective maintenance.

BASIC OPERATION & MAINTENANCE

It is recommended that you develop a preventive maintenance schedule. An effective method of breaking down maintenance duties is by how often the maintenance is required. Depending on the activity, type of equipment and/or the frequency the equipment is used, maintenance may be required daily, weekly, monthly, quarterly, semiannually or annually. The charts below are not designed to include all the duties required at your plant. They are designed to assist you in building an operation and maintenance schedule tailor-made for your plant. Feel free to add or subtract items as you see fit.

OPERATIONAL/MAINTENANCE DUTIES (Every Operator Visit)

(Check the box next to items that apply to your facility)

Basic Observations	Visual Observations (i.e. foam, turbid effluent, etc.) Abnormal or Noxious Odors Abnormal Equipment Operation (Audible or Visual)
Basic Duties	Clean Side Hill Screen
Meter Readings	Calculate & Record Total Daily Flow
Inspections	Inspect Instrumentation for Proper Operation Inspect Pumps & Controls Inspect UV System for Proper Operation Observe Effluent Meter for Proper Operation
Samples	See Monitoring Requirements prior to Sample Operator Log later in section
Security	Complete a Daily Security Check Evidence of Tampering Alarms, Locks & Security Lighting Inspect Fences & Gates

WEEKLY OPERATIONAL/MAINTENANCE DUTIES

Pumps	Inspect Pumps for Abnormal Operation Manually Operate Pumps Inspect & Clean Floats

MONTHLY OPERATIONAL/MAINTENANCE DUTIES

Inspections	Clean & Flush Scum Lines Clean & Flush Sludge Lines (RAS; WAS) Inspect Pumps, Blowers and Moving Equipment Operate Generator
Samples & Monitoring	See Monitoring Requirements prior to Sample Operator Log later in this section
Cleaning	Hose down Plant Clean/Scrub down Clarifier, if necessary
UV Disinfection/ Effluent Disposal System	Change UV Bank Operation to use Other Bank and Change Disposal Bed Use to Other Bed. Inspect bed water quality and record for bed being taken out of monthly service.

QUARTERLY OPERATIONAL/MAINTENANCE DUTIES

Inspections	Inspect Pump Bearings Lubricate Pumps, Motors, Blowers and Moving Equipment
Samples	See Monitoring Requirements prior to Sample Operator Log later in this section

SEMIANNUAL OPERATIONAL/MAINTENANCE DUTIES

Inspections	Inspect & Service Pumps Operate All Valves

ANNUAL OPERATIONAL/MAINTENANCE DUTIES

Inspections	Inspect Tanks for Cracks or Leaks Repack Pump & Motor Bearings Check Pin Wear on All Check Valves Calibrate All Meters

When preparing a maintenance schedule, always refer the manufacturers' manual for each piece of equipment. Equipment manuals will recommend maintenance frequency and also specifications as to the types of fuel, lubricant or oil needed to ensure peak performance and maximum life expectancy. Be sure to follow these recommendations in strict accordance so that you will get the most out of your valuable equipment.

Often overlooked in a maintenance program are grounds. Grounds that are well maintained add to the overall appearance of the plant and also have an impact on an individuals' perception of the plant and its staff.

PREVENTIVE MAINTENANCE RECORDS

Equipment ID #	Description of Work Performed	Service (Date/ Initials)	Service (Date/ Initials)	Service (Date/ Initials)	Service (Date/ Initials)	Service (Date/ Initials)	Service (Date/ Initials)

CORRECTIVE MAINTENANCE RECORDS

Equipment ID #	Description of Work Performed	ID # of Spare Parts Used	Date/Worker Signature

An effective method of tracking maintenance is to develop an equipment service card and also a service record card for each piece of equipment. Examples of both are displayed below. Both examples are taken from California State Universities Office of Water Programs, "Operation of Wastewater Treatment Plants, Volume II."

EQUIPMENT SERVICE CARD				
Equipment: #1 Lift Station Pump				
Item No.	**Work to be Completed**	**Reference**	**Frequency**	**Time**
1	Check water seal and packing gland	Manual 1	Daily	
2	Operate pump alternately	Manual 1	Weekly	Monday
3	Inspect pump assembly	Manual 1	Weekly	Wed.
4	Inspect and lube bearings	Manual 1	Quarterly	1-4-7-10
5	Check operating temp. and bearings	Manual 1	Quarterly	1-4-7-10
6	Check alignment of pump and motor	Manual 1	Semiannually	4 & 10
7	Inspect and service pump	Manual 1	Semiannually	4 & 10
8	Drain pump before shutdown	Manual 1		

1-4-7-10 represent the months of the year when the equipment should be serviced – 1. January, 4. April, 7. July, 10. October.

SERVICE RECORD CARD						
Equipment: #1 Lift Station Pump						
Date	Work Done (Item No.)	Signed		Date	Work Done (Item No.)	Signed
1-5-07	1&2	J.B.				
1-6-07	1	J.B.				
1-7-07	1-3-4-5	R.W.				

BASIC WATEWATER TREATMENT UNIT REQUIREMENTS

Treatment unit requirements. (a) For the private wastewater treatment Works at Heeia Kea Small Boat Harbor with design capacity of less than 100,000 gallons per day:

1) Sludge holding capacity shall be 20 days

2) Subsurface disposal systems do not require disinfection. The WWTP is a Mixed Media Membrane Reactor (MBBR) and sizing has been set by the Manufacturer with respect to 2 the MBBR units. The Heeia Kea WWTP final settling tanks have been for a detention time of not be less than four hours and the surface overflow rate does not exceed 300 gallons per day per square foot based on the average daily flow;

3) Flow equalization has been provided for the Heeia Kea Small Boat Harbor WWTP. The equalization basin is ½ the daily design flow.

4) Easy access shall be provided for operators to allow necessary operation, maintenance, and repair.

Wastewater effluent disposal systems:

1) Effluent disposal systems shall at least consist of a primary disposal component and a separate 100 per cent back-up disposal component.

2) The primary disposal component and the back- up disposal component shall each be designed to handle the peak flow.

3) Each disposal component shall be tested to accommodate the wastewater flow as required in paragraph (2).

   (a) For the Heeia Kea Small Boat Harbor WWTP a Geotechnical Report including percolation data has been prepared.

   (b) The Heeia Kea Small Boat Harbor effluent disposal system consist of leaching filed beds and each bed has been provided an inspection manhole for easy observation of leaching field operation.

   (C) Each effluent disposal system has 3 ports for “shock treatment” as well as the inspection port described above. “Shock Treatment may include use of products such as NT-Max Septic Treatment™, Biomat – X – Ultimate Septic Tank Cleaner™ or equal. Experienced Operator input shall also be evaluated.

MONITORING REQUIREMENTS

Wastewater effluent requirements, monitoring, and reporting requirements. The Heeia Kea Small Boat Harbor WWTP effluent requirements, monitoring requirements and reporting requirements are as follows:

Biochemical oxygen demand (BOD_5)

(A) BOD_5 grab sampling shall occur at least monthly

(B) The BOD_5 in the effluent from a treatment works shall not exceed 30 milligrams per liter based on the monthly average of the results of the analyses of composite samples.

(C) The BOD_5 in the effluent from a treatment works shall not excess 60 milligrams per liter based on a grab sample.

(D) Owners or authorized agents shall submit BOD_5 lab data to the director no later than thirty days after the last day of June and December

Suspended solids

(A) For wastewater treatment works with average daily flows less than 100,000 gallons per day, the owner or operator Suspended grab sampling shall be performed grab at least monthly.

(B) The suspended solids in the effluent from a treatment works shall not exceed 30 milligrams per liter based on the monthly average of the results of the analyses of composite samples.

(C) The suspended solids in the effluent from a treatment works shall not exceed 60 milligrams per liter based on a grab sample.

(D) Owners or authorized agents shall submit suspended solids lab data to the director no later than thirty days after the last day of June and December

Dissolved Oxygen, pH, and Settleability

(A) The dissolved oxygen, pH, and 30 minutes settleability of the contents of the aeration tank shall be sampled and analyzed at least weekly.

(B) Effluent chlorine residual, if any, shall be sampled and analyzed at least weekly.

Daily Flow

(A) Total daily flow shall be monitored on a continuous basis recorded in the Operator Log at minimum of at least weekly.

Sludge Monitoring and Reporting

(A) The volume of wastewater sludge wasted, the solid concentration of wastewater sludge wasted, the name of the wastewater sludge pumping and hauling firm, and the dates of pumping and hauling shall be recorded shall be recorded

Effluent Disposal System (Leaching Fields)

(A) The leaching field usage shall change monthly. At the time of change over the Operator shall open both inspection porta and provide a visual description of the water quality in each leaching with respect to clarity and water level.

Operator Log Book

The operator shall maintain a log or records which shall include but not be limited to the date and time of operator on-site operations and the reporting the data outlined above on the Operator Log attached (next page).

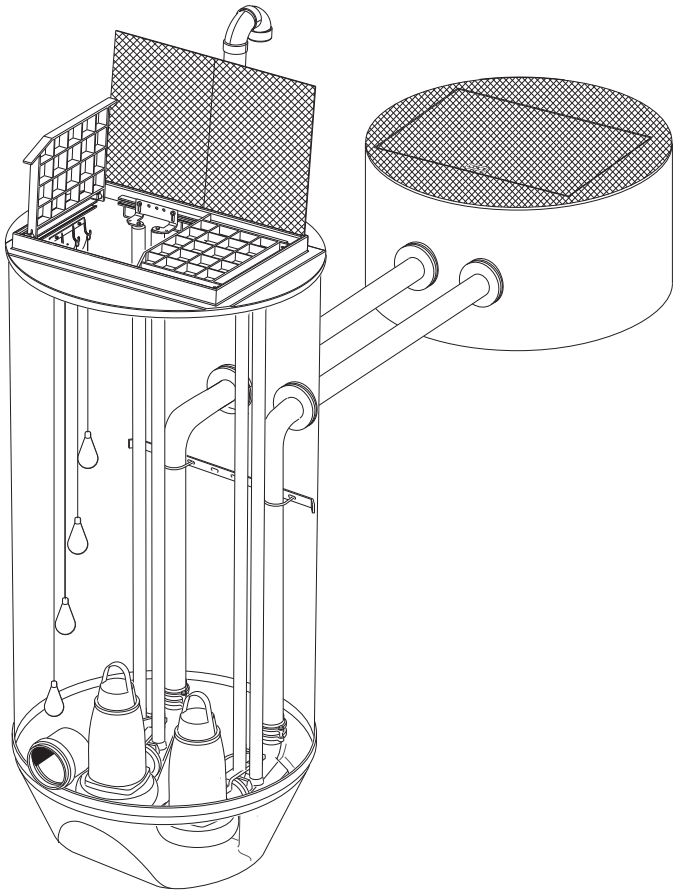
OPERATOR LOG- HEEIA KEA WWTP

DATE	FLOW GPD	BOD_5 MG/L	TSS MG/L	Dissolved Oxygen (DO) MG/L	pH (Units)	Settleability SVI (ML/G)	SEWAGE PUMP STATION (Comments)	LEACHING FIELDS (Comments)

THE MONITORING AND REPORTING SHALL FOLLOW THE MONITORING REQUIREMENTS PRECEDING THIS SAMPLE OPERATOR LOG.

PART 2

FLYGT Sewage Pump Station Operation and Maintenance Manual



FLYGT'S TOP PRE-ENGINEERED PACKAGED PUMP STATIONS

INSTALLATION, CARE AND MAINTENANCE MANUAL

FOR FLYGT'S TOP PRE-ENGINEERED PACKAGE PUMPS STATIONS

FLYGT

a xylem brand

CONTENTS

SAFETY

This manual contains basic information on the Installation, Operation and Maintenance and should be followed carefully. It is essential that these instructions are carefully read before installation or commissioning by both the installation crew as well as those responsible for operation or maintenance. The operating instructions should always be readily available at the location of the unit.

Identification of safety and warning symbols

General Danger:

Non-observance given to safety instructions in this manual, which could cause danger to life have been specifically highlighted with this general danger symbol.

High Voltage:

The presence of a dangerous voltage is identified with this safety symbol.

WARNING!

Non-observance to this warning could damage the unit or affect its function

Qualifications of personnel

An authorized (certified) electrician and mechanic shall carry out all work.

Safety regulations for the owner/operator

All government regulations, local health and safety codes shall be complied with.

All dangers due to electricity must be avoided (for details consult the regulations of your local electricity supply company).

Unilateral modification and spare parts manufacturing.

Modifications or changes to the unit/installation should only be carried out after consulting with Xylem, Flygt Products.

Original spare parts and accessories authorized by the manufacturer are essential for compliance. The use of other parts can invalidate any claims for warranty or compensation.

The pictures in this manual may differ somewhat from the delivered pump station depending on size and configuration.

GUARANTEE

Xylem, Flygt Products undertakes to remedy faults in their products provided that:

- the fault is due to defects in design, materials or workmanship;
- the faults are reported to Xylem, Flygt Products or their representative during the guarantee period;
- the product is used only under conditions described in the Installation, Care and Maintenance manual and in applications for which it is intended;
- the monitoring equipment incorporated in the product is correctly **connected** and **in use;**
- all service and repair work should be done by Xylem, Flygt Products Authroized service personnel;
- genuine Xylem, Flygt Products parts are used.

Hence, the guarantee does not cover faults caused by deficient maintenance, improper installation, incorrectly executed repair work or normal wear and tear.

Xylem, Flygt Products assumes no liability for either bodily injuries, material damages or economic losses beyond what is stated above.

PRODUCT DESCRIPTION

Introduction

In this Installation, Care and Maintenance manual you will find information on how to handle, install and maintain the pump station to give it a long and reliable life.

The pump is installed by means of twin guide bars with automatic connection to the permanently installed discharge connection at the bottom of the sump.

The unique design of the sump and the integrated pump discharge connections has been hydraulically optimized to improve the flow over the sump floor during pumping. This increases turbulence and causes re-suspension of settled solids and entrainment of floating debris. The result: more solids are removed from the sump, leaving minimal residue beneath the pumps which is ready to be removed during the next pumping cycle.

Application

This pump station is intended to be used for;

- pumping of wastewater-domestic, commercial or industrial
- pumping of raw or clean water

For further information on applications, contact your nearest Flygt product representative.

Pump station depth: max. 20 ft.

Materials

The pump station is fabricated of Fiberglass Reinforced Plastic (FRP), i.e. thermosetting resins incorporating reinforcement materials and processing agents and possibly fillers and/or additives.

Design Criteria

The pump station is designed in respect of a subsoil water table up to the ground level.

The pump station carries a pedestrian load rating and shall be installed in such a way that traffic load can not get closer than 3 ft. from the tank edge.

Pipe material

The pump station is available with piping in stainless steel, PVC or ductile iron.

The guide bars are available in galvanized steel or stainless steel.

Weight

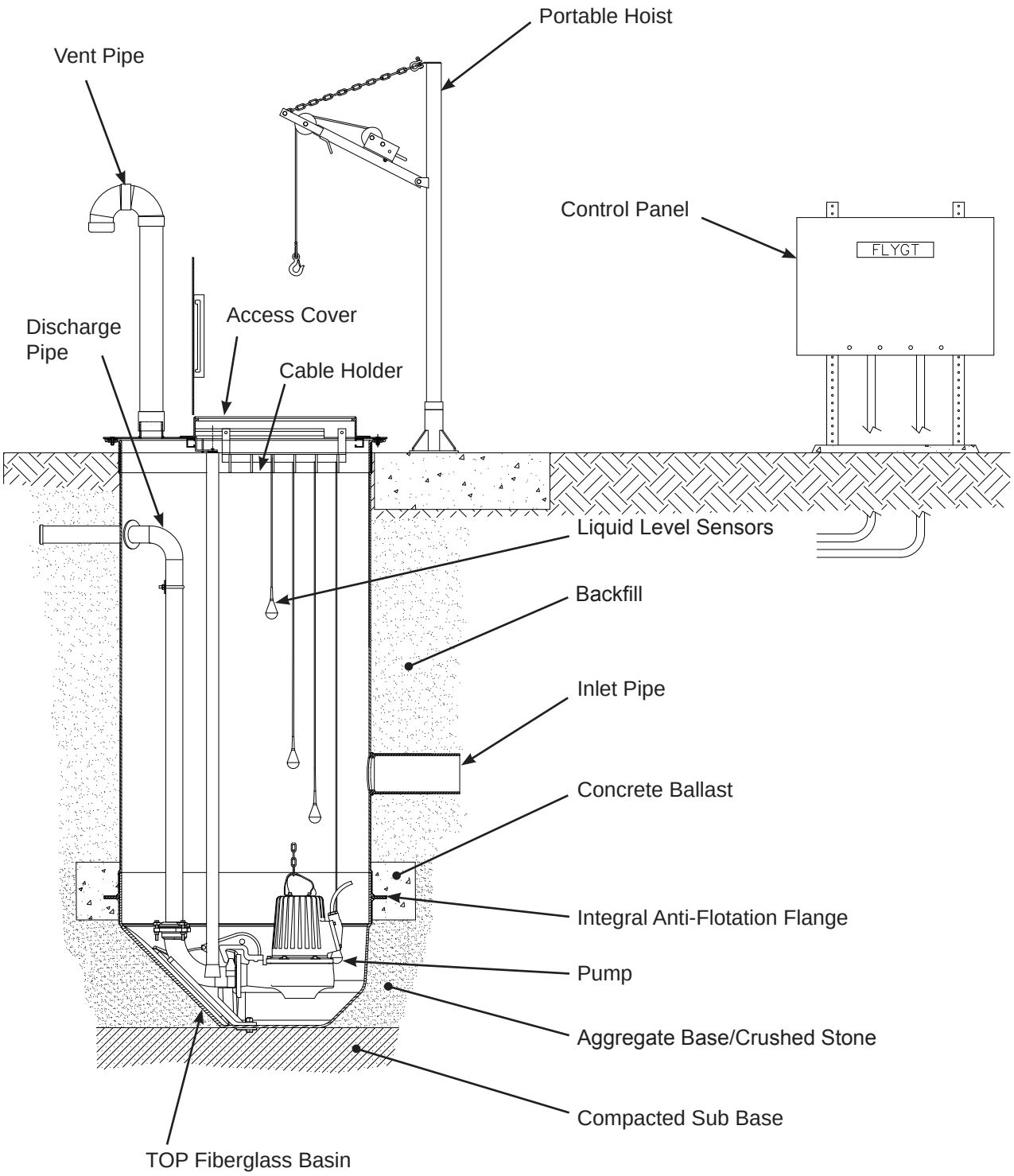
Approximate total weight (lb.) of pump station excluding pumps:

Table 1 PUMP STATION WEIGHT

Station Depth (ft.)	TOP 4 Weight (lbs.)	TOP 5 Weight (lbs.)	TOP 6 Weight (lbs.)
5	1070	1280	1540
10	1480	1890	2430
15	2040	2810	3630
20	2500	3490	4560

Note: All weights assume the use of ductile iron piping within the station and are approximate. Actual station weight will be marked on the outside of the station prior to shipment.

TYPICAL INSTALLATION



TRANSPORTATION AND STORAGE

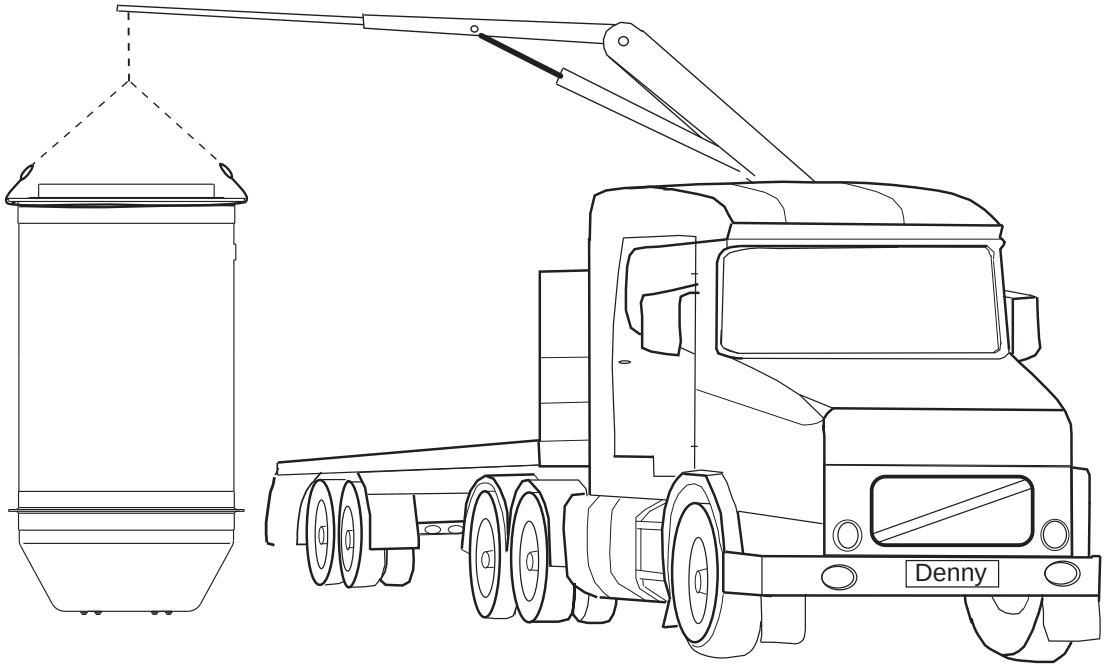
The pump station is delivered in a horizontal position.

Make sure that the station is unloaded from the truck with a suitable crane or lifting equipment.

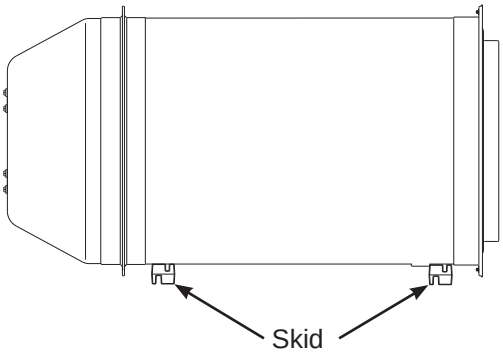
Always lift the pump station by the appropriate load-rated lifting straps.

Do not use chain as chain may damage the station.

Unload and put it down carefully on the ground.



If the pump station shall be stored for some time before installation – keep it in a horizontal position!



- **The pump station and pumps are delivered separately.**
- **Never install the pumps before the pump station is permanently installed.**
- **Make sure that pump station cannot roll over or fall.**

INSTALLATION

Safety precautions

In order to minimize the risk of accidents in connection with transportation and installation work the following rules should be followed:

- **Always pay extra attention to safety aspects when working with lifting equipment.**
- **Never work alone.**
- **Use safety helmet and protective shoes.**
- **Make sure that the lifting equipment is approved and in good condition.**
- **Check that the lifting straps are in good condition.**
- **Stay clear of suspended loads.**
- **Read the installation, care and maintenance manuals for pumps and other equipment.**
- **Follow all other health and safety rules and local codes and ordinances.**

General

The responsibility for installing the pump station is always borne by the installing contractor.

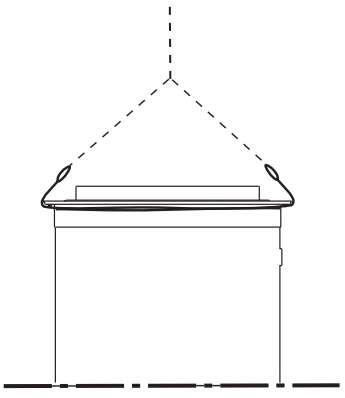
The Flygt brand's Top pre-engineered fiberglass pump station packages are designed for installation with a bottom concrete ballast poured in place at the bottom of the straight shell. The following instructions are an efficient and economical method for installing the Flygt brand's Top pre-engineered fiberglass pump stations. Follow all applicable local and national codes. The installer is responsible to comply with OSHA regulations and all other safety requirements.

Handling

Contractor shall take due care in handling the Flygt brand's Top pre-engineered fiberglass pump station package.

Please be aware of the following restrictions:

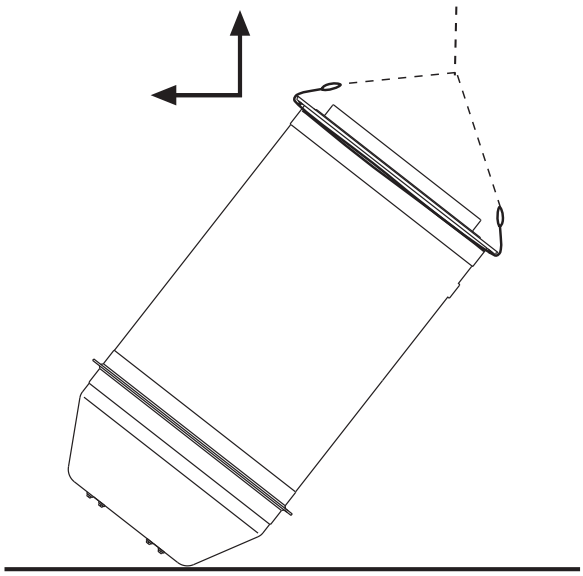
- **Do not** drop or impact the pump station.
- **Do not** use chain or steel cables in direct contact with the fiberglass. Store pump station in a horizontal position using the included shipping skids or chocks such as tires, sand bags or other pliable materials.
- **Do not** permit pump station to rest on large solid objects such as rocks, wood, brick, blocks, and so forth.
- **Do not** permit the pump station to be moved by rolling.
- **Do not** roll or set the pump station on any pipe stubout, accessory or appurtenance installed on the pump station.



Elevation adjustment

If necessary, use shims in the excavation to adjust pump station to correct elevation. Shims can be of any appropriate material that will not degrade, cause locally high contact stresses to the pump station, or rot. An examples of an appropriate shim would be sand bags.

- **When raising from horizontal to upright position the pump station will jolt and possibly sway slightly towards the end of the raising position.**
- **To avoid accidents, stand at a safe distance until this movement has stopped!**
- **Place the pump station on a rigid horizontal surface and make sure it cannot fall.**



Site preparation & concrete ballast

Provide adequate working room around the pump station. See diagram below and tables on page 13 for concrete ballast dimensions. The concrete ballast shall be reinforced as required by local codes.

Concrete ballast design should be sufficient to resist head pressure and soil loading with pump station completely empty and water to grade. Refer to tables 2. 3 and 4 for the required concrete ballast dimensions.

Concrete placement

Do not let concrete free fall to bottom of hole more that 3 to 4 feet. Place concrete using a tremmy chute to help preclude segregation of the aggregate from the matrix. Ensure that concrete flows under the fiberglass anti-flotation flange. Consolidate concrete with proper vibration per the recommended practice of ACI 318-05 section 5.10.

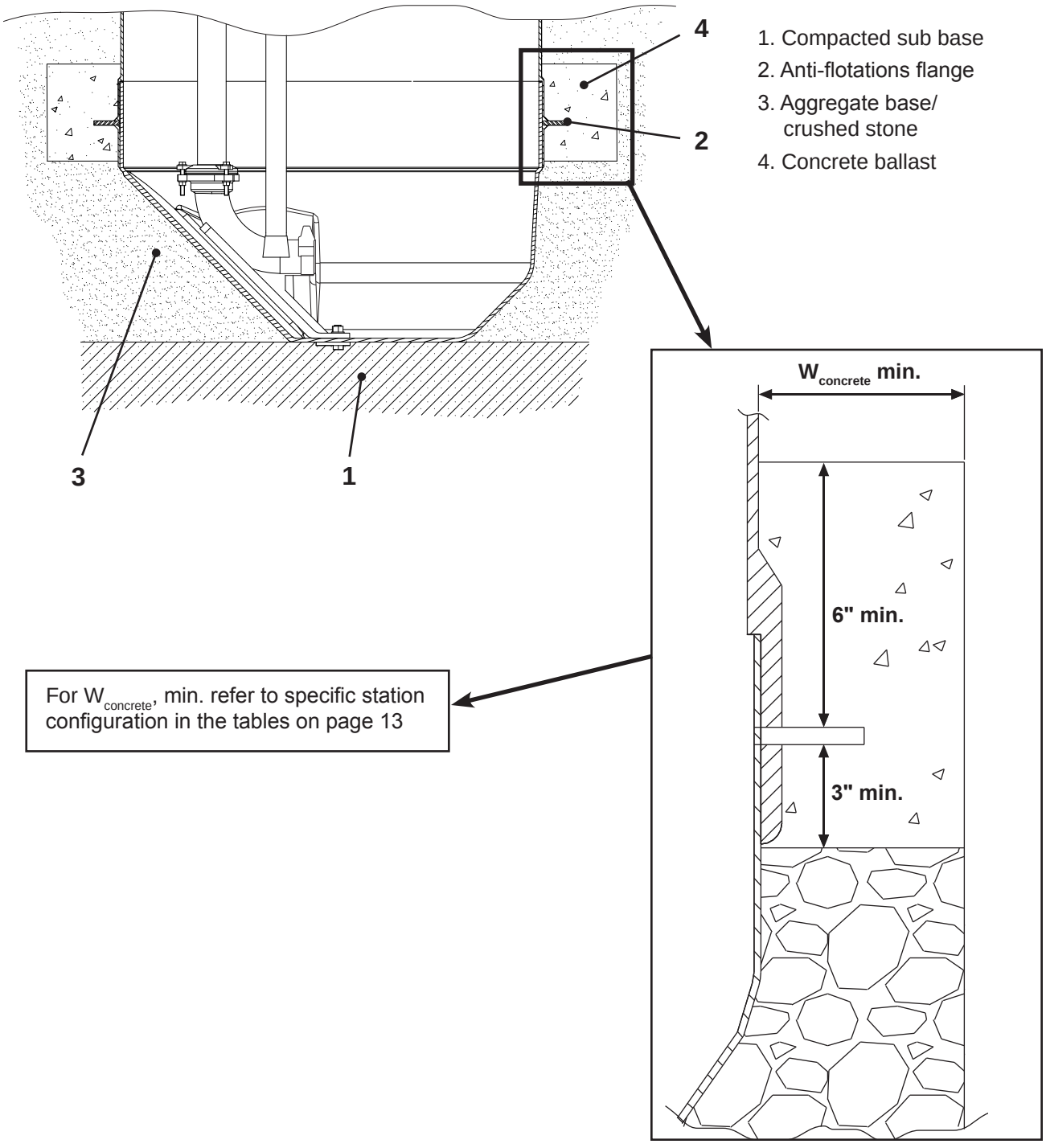


Table 2	TOP 4		
Station type	Diameter (in.)	Overall tank length (in.)	Concrete Ballast Requirements
			$W_{conccrete}$, Width of concrete ballast ring
Top 4	48	60	Ballast not required
	48	72	Ballast not required
	48	84	Ballast not required
	48	96	Ballast not required
	48	108	3” min.
	48	120	4” min.
	48	132	5” min.
	48	144	5” min.
	48	156	6” min.
	48	168	6” min.
	48	180	7” min.
	48	192	7” min.
	48	204	8” min.
	48	216	8” min.
	48	228	9” min.
	48	240	10” min.

Table 3	TOP 5	
Diameter (in.)	Overall tank length (in.)	Concrete Ballast Requirements
		$W_{conccrete}$, Width of concrete ballast ring
60	60	Ballast not required
60	72	Ballast not required
60	84	3” min.
60	96	4” min.
60	108	5” min.
60	120	6” min.
60	132	6” min.
60	144	7” min.
60	156	8” min.
60	168	9” min.
60	180	9” min.
60	192	10” min.
60	204	11” min.
60	216	11” min.
60	228	12” min.
60	240	12” min.

Table 4	TOP 6	
Diameter (in.)	Overall tank length (in.)	Concrete Ballast Requirements
		$W_{conccrete}$, Width of concrete ballast ring
72	60	Ballast not required
72	72	4” min.
72	84	5” min.
72	96	6” min.
72	108	6” min.
72	120	7” min.
72	132	8” min.
72	144	9” min.
72	156	10” min.
72	168	11” min.
72	180	11” min.
72	192	12” min.
72	204	13” min.
72	216	14” min.
72	228	15” min.
72	240	15” min.

Before backfilling

Check that the pipe work and the electrical connections are well protected and supported during backfilling around the station so no load is applied to them by compaction operation.

Place crushed stone uniformly around the base to prevent sideways surge. The pump station shall be adequately braced to prevent movement either by sideways movement or by leaning.

Soil backfill, backfill envelope and soil compaction

Native soils suitable as backfill are shown in table 5. **Do no**t use soils such as muck, bog, peat, and loess. The ideal backfill is well-graded sand, as this will compact relatively easily and typically retains its strength in submerged conditions. **Do not** use fine silts in areas subject to large seismic activity such as on the west coast in seismic zones 3 and 4 per the 1997 UBC. As a minimum Xylem, Flygt product recommends using well-graded sand compacted to 95% standard proctor density, or crushed stone or pea gravel with size ranging from ¼ in to 3/4 in. In these areas, install a filter fabric between the selected backfill and the native soil. At owner's option, consult local geotechnical engineer for determining adequate backfill material and compaction requirements in these areas.

Contact a qualified geotechnical engineer when installing the Flygt brand's Top pre-engineered fiberglass pump station packages in muck, bog, peat, and loess and/or for other difficult soil conditions or in areas such as e.g. a steep slope.

Do not permit ice to form in the backfill and keep backfill material as dry as practical by using adequate drainage techniques and good construction practices.

The size of the backfill envelope is dependent on the in situ soil properties. For native soils with an unconfined compressive strength (UCC) of 0.75 tsf or lower, or an allowable bearing capacity of 3500 psf or lower, the backfill shall extend one radius of pump station away from the pump station wall but not less than 2 ft. For soils exceeding these values the backfill envelop shall be 2 ft.

Compaction of the backfill is highly recommended and beneficial as this helps control long term settlement. See table 5 for compaction requirements and for additional information of soil stiffness and applicability as backfill material.

Flexible connector

Use flexible connectors for each stub-out to connecting pipe to help preclude stresses from long-term settling due to ground consolidation. These connectors should extend 2 stub-out diameters away from the stub-out pipe end.

Concrete

Concrete shall have a minimum 28-day compressive strength of 3000 psi and all reinforcing shall be ASTM A 615 grade 60. Place concrete using a tremmy for free fall distances greater than about 3 to 4 feet. Ensure that concrete extends at least 6" above anti-flotation flange (anchor lip). Refer to figure on page 12.

Backfilling time after casting concrete ballast

Do not backfill until concrete ballast has gained sufficient strength to provide rigid support for both pump station and backfill (typically 1 to 2 days or as specified by EOR). Add backfill in 6 to 8 in lifts for proper compaction evenly all around pump station to avoid uneven backfill loads.

WARNING!

Pump station top is pedestrian rated only and is not designed for wheel loads or other heavy loads.

Field repairs and level changes

Pump stations can be damaged if not properly handled, installed or backfilled. If repair or modification work is required, contact your local Flygt product representative for instruction.

Table 5 Soil Properties (ref AWWA M45 1st ed, Table 5-5 page 49 1996)				
	E' for degree of compaction of bedding, lb/in^2			
Soil type-pipe bedding material (Unified Classification System)	Dumped	Slight, <85% proctor, < 40% relative density	Moderate, 86% - 95% proctor, 40% - 70% relative density	High, >95% proctor, 70% relative density
Fine- grained soils (LL > 50) Soils with medium to high plasticity CH, MH, CH-MH	No data available, consult a geotechnical engineer; otherwise use E' = 0			
Fine- grained soils (LL < 50) Soils with medium to no plasticity CL, ML, ML-CL, with less than 25% coarse-grained particles	**50**	**200**	**400**	**1000**
Fine grained soils (LL < 50) Soils with medium to no plasticity CL, ML, ML-CL with more than 25% coarse-grained particles. Coarse grained soils with fines GM, GC, SM, SC contains more than 12% fines	**100**	**400**	**1000**	**2000**
Coarse-grained soils with little or no fines GW, GP, SW, SP contains less than 12% fines	**200**	**1000**	**2000**	**3000**
Crushed Rock	**1000**	**3000**	**3000**	**3000**

CH - Inorganic clays or high plasticity, fat clays.
MH - Inorganic silts, micaceous or diatomaceous fine sand or silty soils, classic silts.
CL - Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
ML - inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity.
SC - Clayey sands, poorly graded sandy-clay mixtures.
SM - Silty sands, poorly graded sand-silt mixtures.
GC - Clayey gravels, poorly graded gravel and clay mixtures.
GM - Silty gravels, poorly graded gravel-sand-silt mixture.

Do not use shaded area for backfill

Degrees of compaction

- Dumped – No compaction effort
- Slight – Some compactive effort. In-place density <less than 85% standard Proctor Density. Or less than 40% Relative Density
- Moderate – Intermediate level of compactive effort, In-place density greater than or equal to 85% and less than 95% standard Proctor Density, or greater than or equal to 40% and less than 70% Relative Density
- High – Considerable compactive effort, In-place density greater than 95% standard Proctor Density, or greater than or equal to 70% Relative Density

A slight degree of compaction can significantly add to soil density and long-term performance. Greater compaction improves installation and performance.

Definitions:

LL = Liquid Limit

Standard Proctor Density per ASTM D-698

Relative Density Dr = (emax – e)/(emax – emin)

Where e = void ratio = Vv/Vs

Vv = volume of voids

Vs = volume of solids

Electrical connections

- **All electrical work shall be carried out under the supervision of an authorized electrician.**
- **Local codes and regulations shall be complied with and shall be the responsibility of the electrical contractor.**
- **Before starting the work, check that the supply cable is de-energized.**

Install the control panel at the pump station so it is easily accessible during, operation, service and inspection.

Check the data plate on the pump to determine valid voltage supply.

Check that the main voltage and frequency agree with the specifications on the pump data plate.

Thoroughly read the Installation, care and maintenance manual delivered with the pump as well as the manual for the start- and control panel.

Run the cables through the cable entry to the control panel.

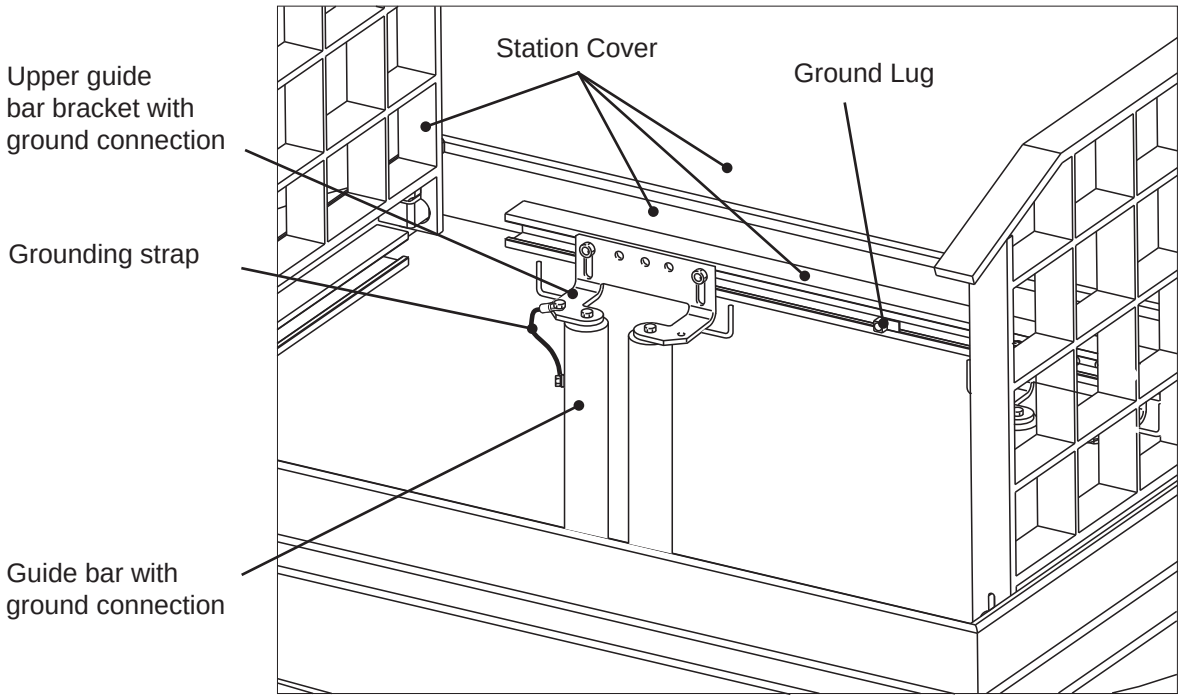
Use appropriate Flygt product support grips for the cables inside the pump station.

Connect the motor cables and cables for the level sensors as illustrated in the wiring diagrams following the control panel.

- **Bear in mind the risk of electric shock and the risk of explosion if the electrical connections are not correctly carried out!**
- **Follow the rules and recommendations in NFPA-70, "Protection against electric shock - common aspects for installation and equipment".**

Pump station grounding

The pump station has been prepared for grounding of the structure. A grounding strap has been installed, as part of the station, and connects the pump and pump guide rails to the station cover. A grounding lug has been included as part of the station cover, that lug shall be used to continue the path to ground. All ground connections shall be performed by licensed authorized personnel and shall be in accordance with local codes.



Inlet Wall Penetrations

Flexible entry boot

Installation instructions

For proper and warranted installation of flexible entry boots, these instructions must be followed. Prior to installing the rubber entry boots, make sure the exact location has been properly calculated.

Bolt Holes

Locate the center entry point in the flat wall section of the sump base and drill a 5/16" hole. Install the entry boot template to the sump base wall using a 1/4" bolt and nut. Drill out the appropriate bolt hole circle for the size boot to be installed using the same 5/16" drill bit. After drilling, remove the template from the sump base wall. For proper installation, the appropriate size fabrication template should be used for accurate hole drilling.

Boot Openings

After the bolt hole circle has been drilled, drill the entry boot opening by using the appropriate size hole saw. After the opening is drilled, clean any rough edges with a deburring tool or razor knife.

WARNING: The appropriate hole saw size must always be used for proper installation of the flexible entry boot. Failure to use the required hole saw could damage the rubber boot after installation or prevent the boot from sealing properly and void product warranty.

Hole Saw	Flexibale Entry Boots
4-1/4"	FEB-6300 (3")
5-1/2"	FEB-7400 (4")
Saber Saw	FEB-8600 (6")

Installing Rubber Boot

Install the rubber boot from outside the sump by inserting the studs through the bolt holes. From the inside of the sump, install the compression ring over the studs and install nuts by hand.

Boot Fastening

Using a 7/16" nut driver, tighten all of the nuts evenly in a clockwise sequence until 60 in.-lbs. is attained on all nuts. This may require two to three revolutions to achieve. To prevent deformation of the boot, do not overtighten nuts.

Clamp Fastening

Insert the appropriate sized pipe or conduit into the flexible boot from outside of the sump. After the pipe or conduit have been positioned, install the band clamp around the boot and tighten to 30 inch/lbs.

WARNING: Do not over tighten the band clamp beyond the maximum torque of 30 in.-lbs. or it is possible to damage the rubber boot.

Cast Iron caulking hub

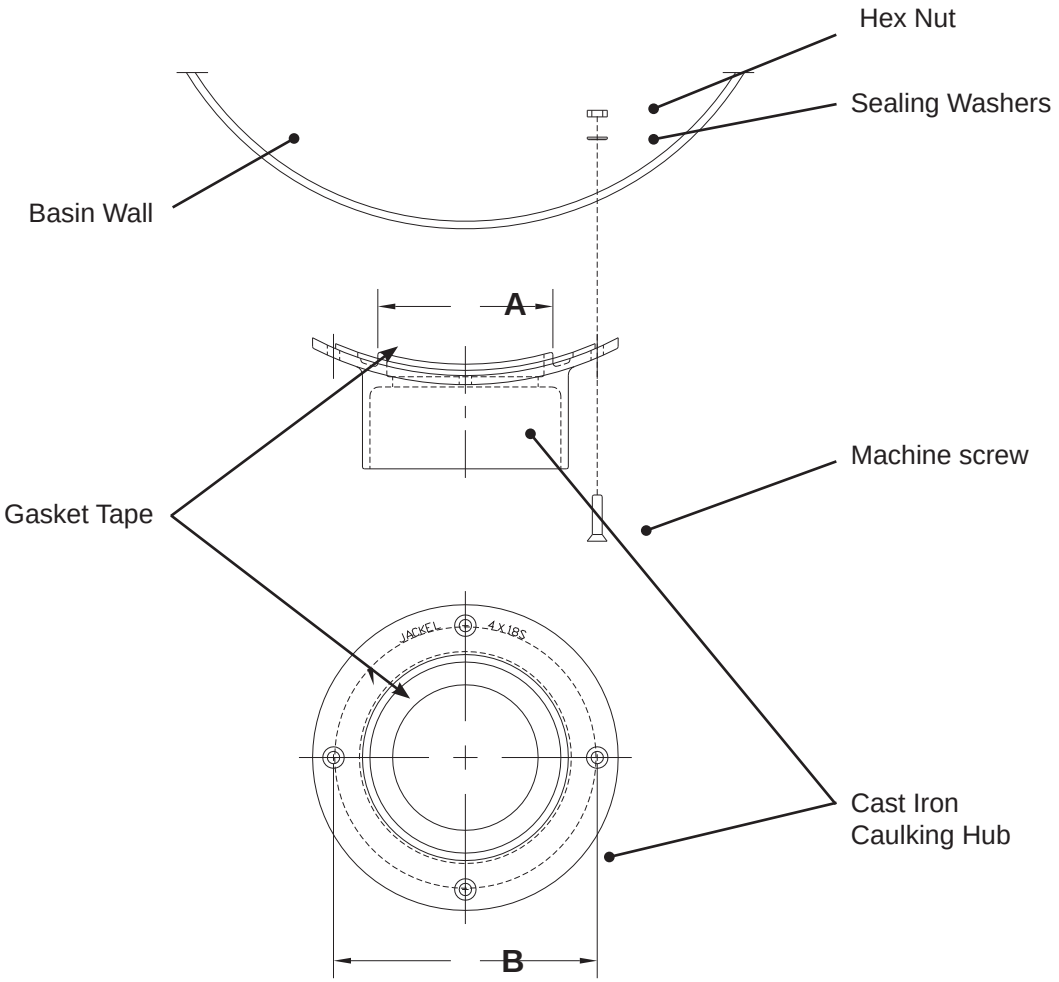
Installation instructions, see figure below

Working from outside of the basin cut a hole in the basin wall at the desired location with a hole saw that is just large enough to accommodate diameter "A", see diagram below.

Using the caulking hub of the cast iron caulking hub as a template drill four (4) 3/8" holes through the basin wall at the four (4) locations on the caulking hub bolt hole circle "B", see diagram below.

Install gasket seal tape on the back of the caulking hub between diameter "A" and the bolt hole circle "B", see diagram below. If the caulking hub and basin do not mate well, an additional bead of silicone caulk may be required to ensure seal.

Install the cast iron caulking hub to the pump station wall and secure using four (4) machine screws, sealing washer and hex nuts.

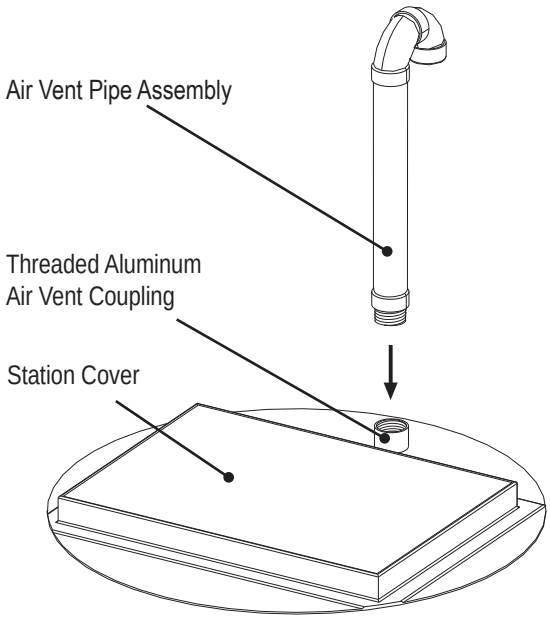


Installation of the air vent pipe

Each pump station is supplied with one (1) or two (2) vents, depending upon end-user's requirements. Each vent is a threaded 4" sch 40, PVC U-vent, which is shipped loose along with the station. The vent(s) must be assembled to the station prior to start-up.

Before installing the vent pipe assembly to the station, lubricate the PVC vent pipe threads with silicone spray or other lubricant applicable for PVC.

Thread the air vent pipe assembly into the threaded aluminum air vent coupling, which is located on the station cover.



Installation of the level regulators

Use appropriate support grips for the Flygt product ENM-10 level regulator cables and hang them on the cable holder. Adjust the height of the level regulators according to the installation drawing.

If another type of level sensor is used please refer to the installation manual provided with that device.

Installation of the pump

Lower the pump along the guide bars.

Upon reaching its bottom position, the pump will automatically connect to the pre-assembled discharge connection.

When needed the pump can be hoisted up along the guide bars for inspection without the need for personnel to enter the station.

Fasten the lifting chain and the motor cables on the cable holder. Use appropriate Flygt product support grips for the cables.

- Make sure that the cables are not sharply bent or pinched.

START UP AND OPERATION

Before installation

The pump station is delivered pre-fabricated complete with discharge connection, pipes, guide bars and other mechanical and electrical equipment.

- When opening the station – check that the top cover and safety grid is properly supported. Note the risk of injury caused by crushing.
- Check that all equipment inside the station is properly fastened and in correct position after the transport and installation in the ground.
- Check all electrical connections.
- Check that the guide bars are placed vertically by using a level or plumb line.
- Carefully read the installation, care and maintenance manual for the pump as well as for the control panel.
- **IMPORTANT! Clean out any debris from the sump bottom.**

Installation of the pump

Lower the pump along the guide bars.

Upon reaching its bottom position, the pump will automatically connect to the pre-assembled discharge connection.

When needed the pump can be hoisted up along the guide bars for inspection without the need for personnel to enter the station.

Fasten the lifting chain and the motor cables on the cable holder. Use appropriate Flygt support grips for the cables.

- Make sure that the cables are not sharply bent or pinched.

Start-up check

During start-up the following checks should be performed:

- Check to insure that the ground connections between the pump guide rails and the upper guide bar bracket are secure. See Pump Station Grounding and figure on page 16.
- When the pumps operate does the water level go down?
- Do the floats or level sensor operate the pumps?
- What are the static and operating voltages at the pump control?
- What is the current draw, per leg, during pump operation?
- Does the impeller rotate in the correct direction when power is applied?
- Are there indications of blow-by or recirculation when the pump is in operation?
- Do the check valves operate correctly when the pump starts and stops?
- Does the pump perform appropriately as determined by the controls?
- Does the pump turn off if the thermal sensor indicates an overtemp condition? (Simulated during start-up by pulling sensor wires from the control box.)

CARE AND MAINTENANCE

The unique design of the bottom basin of the TOP pump station significantly helps to maintain problem-free pump operation and reduces the need for maintenance of the pump station. It is still recommended that the inside of the pump station, valves, level sensors and pipes are kept as clean as possible. Inspections should determine if and when any maintenance effort is required. Flygt product can also provide other ancillary equipment to further improve the operation;

- The Mix-Flush valve is recommended to enhance the removal of floating debris and settling deposits. It can be fitted on all standard Flygt product wastewater pumps. The valve operation is automatic. At each pump start the valve opens and water is forced through the valve in a powerful jet stream for a preset time. The jet sets the water in the tank into turbulent motion so that sludge deposits and floating solids are mixed in and can be pumped out.
- APP521 equipped control panel provides a unique functionality, it enables a cleaning cycle during which the pump draws down the water level to the verge of ingesting air. This is detected by the APP521 ability to precisely monitor changes in motor current. As the water level drops, both settling and floating solids are being removed by the pump, which maintains a clean station without any manual intervention. The frequency of the cleaning cycle can be pre-programmed to suit the specific site needs for each TOP pumping station.

Check with your local Flygt product representative for more detailed information.

Recommendations for preventive maintenance programs and/or service intervals for the actual pumps, level sensors and control panel are given in separate manuals provided with these products.

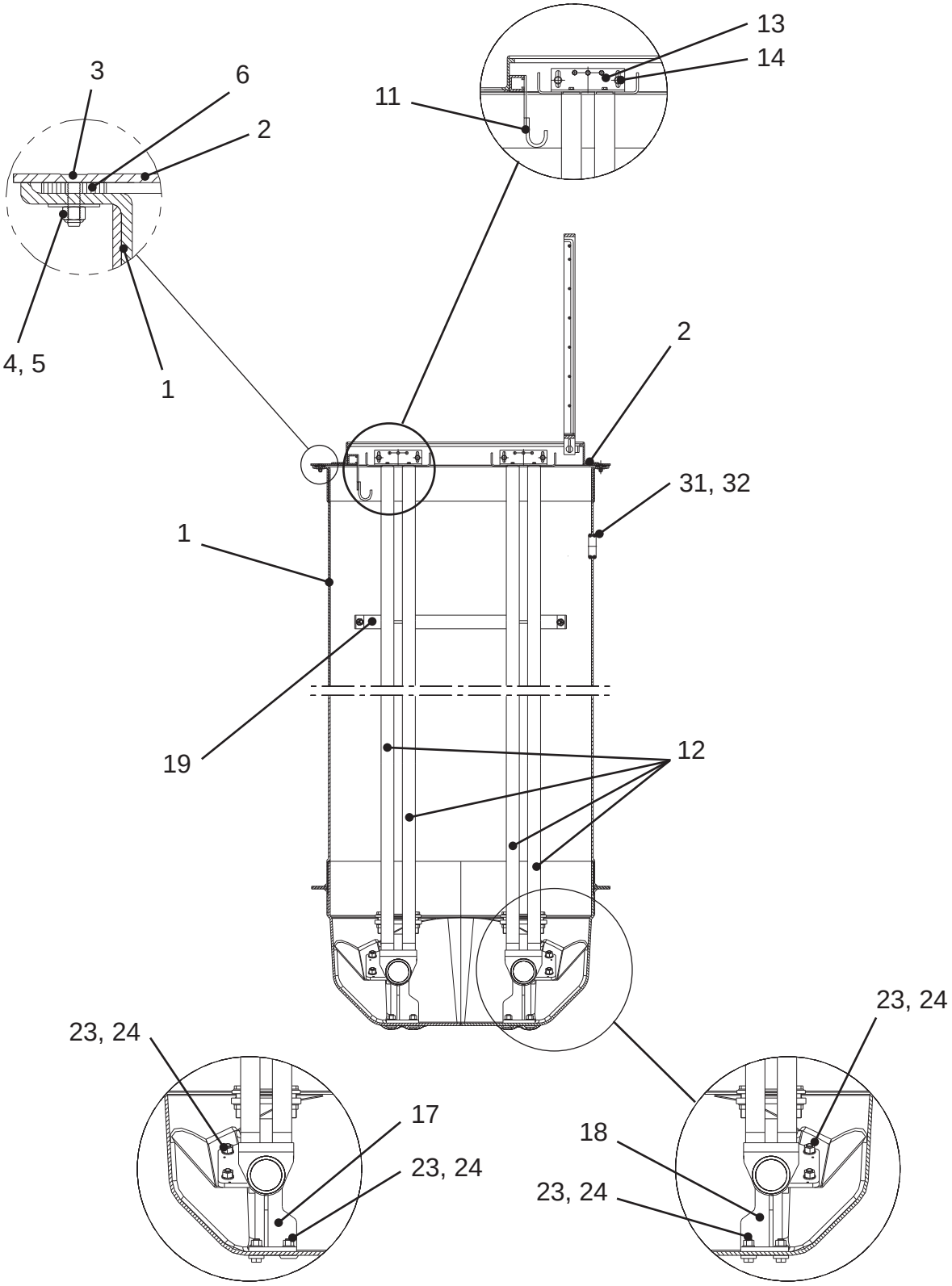
Xylem Flygt products disclaims all responsibility for work done by untrained, unauthorized personnel!

The following points are important in connection with work on the pumping station and associated equipment:

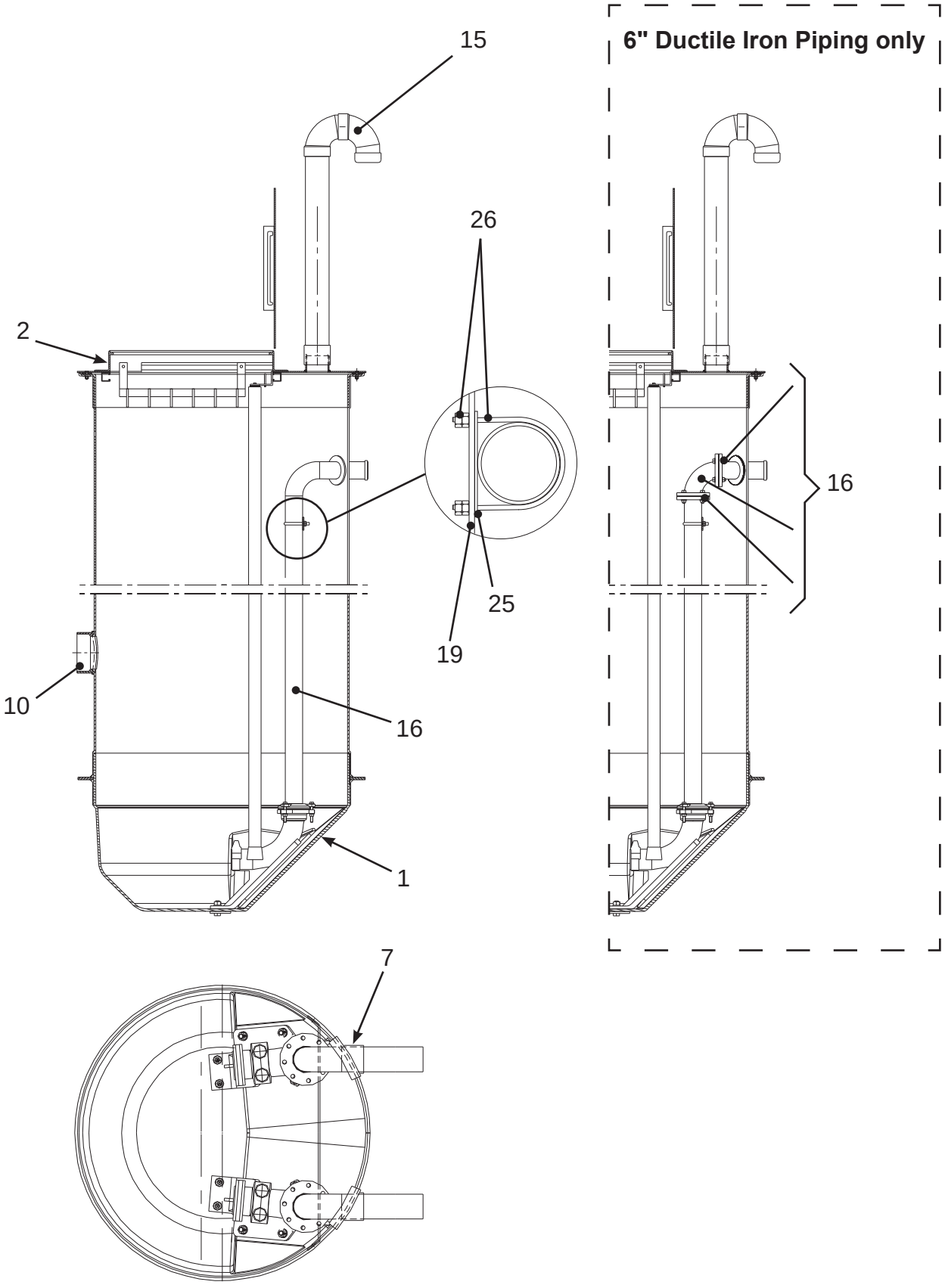
- **Beware of the risk of injury caused by crushing.**
- **If entering the pump station beware of the risk of hazardous gases and always use breathing apparatus.**
- **Check regularly that the lifting equipment is in good condition.**
- **Make sure that all electrical equipment is insulated from the power supply and cannot be energized.**
- **Make sure that the equipment has been thoroughly cleaned.**
- **Beware of the risk of infection.**
- **Follow local safety regulations.**
- **Always wear goggles and rubber gloves.**
- **Always close and lock the cover before leaving the pump station.**

For any fault tracing - carefully follow the recommendations in the Installation, Care and Maintenance manuals for the actual pump and control panel.

TOP 4, 5 & 6



TOP 4, 5 & 6



TOP 4 (3” Piping)				
Item No.	**Description**	**Material**	**Part Number**	**Qty**
1	4’ Basin/Cylinder/Assembly, w/ anti-flotation flange	Fiberglass		1
2	4’ Cover, w/Safe-Hatch	Aluminum		1
	Cover w/1 Vent		FBC-29.75X38AOSH-48-1	
	Cover w/ 2 Vent		FBC-29.75X38AOSH-48-2	
3	Screw, flathead, 82°, 3/8"-16 x 1 1/2"	Stainless Steel		6
4	Nut, 3/8"-16	Stainless Steel		6
5	Washer, 3/8" ID, 1 1/2" OD, 5/16" thick	Stainless Steel		6
6	Cover Spacer 1 7/8” OD x 1/2”ID x 5/16” thk.	PE		6
7	3” Flexible boot (discharge piping)	Rubber	FEB-6300	2
10	Inlet wall penetrations			
	4” Flexible boot (inlet piping)	Rubber	FEB-7400	1
	6” Flexible boot (inlet piping)	Rubber	FEB-8600	1
	4” Cast iron caulking hub (inlet piping)	Cast Iron		1
	6” Cast iron caulking hub (inlet piping)	Cast Iron		1
	8” Cast iron caulking hub (inlet piping)	Cast Iron		1
11	Cable hanger w/ 6 Hooks	316 SS	F-CH-316SS-HD	1
12	2” guide bars	316 SS		
	2” 316 SS guide bars	316 SS		Varies
	2” Galvanized guide bars	Galvanized Steel		Varies
13	2” Upper guide bar brackets	316 SS	613 68 04	2
14	Guide bar bracket mounting hardware	SS	14-590000	3
15	4” PVC vent	PVC		1 or 2
16	Piping			
	PVC			
	3” PVC sch 80 socket weld piping	PVC	P80PM	Varies
	3” PVC sch 80 90 degree socket weld elbow	PVC	P80S9M	2
	Ductile Iron			
	3” ductile iron piping flanged one-end	Ductile Iron		Varies
	3” ductile iron 90 degree flanged elbow	Ductile Iron		2
	3” flange bolts 5/8” (11) x 2-1/2” Hex Head Bolt	316 SS		16
	3” flange nuts 5/8” (11) Nut	316 SS		16
	3” flange washers 21/32” ID x 1-5/16” OD Washer	316 SS		32
	3” flange gasket, 1/8” thick	Rubber (Buna -N)		4
	Stainless Steel			
	3” 316 SS sch 10 butt weld piping	316 SS		Varies
	3” 316 SS sch 10 90 degree butt weld elbow	316 SS		2
17	3” discharge connection, left	Cast Iron	620 00 10	1
18	3” discharge connection, right	Cast Iron	619 99 10	1
19	Pipe support			
	for PVC & Stainless Steel			
	4’ station - 3” PVC/SS pipe support	316 SS		1 or 2

TOP 4 (3” Piping)				
Item No.	**Description**	**Material**	**Part Number**	**Qty**
	for Ductile Iron			
	4’ station - 3” ductile iron pipe support	316 SS		1 or 2
23	Discharge connection nuts - 3/4”-10	316 SS		8
24	Discharge connection washers - 3/4”	316 SS		8
25	Pipe support spacers (PVC and Stainless Steel piping only):	NDPE		
26	U-bolts	316 SS		
	PVC & Stainless Steel			
	for 3" pipe, 3-5/8" O.D. pipe, 3/8"-16	316 SS	McMaster Carr 29605t8	2
	Ductile Iron			
	for 3" pipe, 4-1/8" O.D. pipe, 3/8"-16	316 SS	McMaster Carr 59605T9	2
31	3” NPT threaded plastic coupling (power cables)	Plastic		1
32	1 1/4” NPT threaded plastic coupling(float switches)	Plastic	1860SCF125P	1

TOP 5 (3” Piping)				
Item No.	**Description**	**Material**	**Part Number**	**Qty**
1	5’ Basin/Cylinder/Assembly, w/ anti-flotation flange	Fiberglass		1
2	5’ Cover, w/Safe-Hatch	Aluminum		1
	Cover w/ 1 Vent		FBC-31X42AOSH-60-1	
	Cover w/ 2 Vent		FBC-31X42AOSH-60-2	
3	Screw, flathead, 82°, 3/8"-16 x 1 1/2"	316 SS		8
4	Nut, 3/8"-16	316 SS		8
5	Washer, 13/32" ID, 1 1/2" OD, 1/16" thick, pe	316 SS		8
6	Cover spacer 1 7/8" OD x 1/2" ID x 5/16” thick.	PE		8
7	3" Flexible boot (discharge piping)	Rubber	FEB-6300	
10	Inlet wall penetrations			
	4” Flexible boot (inlet piping)	Rubber	FEB-6300	1
	6” Flexible boot (inlet piping)	Rubber	FEB-7400	1
	4” Cast iron caulking hub (inlet piping)	Cast Iron	CIH4x3660	1
	6” Cast iron caulking hub (inlet piping)	Cast Iron	CIH6x3660	1
	8” Cast iron caulking hub (inlet piping)	Cast Iron	CIH8x3660	1
11	Cable hanger w/ 6 Hooks	316 SS	F-CH-316SS-HD	1
12	2” guide bars			
	2” 316 SS guide bars	316 SS		Varies
	2” Galvanized guide bars	Galvanized Steel		Varies
13	2” Upper guide bar brackets	316 SS	613 68 04	2
14	Guide bar bracket, mounting hardware	SS	14-590000	3
15	4” PVC vent	PVC		1 or 2
16	Piping			
	PVC			
	3” PVC sch 80 socket weld piping	PVC	P80PM	Varies
	3” PVC sch 80 90 degree socket weld elbow	PVC	P80S9M	2
	Ductile Iron			
	3” ductile iron piping flanged one-end	Ductile Iron	SP-DDIPFM	Varies
	3” ductile iron 90 degree flanged elbow	Ductile Iron	DF9M	2
	3” flange bolts 5/8” (11) x 2-1/2” Hex Head Bolt	316 SS		16
	3” flange nuts 5/8” (11) Nut	316 SS		16
	3” flange washers 21/32” ID x 1-5/16” OD Washer	316 SS		32
	3” flange gasket, 1/8” thick	Rubber (Buna -N)		4
	Stainless Steel			
	3” 316 SS sch 10 butt weld piping	316 SS		Varies
	3” 316 SS sch 10 90 degree butt weld elbow	316 SS		2
17	3” discharge connection, left	Cast Iron	620 00 10	1
18	3” discharge connection, right	Cast Iron	619 99 10	1
19	Pipe support			
	for PVC & Stainless Steel			
	5’ station - 3” PVC/SS pipe support	316 SS		1 or 2
	for Ductile Iron			

TOP 5 (3” Piping)				
Item No.	**Description**	**Material**	**Part Number**	**Qty**
	5’ station - 3” ductile iron pipe support includes:	316 SS		1 or 2
23	Discharge connection nuts - 3/4”-10	316 SS		8
24	Discharge connection washers - 3/4”	316 SS		8
25	Pipe support spacers, PVC and Stainless Steel piping only)		14-68 21 66	2
26	U-bolts	316 SS		
	PVC & Stainless Steel			
	for 3" pipe, 3-5/8 O.D. pipe, 3/8"-16	316 SS	MCASTER 29605t8	2
	Ducticle Iron			
	for 3" pipe, 4-1/8" O.D. pipe, 3/8"-16	316 SS	MCASTER 59605T9	2
31	3” NPT threaded plastic coupling (power cables)	Plastic		1
32	1 1/4” NPT threaded plastic coupling(float switches)	Plastic	1860SCF125P	1

TOP 5 (4” Piping)				
Item No.	**Description**	**Material**	**Part Number**	**Qty**
1	5’ Basin/Cylinder/Assembly, w/ anti-flotation flange	Fiberglass		1
2	5’ Cover, w/Safe-Hatch	Aluminum		1
	Cover w/ 1 Vent		FBC-31X42AOSH-60-1	
	Cover w/ 2 Vent		FBC-31X42AOSH-60-2	
3	Screw, flathead, 82”, 3/8"-16 x 1 1/2"	316 SS		8
4	Nut, 3/8-16	316 SS		8
5	Washer, 13/32" ID, 1 1/2" OD, 1/16" thick	316 SS		8
6	Cover spacer 1 7/8" OD x 1/2" ID x 5/16” thick.	PE		8
7	4" Flexible boot (discharge piping)	Rubber	FEB-7400	
10	Inlet wall penetrations			
	4” Flexible boot (inlet piping)	Rubber	FEB-8600	1
	6” Flexible boot (inlet piping)	Rubber	FEB-7400	1
	4” Cast iron caulking hub (inlet piping)	Cast Iron	CIH4x3660	1
	6” Cast iron caulking hub (inlet piping)	Cast Iron	CIH6x3660	1
	8” Cast iron caulking hub (inlet piping)	Cast Iron	CIH8x3660	1
11	Cable hanger w/ 6 Hooks	316 SS	F-CH-316SS-HD	1
12	2” guide bars			
	2” 316 SS guide bars	316 SS		Varies
	2” Galvanized guide bars	Galvanized Steel		Varies
13	2” Upper guide bar brackets	316 SS	613 68 04	2
14	Guide bark bracket, mounting hardware	SS	14-590000	3
15	4” PVC vent	PVC		1 or 2
16	Piping			
	PVC			
	4” PVC sch 80 socket weld piping	PVC	P80PP	Varies
	4” PVC sch 80 90 degree socket weld elbow	PVC	P80S9P	2
	Ductile Iron			
	4” ductile iron piping flanged one-end	Ductile Iron	SP-DPDIFP7	Varies
	4” ductile iron 90 degree flanged elbow	Ductile Iron	DF9P	2
	4” flange bolts 5/8” (11) x 3” Hex Head Bolt	316 SS		32
	4” flange nuts 5/8” (11) Nut	316 SS		32
	4” flange washers 21/32” ID x 1-5/16” OD Washer	316 SS		64
	4” flange gasket, 1/8” thick	Rubber (Buna -N)		4
	Stainless Steel			
	4” 316 SS sch 10 butt weld piping	316 SS		Varies
	4” 316 SS sch 10 90 degree butt weld elbow	316 SS		2
17	4” discharge connection, left	Cast Iron	620 02 10	1
18	4” discharge connection, right	Cast Iron	620 01 10	1
19	Pipe support			
	for PVC & Stainless Steel			
	5’ station - 4” PVC/SS pipe support	316 SS		1 or 2
	for Ductile Iron			

TOP 5 (4” Piping)				
Item No.	**Description**	**Material**	**Part Number**	**Qty**
	5’ station - 4” ductile iron pipe support includes:	316 SS		1 or 2
23	Discharge connection nuts - 3/4”-10	316 SS		8
24	Discharge connection washers - 3/4”	316 SS		8
25	Pipe support spacers, PVC and Stainless Steel only	NDPE		2
26	U-bolts	316 SS		
	PVC & Stainless Steel			
	for 4" pipe, 4-5/8" O.D. pipe, 3/8"-16	316 SS	MCASTER 29605T11	2
	Ducticle Iron			
	for 4" pipe, 5" O.D. pipe, 3/8-16	316 SS		2
31	3” NPT threaded plastic coupling (power cables)	Plastic		1
32	1 1/4” NPT threaded plastic coupling(float switches)	Plastic	1860SCF125P	1

TOP 6 (4” Piping)				
Item No.	**Description**	**Material**	**Part Number**	**Qty**
1	6’ Basin/Cylinder/Assembly, w/ anti-flotation flange	Fiberglass		1
2	6’ Cover, w/Safe-Hatchr	Aluminum		1
	Cover w/ 1 Vent		FBC-33.75X51AOSH-72-1	
	Cover w/ 2 Vent		FBC-33.75X51AOSH-72-2	
3	Screw, flathead, 82”, 3/8"-16 x 1 1/2"	316 SS		8
4	Nut, 3/8"-16	316 SS		8
5	Washer, 13/32" ID, 1 1/2" OD, 1/16" thick	316 SS		8
6	Cover spacer 1 7/8" OD x 1/2" ID x 5/16” thick.	PE		8
7	4" Flexible boot (discharge piping)	Rubber	FEB-7400	2
10	Inlet wall penetrations			
	6” Flexible boot (inlet piping)	Rubber	FEB-8600	1
	6” Cast iron caulking hub (inlet piping)	Cast Iron	CIH6x3660	1
	8” Cast iron caulking hub (inlet piping)	Cast Iron	CIH8x3660	1
11	Cable hanger w/ 6 Hooks	316 SS	F-CH-316SS-HD	1
12	2” guide bars			
	2” 316 SS guide bars	316 SS		Varies
	2” Galvanized guide bars	Galvanized Steel		Varies
13	2” Upper guide bar brackets	316 SS	613 68 04	2
14	Mounting hardware for guide bar	SS	14-590000	3
15	4” PVC vent	PVC		1 or 2
16	Piping			
	PVC			
	4” PVC sch 80 socket weld piping	PVC	P80PP	Varies
	4” PVC sch 80 90 degree socket weld elbow	PVC	P80S9P	2
	Ductile Iron			
	4” ductile iron piping flanged one-end	Ductile Iron	SP-DPDIFP7	Varies
	4” ductile iron 90 degree flanged elbow	Ductile Iron	DF9P	2
	4” flange bolts 5/8” (11) x 3” Hex Head Bolt	316 SS		32
	4” flange nuts 5/8” (11) Nut	316 SS		32
	4” flange washers 21/32” ID x 1-5/16” OD Washer	316 SS		64
	4” flange gasket, 1/8” thick	Rubber (Buna -N)		4
	Stainless Steel			
	4” 316 SS sch 10 butt weld piping	316 SS		Varies
	4” 316 SS sch 10 90 degree butt weld elbow	316 SS		2
17	4” discharge connection, left	Cast Iron	620 02 10	1
18	4” discharge connection, right	Cast Iron	620 01 10	1
19	Pipe support			
	for PVC & Stainless Steel			
	6’ station - 4” PVC/SS pipe support	316 SS		1 or 2

TOP 6 (4” Piping)				
Item No.	**Description**	**Material**	**Part Number**	**Qty**
	for Ductile Iron			
	6’ station - 4” ductile iron pipe support	316 SS		1 or 2
23	Discharge connection nuts - 3/4”-10	316 SS		8
24	Discharge connection washers - 3/4”	316 SS		8
25	Pipe support spacers, PVC and Stainless Steel only	NDPE	14-68 21 66	2
26	U-bolts	316 SS		
	PVC & Stainless Steel			
	for 4" pipe, 4-5/8" O.D. pipe, 3/8"-16	316 SS	MCASTER 29605T11	2
	Ducticle Iron			
	for 4" pipe, 5" O.D. pipe, 3/8-16	316 SS		2
31	3” NPT threaded plastic coupling (power cables)	Plastic		1
32	1 1/4” NPT threaded plastic coupling(float switches)	Plastic	1860SCF125P	1

TOP 6 (6” Piping)				
Item No.	**Description**	**Material**	**Part Number**	**Qty**
1	6’ Basin/Cylinder/Assembly, w/ anti-flotation flange	Fiberglass		1
2	6’ Cover, w/Safte-Hatchr	Aluminum		1
	Cover w/ 1 Vent		FBC-33.75X51AOSH-72-1	
	Cover w/ 2 Vent		FBC-33.75X51AOSH-72-2	
3	Screw, flathead, 82°, 3/8"-16 x 1 1/2"	316 SS		8
4	Nut, 3/8"-16	316 SS		8
5	Washer, 13/32" ID, 1 1/2" OD, 1/16" thick	316 SS		8
6	Cover spacer 1 7/8" OD x 1/2" ID x 5/16” thick.	PE		8
7	6" Flexible boot (discharge piping)	Rubber	FEB-8600	2
10	Inlet wall penetrations			
	6” Flexible boot (inlet piping)	Rubber	FEB-8600	1
	6” Cast iron caulking hub (inlet piping)	Cast Iron	CIH6x3660	1
	8” Cast iron caulking hub (inlet piping)	Cast Iron	CIH8x3660	1
11	Cable hanger w/ 6 Hooks	316 SS	F-CH-316SS-HD	1
12	2” guide bars			
	2” 316 SS guide bars	316 SS		Varies
	2” Galvanized guide bars	Galvanized Steel		Varies
13	2” Upper guide bar brackets	316 SS	613 68 04	2
14	Guide bar bracket, mounting hardware	SS	14-590000	3
15	4” PVC vent	PVC		1 or 2
16	Piping			
	PVC			
	6” PVC sch 80 socket weld piping	PVC	P80PU	Varies
	6” PVC sch 80 90 degree socket weld elbow	PVC	P8069U	2
	6” PVC sch 80 45 degree socket weld elbow		P80S4U	2
	Ductile Iron			
	6” ductile iron plain-end piping	Ductile Iron		Varies
	6” ductile iron 22.5 degree mechanical joint x mechanical joint elbow	Ductile Iron		2
	6" ductile iron 90 degree mechanical joint x mechanical joint elbow	Ductile Iron	MJ9LAU	2
	Stainless Steel			
	6” 316 SS sch 10 butt weld piping	316 SS		Varies
	6” 316 SS sch 10 90 degree butt weld elbow	316 SS		2
	6” 316 SS sch 10 45 degree butt weld elbow	316 SS		2
	6" Mechanical joint fjield locking accessory kit (includes tee bolts, nuts, gasket and gland		MJFLAKDIU	8
17	6” discharge connection, left	Cast Iron	620 04 10	1
18	6” discharge connection, right	Cast Iron	620 03 10	1
19	Pipe support			

TOP 6 (6” Piping)				
Item No.	**Description**	**Material**	**Part Number**	**Qty**
	for PVC & Stainless Steel			
	6’ station - 6” PVC/SS pipe support	316 SS		1 or 2
	for Ductile Iron			
	6’ station - 6” ductile iron pipe support	316 SS		1 or 2
23	Discharge connection nuts - 3/4”-10	316 SS		8
24	Discharge connection washers - 3/4”	316 SS		8
25	Pipe support spacers, for PVC and Stainless Steel only	NDPE		2
26	U-bolts	316 SS		
	PVC & Stainless Steel			
	for 6" pipe, 6-5/8" O.D. pipe, 1/2"-13	316 SS		2
	Ducticle Iron			
	for 6" pipe, 7" O.D. pipe, 1/2-13	316 SS		2
31	3” NPT threaded plastic coupling (power cables)	Plastic		1
32	1 1/4” NPT threaded plastic coupling(float switches)	Plastic	1860SCF125P	1

NOTES

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Installation, Operation, and
Maintenance Manual

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Table of Contents

1 Introduction and Safety

1.1 Introduction

Purpose of the manual

The purpose of this manual is to provide necessary information for working with the unit. Read this manual carefully before starting work.

Read and keep the manual

Save this manual for future reference, and keep it readily available at the location of the unit.

Intended use

WARNING:

Operating, installing, or maintaining the unit in any way that is not covered in this manual could cause death, serious personal injury, or damage to the equipment and the surroundings. This includes any modification to the equipment or use of parts not provided by Xylem. If there is a question regarding the intended use of the equipment, please contact a Xylem representative before proceeding.

Other manuals

See also the safety requirements and information in the original manufacturer's manuals for any other equipment furnished separately for use in this system.

1.2 Safety terminology and symbols

About safety messages

It is extremely important that you read, understand, and follow the safety messages and regulations carefully before handling the product. They are published to help prevent these hazards:

- Personal accidents and health problems
- Damage to the product and its surroundings
- Product malfunction

Hazard levels

Hazard level	Indication
 DANGER:	A hazardous situation which, if not avoided, will result in death or serious injury
 WARNING:	A hazardous situation which, if not avoided, could result in death or serious injury
 CAUTION:	A hazardous situation which, if not avoided, could result in minor or moderate injury
NOTICE:	Notices are used when there is a risk of equipment damage or decreased performance, but not personal injury.

Special symbols

Some hazard categories have specific symbols, as shown in the following table.

Electrical hazard	Magnetic fields hazard
 Electrical Hazard:	 CAUTION:

1.3 User safety

All regulations, codes, and health and safety directives must be observed.

The site

- Observe lockout/tagout procedures before starting work on the product, such as transportation, installation, maintenance, or service.
- Pay attention to the risks presented by gas and vapors in the work area.
- Always be aware of the area surrounding the equipment, and any hazards posed by the site or nearby equipment.

Qualified personnel

This product must be installed, operated, and maintained by qualified personnel only.

Protective equipment and safety devices

- Use personal protective equipment as needed. Examples of personal protective equipment include, but are not limited to, hard hats, safety goggles, protective gloves and shoes, and breathing equipment.
- Make sure that all safety features on the product are functioning and in use at all times when the unit is being operated.

1.4 Ex-approved products

Follow these special handling instructions if you have an Ex-approved unit.

Personnel requirements

These are the personnel requirements for Ex-approved products in potentially explosive atmospheres:

- All work on the product must be carried out by certified electricians and Xylem-authorized mechanics. Special rules apply to installations in explosive atmospheres.
- All users must know about the risks of electric current and the chemical and physical characteristics of the gas, the vapor, or both present in hazardous areas.
- Any maintenance for Ex-approved products must conform to international and national standards (for example, IEC/EN 60079-17).

Xylem disclaims all responsibility for work done by untrained and unauthorized personnel.

Product and product handling requirements

These are the product and product handling requirements for Ex-approved products in potentially explosive atmospheres:

- Only use the product in accordance with the approved motor data.
- The Ex-approved product must never run dry during operation. The volute must be filled with liquid during operation. Dry running during service and inspection is only permitted outside the classified area.
- Before you start work on the product, make sure that the product and the control panel are isolated from the power supply and the control circuit, so they cannot be energized.
- Do not open the product while it is energized or in an explosive gas atmosphere.

- Intrinsically safe circuits are normally required for the automatic level-control system by the level regulator if mounted in zone 0.
- The yield stress of fasteners must be in accordance with the approval drawing and the product specification.
- Do not modify the equipment without approval from an Ex-approved Xylem representative.
- Only use original Xylem spare parts that are provided by an Ex-approved Xylem representative.
- The thermal detectors that are fitted to the stator windings must be connected correctly to a separate motor control circuit and in use. The detectors disconnect the power supply to the motor timely. This action prevents the rise of temperatures above the temperature value for the approval classification.
- The width of flameproof joints is more than the values specified in the tables of the IEC 60079–1 standard.
- The gap of flameproof joints is less than the values specified in Table 1 of the IEC 60079–1 standard.
- The flameproof joints are NOT intended to be repaired.

Guidelines for compliance

Compliance is fulfilled only when you operate the unit within its intended use. Do not change the conditions of the service without the approval of an Ex-approved Xylem representative. When you install or maintain explosion proof products, always comply with the directive and applicable standards (for example, IEC/EN 60079–14).

Minimum permitted liquid level

The approval for explosion proof products is predicated on a minimum permitted liquid level. See *Technical Reference* on page 56 .

Monitoring equipment

For additional safety, use condition-monitoring devices. Examples of condition-monitoring devices include, but are not limited to, the following:

- Level indicators
- Temperature detectors in addition to the stator thermal detectors

Any thermal detectors or thermal protection devices delivered with the pump must be installed and in use at all times.

1.5 Special hazards

Biological hazards

The product is designed for use in liquids that can be hazardous to your health. Observe these rules when you work with the product:

- Make sure that all personnel who may come into contact with biological hazards are vaccinated against diseases to which they may be exposed.
- Observe strict personal cleanliness.

WARNING: Biological Hazard

Infection risk. Rinse the unit thoroughly with clean water before working on it.

Wash the skin and eyes

Follow these procedures for chemicals or hazardous fluids that have come into contact with your eyes or your skin:

Condition	Action
Chemicals or hazardous fluids in eyes	1. Hold your eyelids apart forcibly with your fingers. 2. Rinse the eyes with eyewash or running water for at least 15 minutes. 3. Seek medical attention.
Chemicals or hazardous fluids on skin	1. Remove contaminated clothing. 2. Wash the skin with soap and water for at least 1 minute. 3. Seek medical attention, if necessary.

1.6 Protecting the environment

Emissions and waste disposal

Observe the local regulations and codes regarding:

- Reporting of emissions to the appropriate authorities
- Sorting, recycling and disposal of solid or liquid waste
- Clean-up of spills

Exceptional sites

CAUTION: Radiation Hazard

Do NOT send the product to Xylem if it has been exposed to nuclear radiation, unless Xylem has been informed and appropriate actions have been agreed upon.

1.7 Spare parts

CAUTION:

Only use the manufacturer's original spare parts to replace any worn or faulty components. The use of unsuitable spare parts may cause malfunctions, damage, and injuries as well as void the warranty.

1.8 Warranty

For information about warranty, see the sales contract.

2 Transportation and Storage

2.1 Examine the delivery

2.1.1 Examine the package

1. Examine the package for damaged or missing items upon delivery.
2. Record any damaged or missing items on the receipt and freight bill.
3. If anything is out of order, then file a claim with the shipping company.

   If the product has been picked up at a distributor, make a claim directly to the distributor.

2.1.2 Examine the unit

1. Remove packing materials from the product.

   Dispose of all packing materials in accordance with local regulations.
2. To determine whether any parts have been damaged or are missing, examine the product.
3. If applicable, unfasten the product by removing any screws, bolts, or straps.

   Use care around nails and straps.
4. If there is any issue, then contact a sales representative.

2.2 Transportation guidelines

Precautions

DANGER: Crush Hazard

Moving parts can entangle or crush. Always disconnect and lock out power before servicing to prevent unexpected startup. Failure to do so could result in death or serious injury.

Position and fastening

The unit can be transported either horizontally or vertically. Make sure that the unit is correctly fastened during transportation, and cannot roll or fall over.

2.2.1 Lifting

Always inspect the lifting equipment and tackle before starting any work.

WARNING: Crush Hazard

1) Always lift the unit by its designated lifting points. 2) Use suitable lifting equipment and ensure that the product is properly harnessed. 3) Wear personal protective equipment. 4) Stay clear of cables and suspended loads.

NOTICE:

Never lift the unit by its cables or hose.

Lifting equipment

Lifting equipment is always required to handle the unit. The lifting equipment must fulfill the following requirements:

- The minimum height between the lifting hook and the floor must be sufficient to lift the unit. Contact a Xylem representative for more information.
- The lifting equipment must be able to hoist the unit straight up and down, preferably without the need for resetting the lifting hook.
- The lifting equipment must be correctly anchored and in good condition.
- The lifting equipment must support the weight of the entire assembly. Only authorized personnel may use the lifting equipment.
- Two sets of lifting equipment must be used to lift the unit for repair work.
- The lifting equipment must be dimensioned to lift the unit with any remaining pumped media in it.
- The lifting equipment must not be oversized.

CAUTION: Crush Hazard

Over-dimensioned lifting equipment can lead to injury. A site-specific risk analysis must be done.

2.3 Temperature ranges for transportation, handling and storage

Handling at freezing temperature

At temperatures below freezing, the product and all installation equipment, including the lifting gear, must be handled with extreme care.

Make sure that the product is warmed up to a temperature above the freezing point before starting up. Avoid rotating the impeller/propeller by hand at temperatures below the freezing point. The recommended method to warm the unit up is to submerge it in the liquid which will be pumped or mixed.

NOTICE:

Never use a naked flame to thaw the unit.

Unit in as-delivered condition

If the unit is still in the condition in which it left the factory - all packing materials are undisturbed - then the acceptable temperature range during transportation, handling and storage is: –50°C (–58°F) to +60°C (+140°F).

If the unit has been exposed to freezing temperatures, then allow it to reach the ambient temperature of the sump before operating.

Lifting the unit out of liquid

The unit is normally protected from freezing while operating or immersed in liquid, but the impeller/propeller and the shaft seal may freeze if the unit is lifted out of the liquid into a surrounding temperature below freezing.

Follow these guidelines to avoid freezing damage:

1. Empty all pumped liquid, if applicable.
2. Check all liquids used for lubrication or cooling, both oil and water-glycol mixtures, for the presence of unacceptable amounts of water. Change if needed.

Water-glycol mixtures: Units equipped with an internal closed-loop cooling system are filled with a mixture of water and 30% glycol. This mixture remains a flowing liquid at temperatures down to –13°C (9°F). Below –13°C (9°F), the viscosity increases such that the glycol mixture will lose its flow properties. However, the glycol-water mixture will not solidify completely and thus cannot harm the product.

2.4 Storage guidelines

Storage location

The product must be stored in a covered and dry location free from heat, dirt, and vibrations.

NOTICE:

Protect the product against humidity, heat sources, and mechanical damage.

NOTICE:

Do not place heavy weights on the packed product.

Long-term storage

If the unit is stored more than six months, then the following apply:

- Before operating the unit after storage, it must be inspected with special attention to the seals and the cable entry.
- The impeller/propeller must be rotated every other month to prevent the seals from sticking together.

Packaging material stacking limit

If the packaging material has an indicated stacking limit, then it is valid for 23°C (73°F) and 50% relative humidity. Depending on the material, other temperature and humidity ranges can reduce the stacking limit.

3 Product Description

Products included

Pump	D-hydraulic	F-hydraulic	M-hydraulic (Grinder)	N-hydraulic, cast iron	N-hydraulic, Hard-Iron™	N-hydraulic, stainless steel
3069.060					MT, SH	
3069.070[1]					MT, SH	
3069.090[1]	LT, MT, HT	LT				
3069.160				MT, SH		
3069.170			HT			
3069.180	LT, MT, HT	LT				
3069.190[1]				MT, SH		
3069.760						MT, SH
3069.770[1]						MT, SH
3069.890[1]			HT			
[1] Explosion proof drive unit						

Pump-specific information

For the specific weight, current, voltage, power ratings, and speed of the pump, see the data plate of the pump.

3.1 Pump design

The pump is submersible, and driven by an electric motor. For motor data, see *Technical Reference* on page 56 .

Intended use

The product is intended for moving waste water, sludge, raw and clean water. Always follow the limits given in *Technical Reference* on page 56 . If there is a question regarding the intended use of the equipment, please contact a local sales and service representative before proceeding.

DANGER: Explosion/Fire Hazard

Special rules apply to installations in explosive or flammable atmospheres. Do not install the product or any auxiliary equipment in an explosive zone unless it is rated explosion-proof or intrinsically-safe. If the product is EN/ATEX-, MSHA- or FM-approved, then see the specific EX information in the Safety chapter before taking any further actions.

Corrosive liquids

NOTICE:

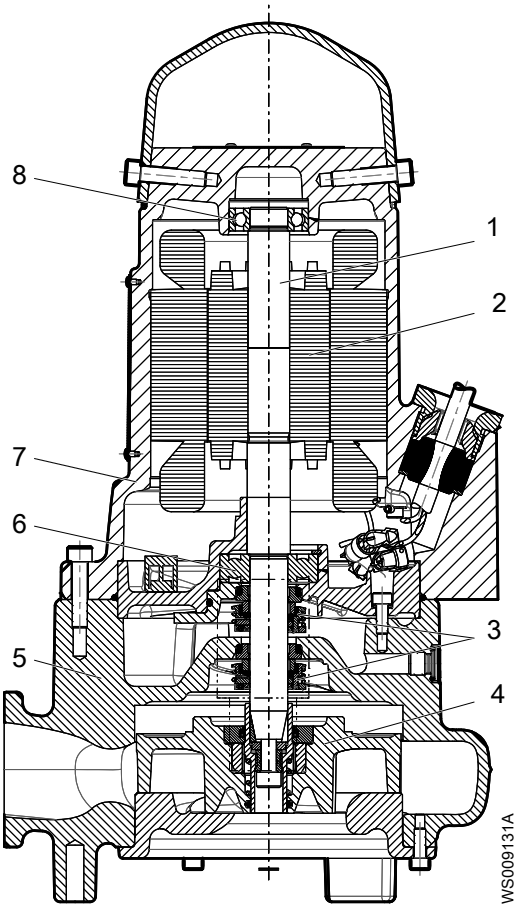
Do NOT use the unit in highly corrosive liquids.

Pressure classes

LT	Low head
MT	Medium head
HT	High head
SH	Super high head

Parts

The information describes the product in general. The supplied product can differ on a detailed level.



Position	Part	Description
1	Shaft	Stainless steel shaft with integrated rotor
2	Electric motor	For more information about the motor, see *Motor data* on page 56
3	Mechanical seal	One stationary and one rotating seal ring • Aluminum oxide Al_2O_3 • Carbon CSB • Corrosion-resistant cemented carbide WCCR
4	Impeller	
5	Pump housing	The pump housing includes a coolant that lubricates and cools the seals; the housing acts as a buffer between the pumped fluid and the drive unit.
6	Main bearing	Single-row deep-groove ball bearing
7	Stator housing	The pump is cooled by the ambient liquid or air.
8	Support bearing	Single-row deep-groove ball bearing
–	Screws and nuts	Property class 80 See *Torque values* on page 35 .

3.2 Monitoring equipment

The following applies to the monitoring equipment of the pump:

- The stator incorporates three thermal contacts connected in series that activate the alarm and stops the pump at overtemperature
- The thermal contacts open at 125°C (257°F).

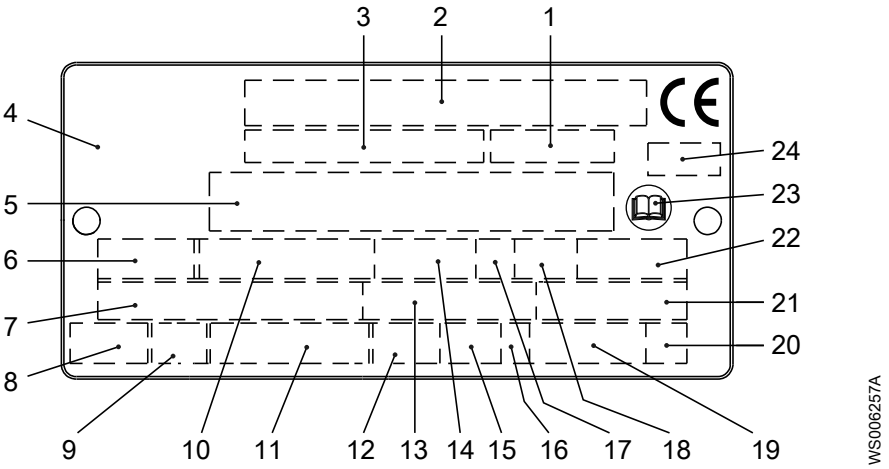
- Ex-approved pumps must have thermal contacts connected to the control panel.
- The sensors must be connected to either the MiniCAS II monitoring equipment or an equivalent equipment.
- The monitoring equipment must be of a design that makes automatic restart impossible.

Optional sensors

FLS FLS is a miniature float switch for detection of liquid in the stator housing. Due to its design it is best suited for pumps in a vertical position. The FLS sensor is installed in the bottom of the stator housing.

3.3 The data plate

The data plate is a metal label that is located on the main body of the products. The data plate lists key product specifications. Specially approved products also have an approval plate.



1. Curve code or Propeller code
2. Serial number
3. Product number
4. Country of origin
5. Additional information
6. Phase; type of current; frequency
7. Rated voltage
8. Thermal protection
9. Thermal class
10. Rated shaft power
11. International standard
12. Degree of protection
13. Rated current
14. Rated speed
15. Maximum submergence
16. Direction of rotation: L=left, R=right
17. Duty class
18. Duty factor
19. Product weight
20. Locked rotor code letter
21. Power factor
22. Maximum ambient temperature
23. Read installation manual
24. Notified body, only for EN-approved Ex products

Figure 1: The data plate

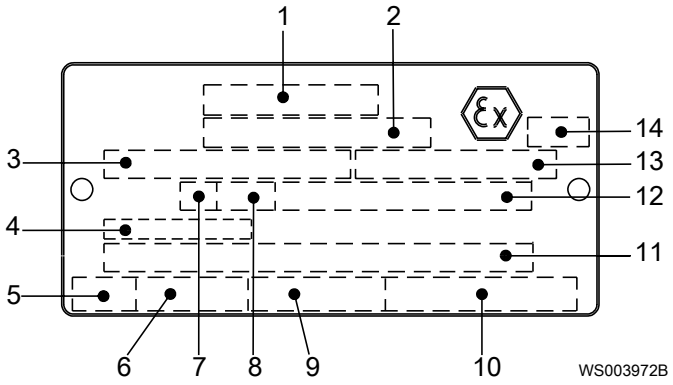
3.4 Approvals

Product approvals for hazardous locations

Pump	Approval
• 3069.070 • 3069.090 • 3069.190 • 3069.770 • 3069.890	European Norm (EN) • ATEX Directive FM18ATEX0006X • EN 60079-0:2012/A11:2013, EN 60079-1:2014, EN 13463-1:2009, EN 13463-5:2011 • Ex II 2 G c Ex db IIB T3 Gb • Ex II 2 G c Ex db IIB T4 Gb
	IEC • IECEx scheme IECEx_FMG_17.0036X • IEC 60079-0, IEC 60079-1 • Ex d IIB T3 Gb • Ex d IIB T4 Gb
	FM (FM Approvals) • Explosion proof for use in Class I, Div. 1, Group C and D

EN approval plate

This illustration describes the EN approval plate and the information that is contained in its fields.

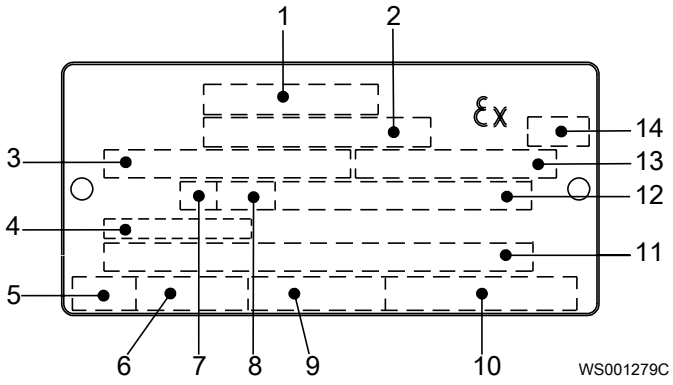


1. Approval
2. Approval authority and Approval number
3. Approved for drive unit
4. Cable entry temperature
5. Stall time
6. Starting current or Rated current
7. Duty class
8. Duty factor
9. Input power
10. Rated speed
11. Additional information
12. Maximum ambient temperature
13. Serial number
14. ATEX marking

IEC approval plate

This illustration describes the IEC approval plate and the information that is contained in its fields.

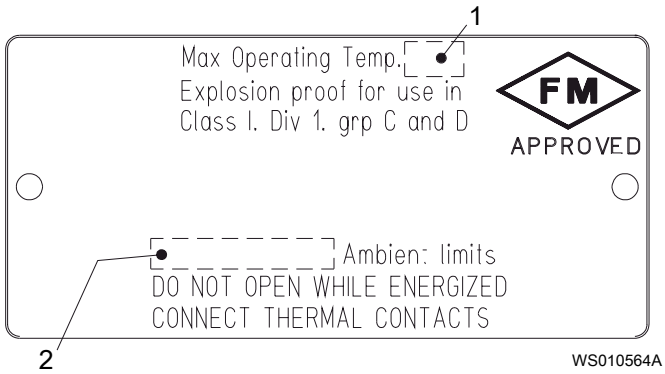
International Norm; not for EU member countries.



1. Approval
2. Approval authority and Approval number
3. Approved for drive unit
4. Cable entry temperature
5. Stall time
6. Starting current or Rated current
7. Duty class
8. Duty factor
9. Input power
10. Rated speed
11. Additional information
12. Maximum ambient temperature
13. Serial number
14. ATEX marking

FM approval plate

This illustration describes the FM approval plate and the information that is contained in its fields.



1. Temperature class
2. Maximum ambient temperature

3.5 Product denomination

Reading instruction

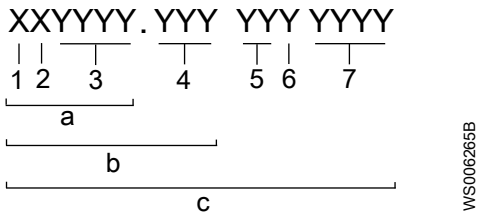
In this section, code characters are illustrated accordingly:

X = letter

Y = digit

The different types of codes are marked up with a, b and c. Code parameters are marked up with numbers.

Codes and parameters



Type of Callout	Number	Indication
Type of code	a	Sales denomination
	b	Product code
	c	Serial number
Parameter	1	Hydraulic end
	2	Type of installation
	3	Sales code
	4	Version
	5	Production year
	6	Production cycle
	7	Running number

4 Installation

4.1 Install the pump

Before starting work, make sure that the safety instructions in the chapter *Introduction and Safety* on page 3 have been read and understood.

DANGER: Electrical Hazard

Before starting work on the unit, make sure that the unit and the control panel are isolated from the power supply and cannot be energized. This applies to the control circuit as well.

DANGER: Inhalation Hazard

Before entering the work area, make sure that the atmosphere contains sufficient oxygen and no toxic gases.

Hazardous atmospheres

DANGER: Explosion/Fire Hazard

Special rules apply to installations in explosive or flammable atmospheres. Do not install the product or any auxiliary equipment in an explosive zone unless it is rated explosion-proof or intrinsically-safe. If the product is EN/ATEX-, MSHA- or FM-approved, then see the specific EX information in the Safety chapter before taking any further actions.

WARNING: Explosion/Fire Hazard

Do not install CSA-approved products in locations that are classified as hazardous in the National Electric Code(TM), ANSI/NFPA 70-2005.

General requirements

These requirements apply:

- Use the pump dimensional drawing in order to ensure proper installation.

Before installing the pump, do the following:

- Provide a suitable barrier around the work area, for example, a guard rail.
- Make sure that equipment is in place so that the unit cannot roll or fall over during the installation process.
- Check the explosion risk before you weld or use electric hand tools.
- Check that the cable and cable entry have not been damaged during transport.
- Always remove all debris and waste material from the sump, inlet piping, and discharge connection, before you install the pump.
- Always check the impeller rotation before lowering the pump into the pumped liquid.

NOTICE:

Do not run the pump dry.

NOTICE:

Never force piping to make a connection with a pump.

Authority regulation

Vent the tank of a sewage station in accordance with local plumbing codes.

Pressure restriction

The maximum working pressure must not exceed the value in the approved performance curve for the pump. A closed valve or a clogged pipe can rapidly build up the pressure. A motor protector or a relief valve on the discharge line is always recommended.

NOTICE:

Never operate the pump with the discharge line blocked, or the discharge valve closed.

Fasteners

- Only use fasteners of the correct size and material.
- Replace all corroded or damaged fasteners.
- Make sure that all the fasteners are correctly tightened and that there are no missing fasteners.

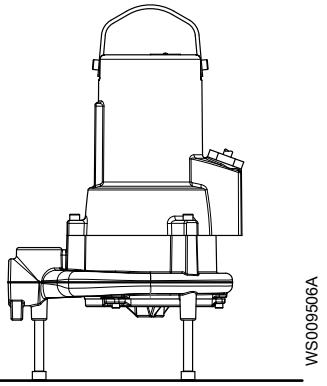
4.1.1 Install the pump

These requirements and instructions only apply when the installation is made according to the dimensional drawing.

1. Run the cable so that it has no sharp bends. Make sure that it is not pinched, and cannot be sucked into the pump inlet.
2. Install the pump according to the instructions for the installation type.

   Where applicable, the installation instructions are included in the mechanical accessories.
3. Connect the motor cable and the starter and monitoring equipment according to the separate instructions.

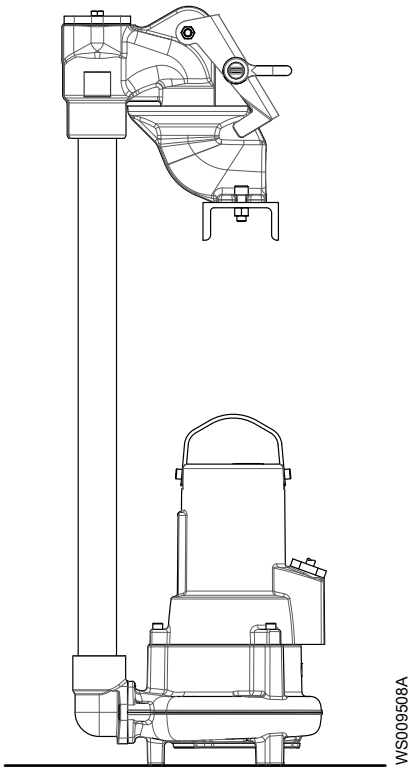
4.1.1.1 F-installation



F Free standing semipermanent, wet well arrangement where the pump is placed on a firm surface.

The pump is intended to operate completely or partially submerged in the pumped liquid.

4.1.1.2 H-installation



H Semipermanent, wet well quick connection suspended arrangement, incorporating integral non-return valve.

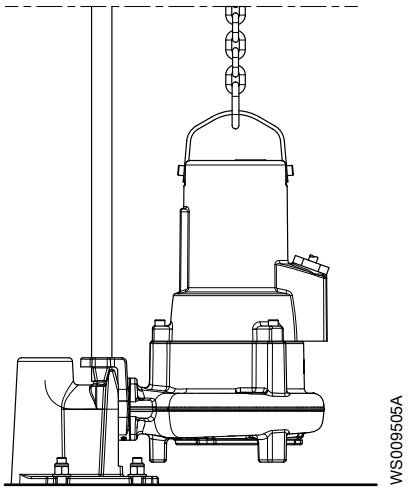
The pump is intended to operate completely or partially submerged in the pumped liquid.

These items are required:

- Discharge connection
- Pipe

For installation instructions, see appropriate mechanical accessories.

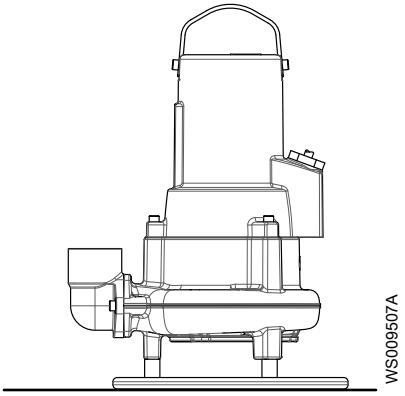
4.1.1.3 P-installation



P Semipermanent, wet well arrangement with the pump installed on two guide bars. The connection to the discharge is automatic.

The pump is intended to operate either completely or partially submerged in the pumped liquid.

4.1.1.4 S-installation

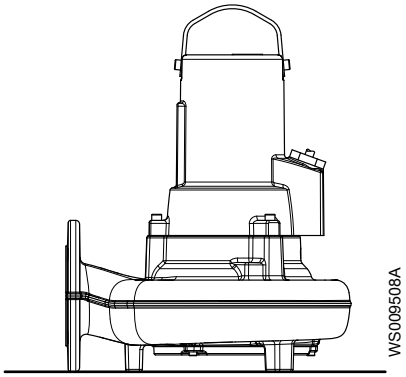


S Portable semipermanent, wet well arrangement with hose coupling or flange for connection to the discharge pipeline.

The pump is intended to operate completely or partially submerged in the pumped liquid.

4.1.1.5 X-installation

In the X-installation, the pump has no pre-determined mechanical connection. The flange is drilled.

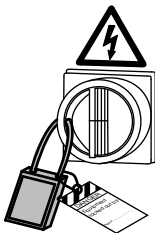


4.2 Make the electrical connections

General precautions

DANGER: Electrical Hazard

Before starting work on the unit, make sure that the unit and the control panel are isolated from the power supply and cannot be energized. This applies to the control circuit as well.



WARNING: Electrical Hazard

Risk of electrical shock or burn. A certified electrician must supervise all electrical work. Comply with all local codes and regulations.

WARNING: Electrical Hazard

There is a risk of electrical shock or explosion if the electrical connections are not correctly carried out, or if there is fault or damage on the product. Visually inspect equipment for damaged cables, cracked casings or other signs of damage. Make sure that electrical connections have been correctly made.

WARNING: Crush Hazard

Risk of automatic restart.

CAUTION: Electrical Hazard

Prevent cables from becoming sharply bent or damaged.

NOTICE:

Leakage into the electrical parts can cause damaged equipment or a blown fuse. Keep the cable ends dry at all times.

Requirements

These general requirements apply for electrical installation:

- The supply authority must be notified before installing the pump if it will be connected to the public mains. When the pump is connected to the public power supply, it may cause flickering of incandescent lamps when started.
- The mains voltage and frequency must agree with the specifications on the data plate. If the pump can be connected to different voltages, then the connected voltage is specified by a yellow sticker close to the cable entry.
- The fuses and circuit breakers must have the proper rating, and the pump overload protection (motor protection breaker) must be connected and set to the rated current according to the data plate and if applicable the cable chart. The starting current in direct-on-line start can be up to six times higher than the rated current.
- The fuse rating and the cables must be in accordance with the local rules and regulations.
- If intermittent operation is prescribed, then the pump must be provided with monitoring equipment supporting such operation.
- If stated on the data plate, then the motor is convertible between different voltages.
- The thermal contacts/thermistors must be in use.
- If the temperature of the pumped liquid is above 40°C (104°F), then do not connect the T1 and T2 leads to thermal contacts.
- For FM-approved pumps, a leakage sensor must be connected and in use in order to meet approval requirements.

Cables

These are the requirements to follow when you install cables:

- The cables must be in good condition, not have any sharp bends, and not be pinched.
- The cables must not be damaged and must not have indentations or be embossed (with markings, etc.) at the cable entry.
- The cable entry seal sleeve and washers must conform to the outside diameter of the cable.
- The minimum bending radius must not be below the accepted value.
- If using a cable which has been used before, a short piece must be peeled off when refitting it so that the cable entry seal sleeve does not close around the cable at the same point again. If the outer sheath of the cable is damaged, then replace the cable.

  Contact a sales or authorized service representative.

- The voltage drop in long cables must be taken into account. The drive unit's rated voltage is the voltage measured at the cable connection point in the pump.
- The screened cable must be used according to the European CE and EMC requirements if a Variable Frequency Drive (VFD) is used. For more information, contact a sales or authorized service representative (VFD-supplier).
- Make sure that the cable is long enough for maintenance work.
- For SUBCAB® cables, the twisted pair copper foil must be trimmed.
- All unused conductors must be insulated.

NOTICE:

Do not use Variable Frequency Drive (VFD) with this unit.

Grounding (earthing)

Grounding (earthing) must be done in compliance with all local codes and regulations.

DANGER: Electrical Hazard

All electrical equipment must be grounded (earthed). Test the ground (earth) lead to verify that it is connected correctly and that the path to ground is continuous.

WARNING: Electrical Hazard

If the power cable is jerked loose, then the ground (earth) conductor must be the last conductor to come loose from its terminal. Make sure that the ground (earth) conductor is longer than the phase conductors at both ends of the cable.

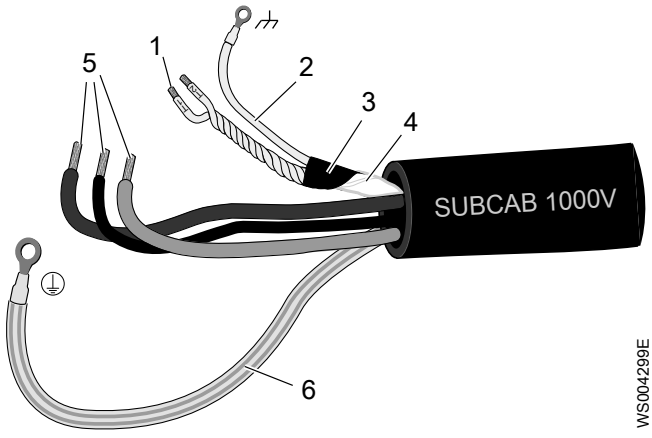
WARNING: Electrical Hazard

Risk of electrical shock or burn. You must connect an additional ground- (earth-) fault protection device to the grounded (earthed) connectors if persons are likely to come into contact with liquids that are also in contact with the pump or pumped liquid.

4.2.1 Prepare the SUBCAB® cables

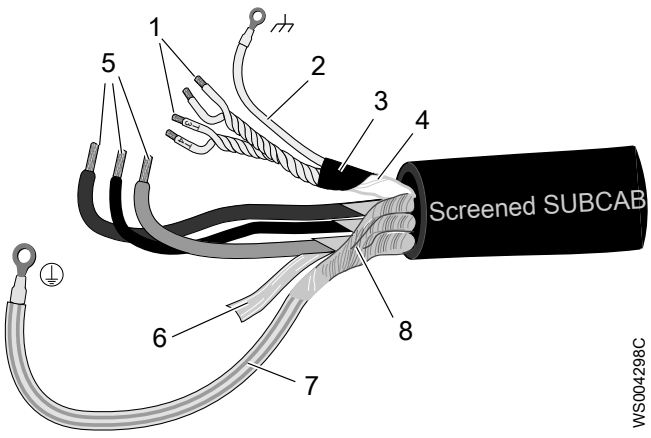
This section applies to SUBCAB® cables with twisted-pair control cores.

The prepared SUBCAB® cable



1. T1+T2 twisted pairs in control element
2. Drain wire in control element (bare aluminum wire)
3. Screened aluminum pt-foil
4. Insulation sheath (jacket) or PT-foil for control element
5. Power cores
6. Ground (earth) core

The prepared screened SUBCAB® cable



1. T1+T2 and T3+T4 twisted pairs in control element
2. Drain wire in control element (bare aluminum wire)
3. Screened aluminum pt-foil
4. Insulation sheath (jacket) for control element
5. Power cores
6. Aluminum foil
7. Ground (earth) core with green/yellow shrink hose
8. Uncovered screen/braided wire

1. Peel off the outer sheath at the end of the cable.
2. Prepare the control element:

a) Peel the sheath (if applicable) and the aluminum foil.

The aluminum foil is a screen and is conductive. Do not peel more than necessary, and remove the peeled foil.

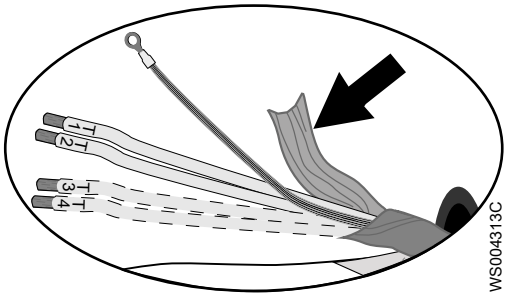


Figure 2: Aluminum foil on control element.

b) Put a white shrink hose over the drain wire and the cable terminal.
c) Fit a cable lug on the drain wire.
d) Twist T1+T2 and T3+T4.
e) Put a shrink hose over the control element.

Make sure that the conductive aluminum foil and drain wire is covered.

3. Prepare the ground (earth) core for SUBCAB™ cable:
   a) Peel the yellow-green insulation from the ground (earth) core.
   b) Check that the ground (earth) core is at least 10% longer than the phase cores in the cabinet.
   c) If applicable, put a cable lug on the ground core.
4. Prepare the ground (earth) core for screened SUBCAB™ cable:
   a) Untwist the screens around the power cores.
   b) Put a yellow-green shrink hose over the ground (earth) core.

      Leave a short piece uncovered.
   c) If applicable, put a cable lug on the screened ground core.
   d) Twist all power core screens together to create a ground (earth) core and fit a cable terminal to the end.
   e) Check that the ground (earth) core is at least 10% longer than the phase cores in the cabinet.
5. Connect to ground (earth):
   - Screw: Fit cable terminals to the ground (earth) core and the power cores.
   - Terminal block: Leave the core ends as they are.
6. Prepare the main leads:
   a) Remove the aluminum foil around each power core.
   b) Peel the insulation from each power core.

4.2.2 Connect the motor cable to the pump

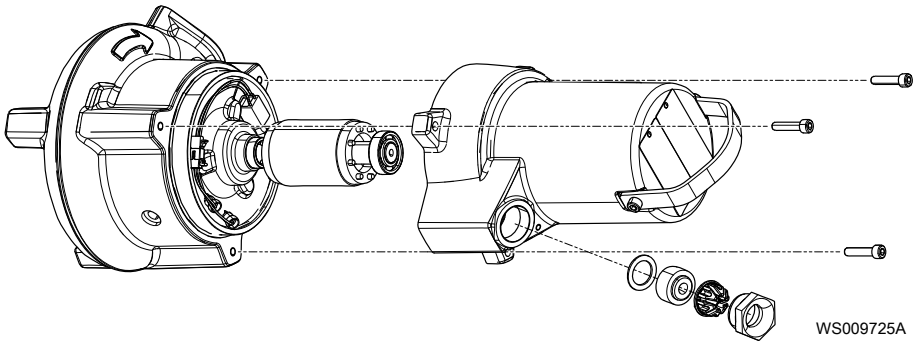
NOTICE:

Leakage into the electrical parts can cause damaged equipment or a blown fuse. Keep the end of the motor cable dry at all times.

At delivery from the factory, the motor cable is usually already connected to the pump.

1. Remove the entry gland screw from the stator housing.
2. Detach the stator housing from the pump housing.

   This provides access to the electrical connections.



3. Check the data plate to see which connections are required for the power supply.
4. Arrange the connections in accordance with the required power supply.
5. Connect the mains leads (L1, L2, L3, and ground (earth)) according to the applicable cable chart.

   The ground (earth) lead must be 50 mm (2.0 in) longer than the phase leads in the unit.
6. Make sure that the pump is correctly connected to ground (earth).
7. Make sure that any thermal contacts incorporated in the pump are properly connected.
8. Attach the stator housing to the pump housing.
9. Install the entry gland screw on the stator housing.

4.2.3 Connect the motor cable to the starter and monitoring equipment

DANGER: Explosion/Fire Hazard

Special rules apply to installations in explosive or flammable atmospheres. Do not install the product or any auxiliary equipment in an explosive zone unless it is rated explosion-proof or intrinsically-safe. If the product is EN/ATEX-, MSHA- or FM-approved, then see the specific EX information in the Safety chapter before taking any further actions.

NOTICE:

Thermal contacts must never be exposed to voltages higher than 250 V, breaking current maximum 5 A. It is recommended that they are connected to 24 V over separate fuses to protect other automatic equipment.

The single phase pumps must be equipped with a starter which has start and run capacitors.

A specially Flygt designed starter is required for the operation of single phase pumps. The connection of the motor cable to the starter is shown in the wiring diagram.

1. If thermal contacts are included in the pump installation, then connect the T1 and T2 control conductors to the MiniCAS II monitoring equipment.

   If the temperature of the pumped liquid is above 40°C (104°F), then do not connect the T1 and T2 leads to thermal contacts.
2. Connect the mains leads (L1, L2, L3, and ground (earth)) to the starter equipment.

   For information about the phase sequence and the color codes of the leads, see Cable charts.
3. Check the functionality of the monitoring equipment:

   a) Check that the signals and the tripping function work properly.

   b) Check that the relays, lamps, fuses, and connections are intact.

   Replace any defective equipment.

4.2.4 Cable charts

Description

This topic contains general connection information. It also provides cable charts that show connection alternatives for use with different cables and power supply.

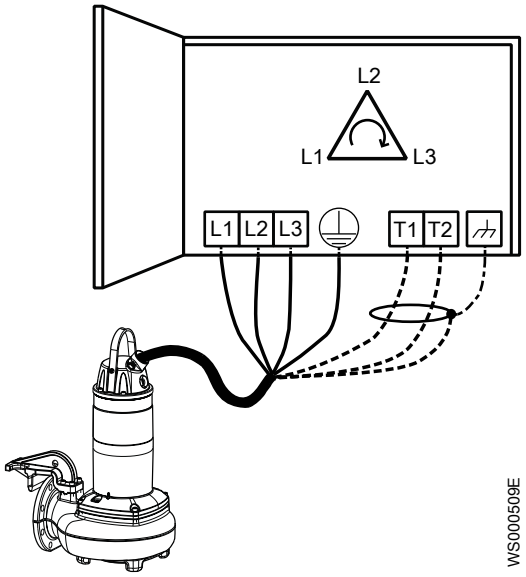
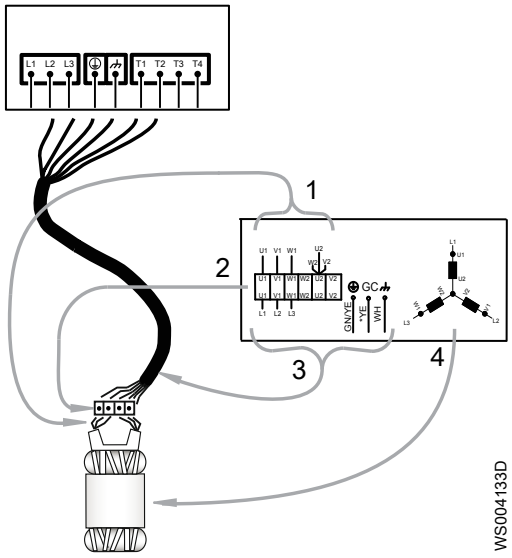


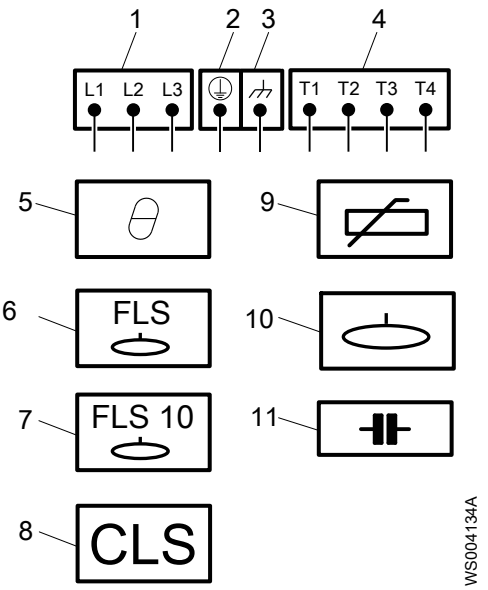
Figure 3: Phase sequence

Connection locations

The figures in this section illustrate how to interpret the connection strip symbols.



1. Stator leads
2. Terminal board
3. Power cable leads
4. Stator (internal connection illustrated)



1. Starter equipment and mains leads (L1, L2, L3)
2. ground (earth)
3. Functional ground
4. Control leads (T1, T2, T3, T4)
5. Thermal contact
6. FLS
7. FLS 10
8. CLS
9. Thermistor
10. Level sensor
11. Capacitor

Color code standard

Code	Description
BN	Brown
BK	Black
WH	White
OG	Orange
GN	Green
GNYE	Green-Yellow
RD	Red
GY	Grey
BU	Blue
YE	Yellow

4.2.4.1 Colors and markings of leads

Motor connection

Colours and marking of main leads

COLOUR STANDARD

BN=Brown
BK=Black
WH=White
OG=Orange
GN=Green
GN/YE=Green-Yellow
RD=Red
GY=Grey
BU=Blue
YE=Yellow

STATOR LEADS

U1,U5 RD
U2,U6 GN
V1,V5 BN
V2,V6 BU
W1,W5 YE
W2,W6 BK
T1,T2 WH/YE

*SUBCAB AWG
* * Ground Conductor is stranded around cores
GC=Ground Check

772 17 00 (REV 6)

Mains 1~	Mains 3~	SUBCAB 7GX Screenflex 7GX	SUBCAB 4GX Screenflex 4GX	SUBCAB AWG	SUBCAB Screened
1	L1	BK 1	BN	RD	BN
2	L2	BK 2	BK	BK	BK
3	L3	BK 3	GY	WH	GY
	L1	BK 4	-	-	-
	L2	BK 5	-	-	-
	L3	BK 6	-	-	-
⏚		GN/YE	GN/YE	GN/YE	**Screen/PE from cores
⏚		Screen (WH)	Screen (WH)	-	Screen (WH)
GC		-	-	YE	-

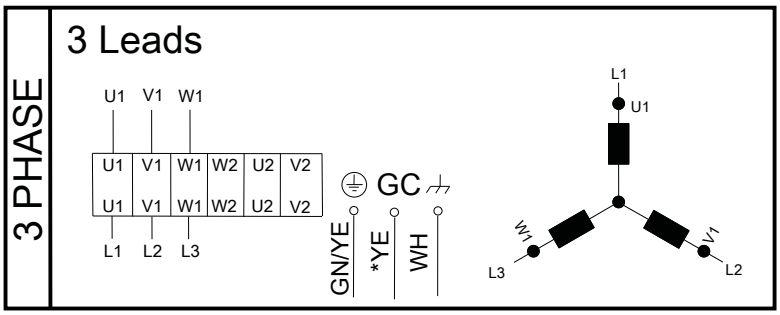
WS004125B

For markings on sensor leads, see *Sensors connection* on page 28 .

4.2.4.2 Connections included

- *3-phase connection* on page 25
- *1-phase connection* on page 27
- *Sensors connection* on page 28
- *Screened cable connection* on page 28

4.2.4.3 3-phase connection



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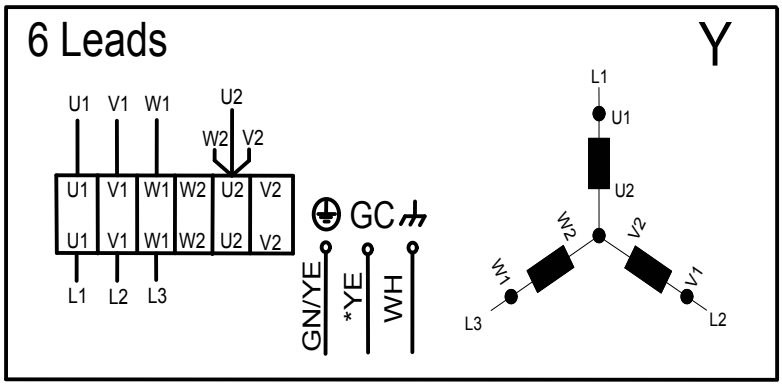

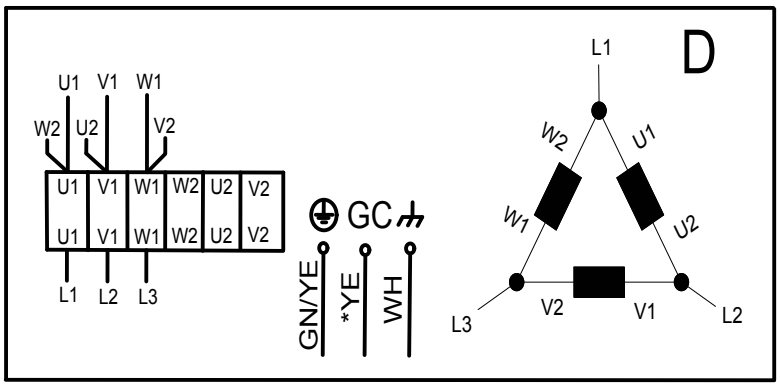

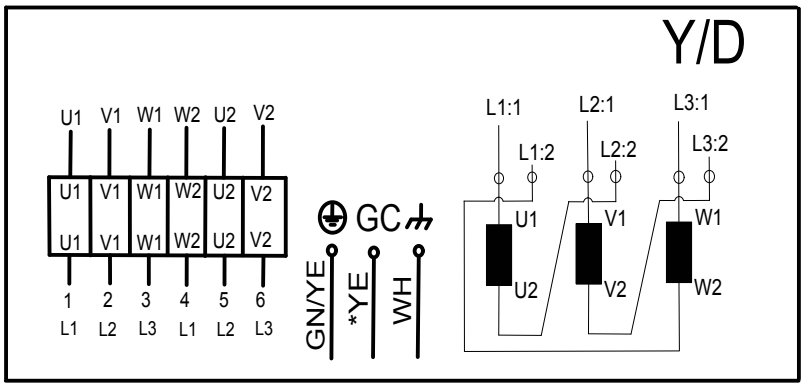

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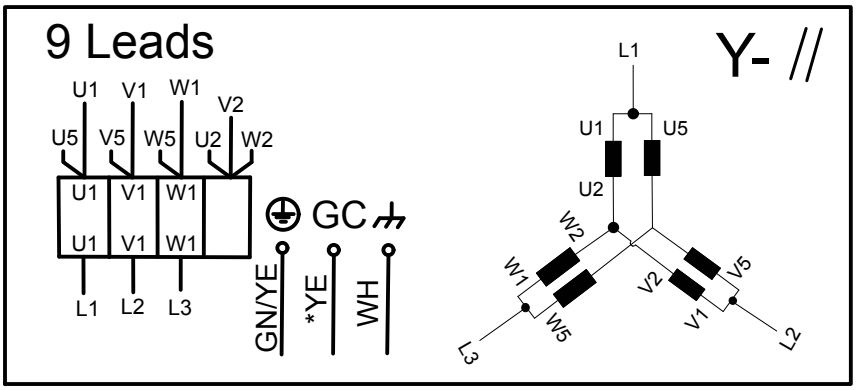

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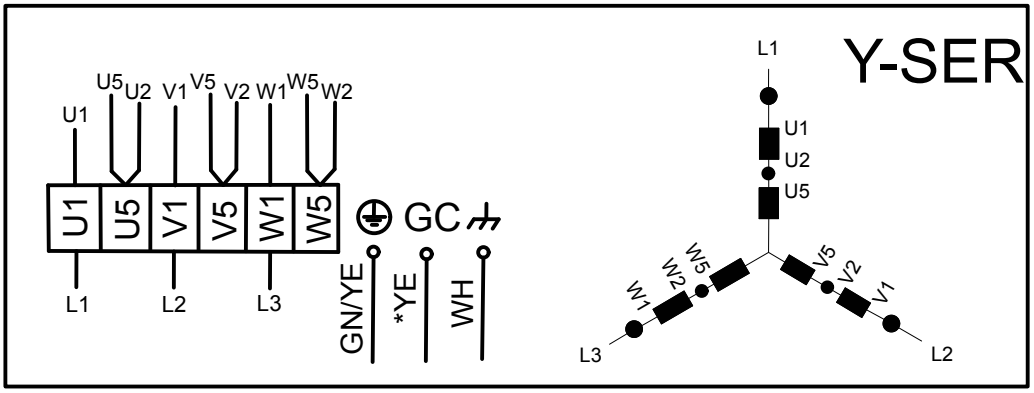

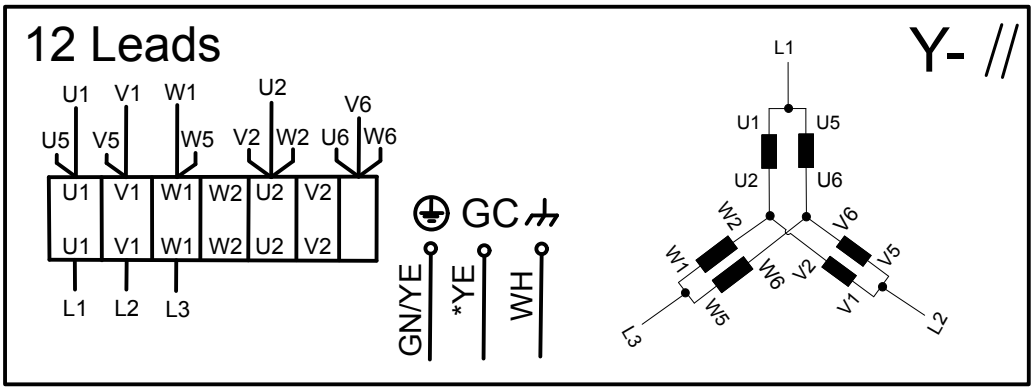

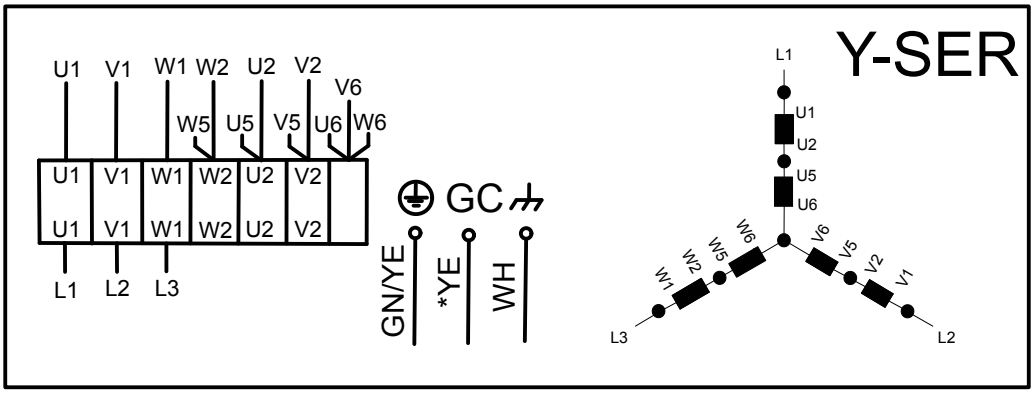

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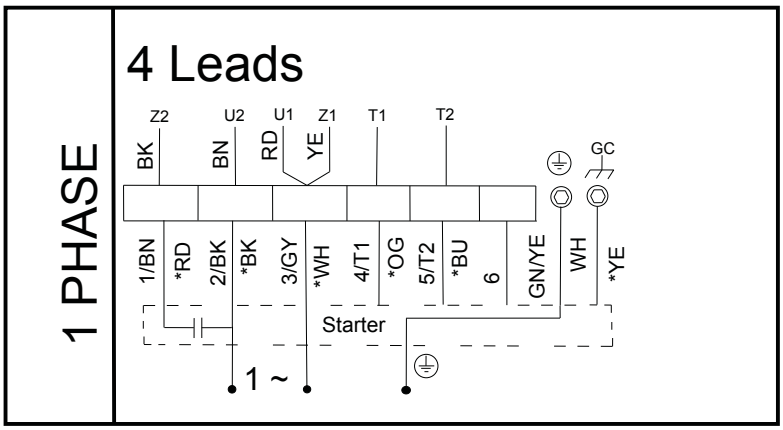
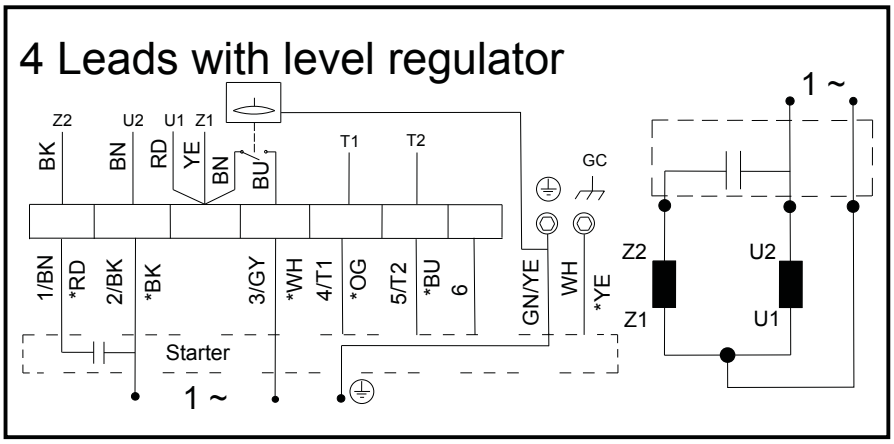
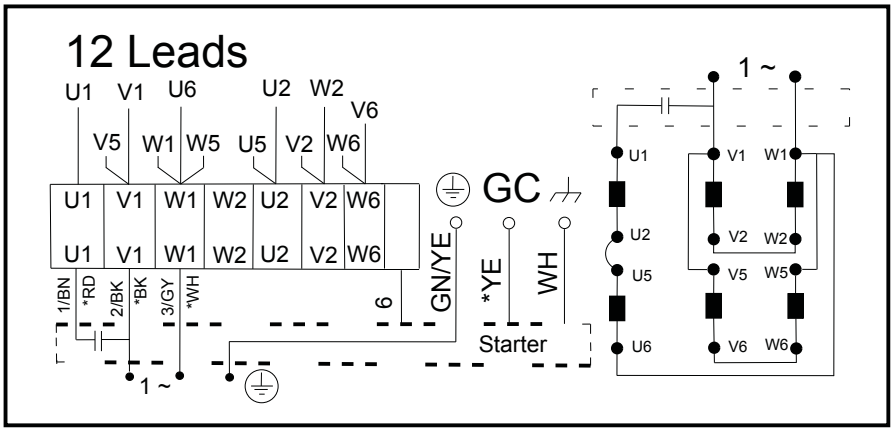
4.2.4.4 1-phase connection







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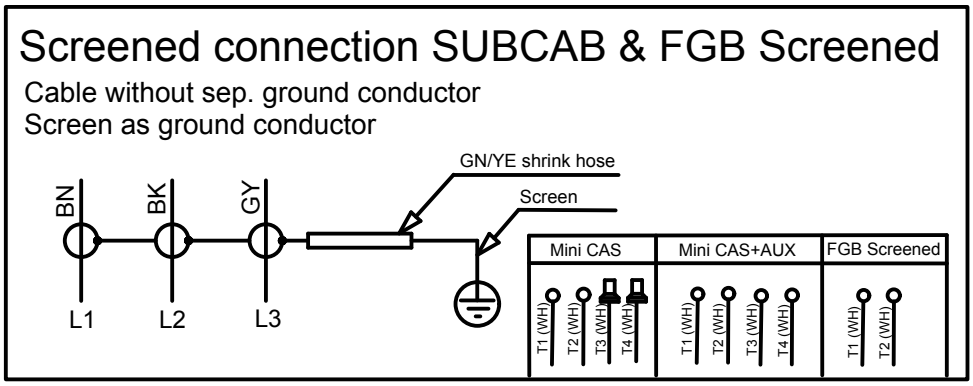
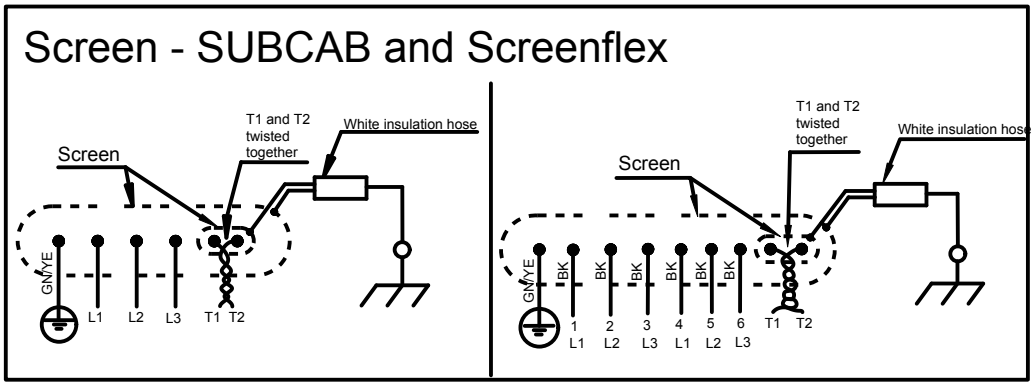
4.2.4.5 Screened cable connection

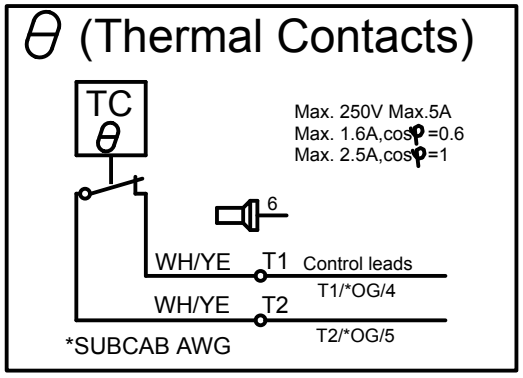


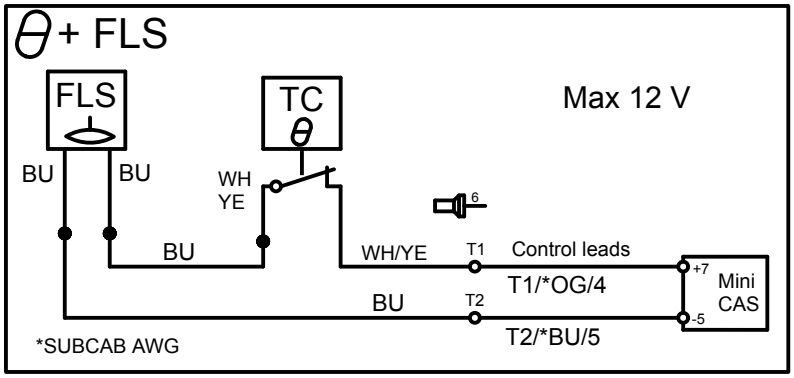


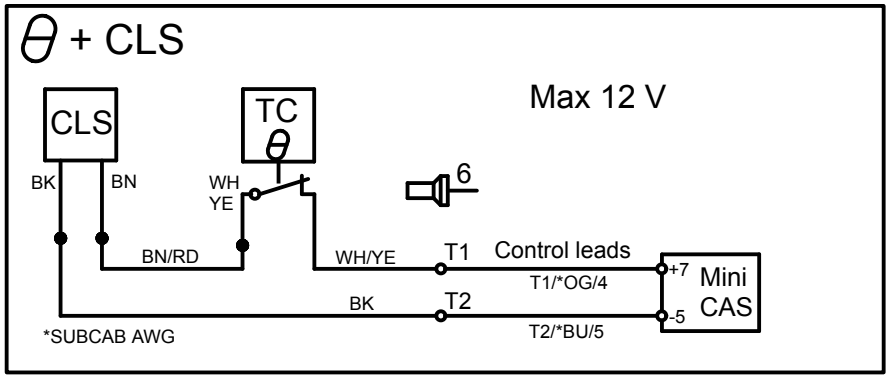
4.2.4.6 Sensors connection

Not all charts are applicable for every product.

SENSORS	Control	SUBCAB 7GX & 4GX Screenflex	SUBCAB AWG	SUBCAB screened
	T1	WH T1	OG	WH T1
	T2	WH T2	BU	WH T2
	T3	-	-	WH T3
	T4	-	-	WH T4







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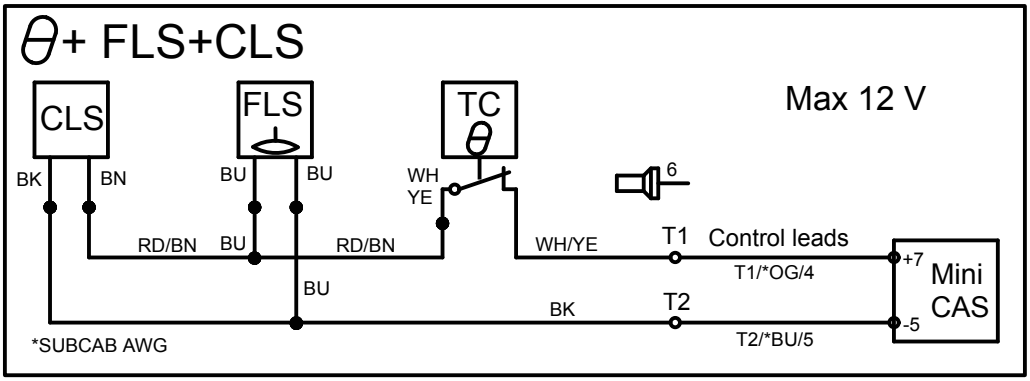

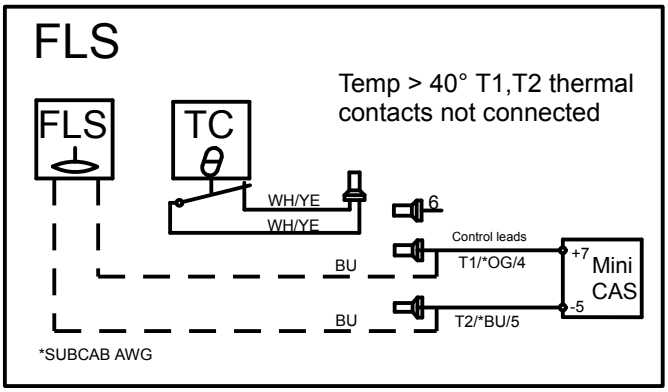

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4.2.4.7 Sensor connection characteristics

The values have a 10% tolerance.

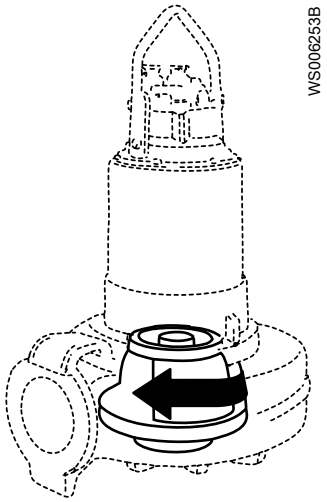
Sensors	Value (mA)	Definition
FLS and thermal contact	0	Overtemperature
	7.8	OK
	36	Leakage

4.3 Check the impeller rotation

CAUTION: Crush Hazard

The starting jerk can be powerful. Make sure nobody is close to the unit when it is started.

1. Start the motor.
2. Stop the motor after a few seconds.
3. Check that the impeller rotates according to this illustration.



The correct direction of impeller rotation is clockwise when you look at the pump from above.

4. If the impeller rotates in the wrong direction, then do one of these steps:
   - If the motor has a 1-phase connection, then contact a sales or authorized service representative.
   - If the motor has a 3-phase connection, then transpose two phase leads and do this procedure again.

5 Operation

5.1 Precautions

Before taking the unit into operation, check the following:

- All recommended safety devices are installed.
- The cable and cable entry have not been damaged.
- All debris and waste material has been removed.

NOTICE:

Never operate the pump with the discharge line blocked, or the discharge valve closed.

WARNING: Crush Hazard

Risk of automatic restart.

Distance to wet areas

WARNING: Electrical Hazard

Risk of electrical shock or burn. You must connect an additional ground- (earth-) fault protection device to the grounded (earthed) connectors if persons are likely to come into contact with liquids that are also in contact with the pump or pumped liquid.

CAUTION: Electrical Hazard

Risk of electrical shock or burn. The equipment manufacturer has not evaluated this unit for use in swimming pools. If used in connection with swimming pools then special safety regulations apply.

Noise level

NOTICE:

The sound power level of the product is lower than 70 dB(A). However, in some installations the resulting sound pressure level may exceed 70 dB(A) at certain operating points on the performance curve. Make sure that you understand the noise level requirements in the environment where the product is installed. Failure to do so may result in hearing loss or violation of local laws.

5.2 Estimate zinc anode replacement intervals

The mass and surface area of the zinc anodes are designed to protect the pump surface for 1 year in sea water with an average temperature of 20°C (68°F). Shorter inspection intervals and anode replacement can be required, depending upon the water temperature and the chemical composition as well as the presence of other metals in the vicinity of the pump.

The rate of zinc consumption, and the appropriate inspection intervals, can be estimated by measuring how much zinc is consumed during the first two months following installation.

Anodes are replaced when the anode mass is reduced to a selected fraction of its initial mass. The recommended interval for the selection fraction is 0.25–0.50 (25–50%).

1. Remove, weigh, and reinstall one or more of the exterior zinc anodes before starting up the pump.
2. After two months, remove and weigh the same zinc anode or anodes again.

3. Divide the lapsed time in days (between steps 1 and 2) by the anode weight loss in grams to get the calculated anode consumption rate (days/gram).

   If multiple anodes were weighed, then use the anode which has lost the most weight for this calculation.
4. Calculate future replacement intervals so that they occur when the selected fraction of zinc is remaining.

5.3 Start the pump

CAUTION: Crush Hazard

The starting jerk can be powerful. Make sure nobody is close to the unit when it is started.

NOTICE:

Make sure that the rotation of the impeller is correct. For more information, see Check the impeller rotation.

1. Check the oil level in the oil housing.
2. Remove the fuses or open the circuit breaker, and check that the impeller can rotate freely.

WARNING: Crush Hazard

Never put your hand into the pump housing.

3. Conduct insulation test phase to ground. To pass, the value must exceed 5 megaohms.
4. Check that the monitoring equipment works.
5. Start the pump.

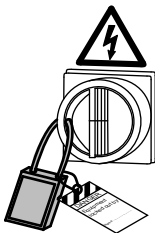
6 Maintenance

Precautions

Before starting work, make sure that the safety instructions in the chapter *Introduction and Safety* on page 3 have been read and understood.

DANGER: Crush Hazard

Moving parts can entangle or crush. Always disconnect and lock out power before servicing to prevent unexpected startup. Failure to do so could result in death or serious injury.



WARNING: Biological Hazard

Infection risk. Rinse the unit thoroughly with clean water before working on it.

CAUTION: Crush Hazard

Make sure that the unit cannot roll or fall over and injure people or damage property.

Make sure that you follow these requirements:

- Check the explosion risk before you weld or use electrical hand tools.
- Allow all system and pump components to cool before you handle them.
- Make sure that the product and its components have been thoroughly cleaned.
- Make sure that the work area is well-ventilated before you open any vent or drain valves, remove any plugs, or disassemble the unit.
- Do not open any vent or drain valves or remove any plugs while the system is pressurized. Make sure that the pump is isolated from the system and that pressure is relieved before you disassemble the pump, remove plugs, or disconnect piping.

Ground continuity verification

A ground (earth) continuity test must always be performed after service.

Maintenance guidelines

During the maintenance and before reassembly, always remember to perform these tasks:

- Clean all parts thoroughly, particularly O-ring grooves.
- Change all O-rings, gaskets, and seal washers.
- Lubricate all springs, screws, O-rings with grease.

During the reassembly, always make sure that existing index markings are in line.

The reassembled drive unit must always be insulation-tested and the reassembled pump must always be test-run before normal operation.

6.1 Torque values

All screws and nuts must be lubricated to achieve correct tightening torque. Screws that are screwed into stainless steel must have the threads coated with suitable lubricants to prevent seizing.

If there is a question regarding the tightening torques, then contact a sales or authorized service representative.

Screws and nuts

Table 1: Stainless steel, A2 and A4, torque Nm (ft-lbs)

Property class	M4	M5	M6	M8	M10	M12	M16	M20	M24	M30
50	1.0 (0.74)	2.0 (1.5)	3.0 (2.2)	8.0 (5.9)	15 (11)	27 (20)	65 (48)	127 (93.7)	220 (162)	434 (320)
70, 80	2.7 (2)	5.4 (4)	9.0 (6.6)	22 (16)	44 (32)	76 (56)	187 (138)	364 (268)	629 (464)	1240 (915)
100	4.1 (3)	8.1 (6)	14 (10)	34 (25)	66 (49)	115 (84.8)	248 (183)	481 (355)	–	–

Table 2: Steel, torque Nm (ft-lbs)

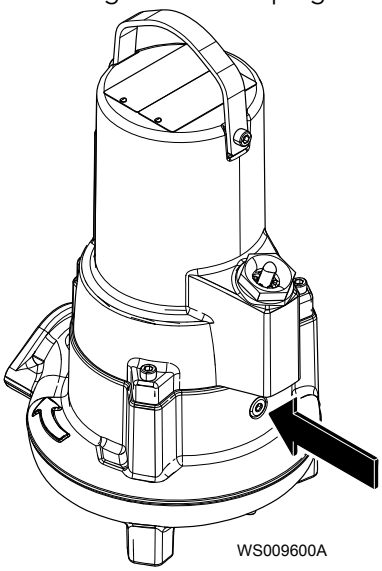
Property class	M4	M5	M6	M8	M10	M12	M16	M20	M24	M30
8.8	2.9 (2.1)	5.7 (4.2)	9.8 (7.2)	24 (18)	47 (35)	81(60)	194 (143)	385 (285)	665 (490)	1310 (966.2)
10.9	4.0 (2.9)	8.1 (6)	14 (10)	33 (24)	65 (48)	114 (84)	277 (204)	541 (399)	935 (689)	1840 (1357)
12.9	4.9 (3.6)	9.7 (7.2)	17 (13)	40 (30)	79 (58)	136 (100)	333 (245)	649 (480)	1120 (825.1)	2210 (1630)

Hexagon screws with countersunk heads

For hexagon socket head screws with countersunk head, maximum torque for all property classes must be 80% of the values for property class 8.8 above.

6.2 Change the oil

This image shows the plug that is used to change the oil.

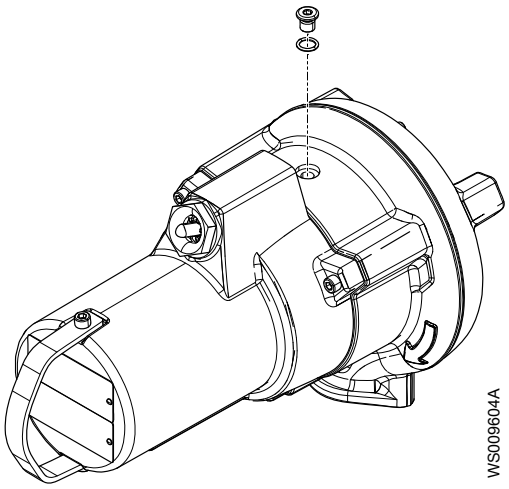


Empty the oil

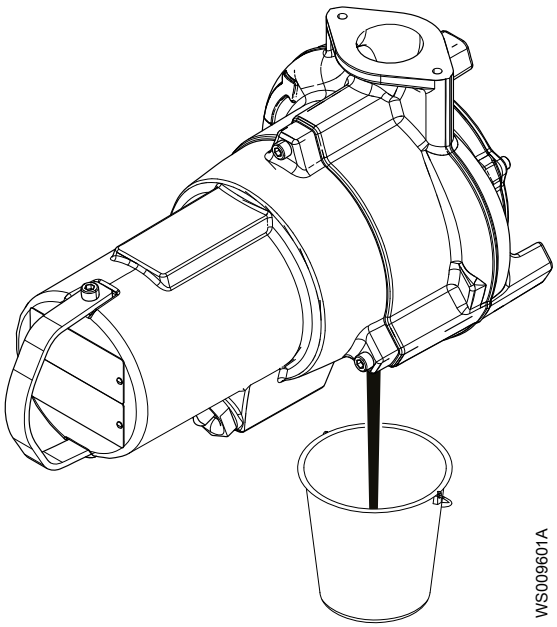
CAUTION: Compressed Gas Hazard

Air inside the chamber may cause parts or liquid to be propelled with force. Be careful when opening. Allow the chamber to de-pressurize before removal of the plug.

1. Put the pump in a horizontal position and unscrew the oil plug.



2. Put a container under the pump and turn the pump.



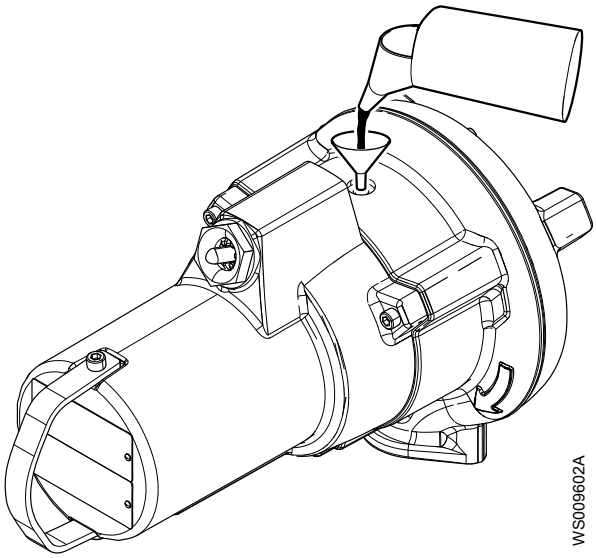
Fill with oil

The oil should be a medical white oil of paraffin type that fulfills FDA 172.878 (a) and viscosity close to VG32. Examples of applicable oil types are the following:

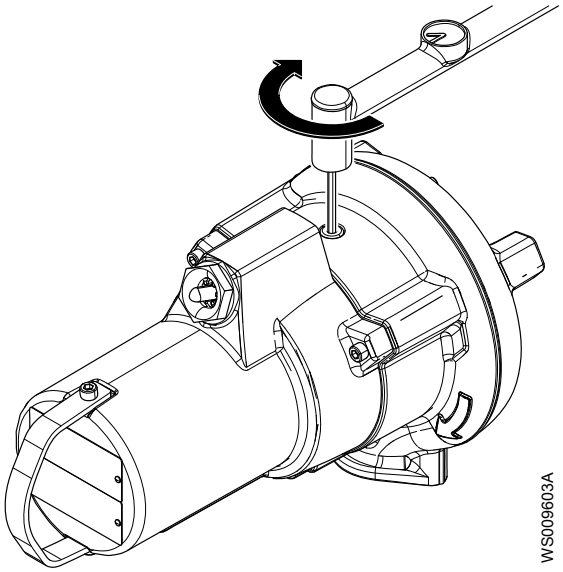
- Statoil MedicWay 32™
- BP Enerpar M 004™
- Shell Ondina 927™
- Shell Ondina X430™

1. Replace the O-ring of the oil plug.
2. Fill with oil.

   Quantity: approximately 0.6 L (0.6 quarts).



3. Refit and tighten the oil plug.
   Tightening torque: 10–40 Nm (7.5–29.5 ft-lb).



6.3 Service the pump

Type of maintenance	Purpose	Inspection interval
Initial inspection	A Xylem-authorized personnel checks the pump condition. From the results, the personnel recommends the intervals for the periodical inspection and overhaul for the installation.	Within the first year of operation.
Periodical inspection	The inspection prevents operational interruptions and machine breakdowns. The measures to increase performance and pump efficiency are decided for each application. They can include such things as impeller trimming, wear part control and replacement, control of zinc-anodes and control of the stator.	Up to every year Applies to normal applications and operating conditions at media (liquid) temperatures <40°C (104°F).

Type of maintenance	Purpose	Inspection interval
Overhaul	The overhaul lengthens the operating lifetime of the product. It includes the replacement of key components and the measures that are taken during an inspection.	Up to every three years Applies to normal applications and operating conditions at media (liquid) temperatures <40°C (104°F).

NOTICE:

Shorter intervals may be required when the operating conditions are extreme, for example with very abrasive or corrosive applications or when the liquid temperatures exceed 40°C (104°F).

6.3.1 Inspection

Service item	Action
Cable	1. If the outer jacket is damaged, replace the cable. 2. Check that the cables do not have any sharp bends and are not pinched.
Connection to power	Check that the connections are properly secured.
Electrical cabinets	Check that they are clean and dry.
Impeller	1. Check the clearance. 2. If necessary, adjust.
Stator housing	1. Drain any liquid. 2. Check the resistance of the leakage sensor. Normal value approximately 1500 ohms, alarm approximately 430 ohms.
Insulation	Use a megger maximum 1000 V. 1. Check that the resistance between the ground (earth) and phase lead is more than 5 megohms. 2. Conduct a phase-to-phase resistance check.
Junction box	Check that it is clean and dry.
Lifting device	Check that the local safety regulations are followed.
Lifting handle	1. Check the screws. 2. Check the condition of the lifting handle and the chain. 3. If necessary, replace.
O-rings	1. Replace the O-rings of the oil plugs. 2. Replace the O-rings at the entrance or junction cover. 3. Lubricate the new O-rings.
Overload protection and other protections	Check the correct settings.
Personnel safety devices	Check the guard rails, covers, and other protections.
Rotation direction	Check the impeller rotation.
Oil housing	If necessary, fill with new oil.
Electrical connections	Check that the connections are properly secured.
Thermal contacts	Normally closed circuit; interval 0–1 ohm.
Voltage and amperage	Check the running values.

6.3.2 Overhaul

The basic repair kit includes O-rings, seals, and bearings.

For an overhaul, do the following in addition to the tasks listed under Inspection.

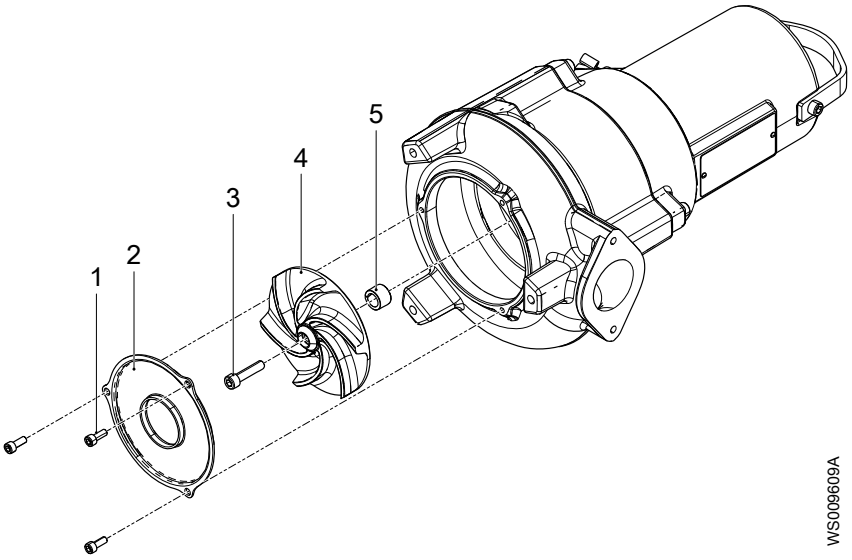
Service item	Action
Support and main bearing	Replace the bearings with new bearings.
Mechanical seal	Replace with new seal units.

6.3.3 Service in case of alarm

For information about indication values for sensors, see *Sensors connection* on page 28 .

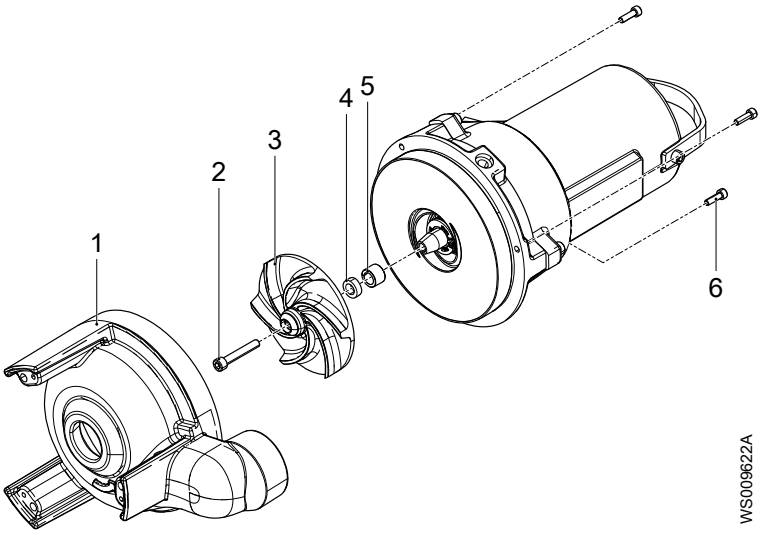
Alarm source	Action
FLS	1. Check for liquid in the stator housing. 2. Drain all liquid, if any. 3. Check the mechanical seal unit, the O-rings, and the cable entry, if liquid was found.
Thermal contact	Check the start and stop levels.
The overload protection	Check that the impeller can rotate freely.

6.4 Replace the D-impeller



1. Screws
2. Suction cover
3. Impeller screw
4. Impeller
5. Sleeve

Figure 4: Standard variant



1. Pump housing
2. Impeller screw
3. Impeller
4. Spacer
5. Sleeve
6. Screws

Figure 5: Abrasive resistant variant

6.4.1 Remove the D-impeller

CAUTION: Cutting Hazard

Worn parts can have sharp edges. Wear protective clothing.

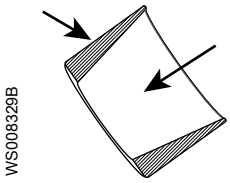
1. Uncover the impeller:
   - For the standard variant, remove the screws and the suction cover.
   - For the abrasive resistant variant, remove the screws and the pump housing.
2. Remove the impeller screw.

   Prevent the impeller from rotating.
3. Remove the impeller:
   - For the standard variant, remove the impeller and the sleeve.
   - For the abrasive resistant variant, remove the impeller, the spacer, and the sleeve.

6.4.2 Install the D-impeller

1. Prepare the shaft:
   a) Polish off any flaws with a fine emery cloth.

      The end of the shaft must be clean and free from burrs.
   b) Coat the inner conic and the outer cylindrical surfaces of the sleeve with a thin layer of grease.

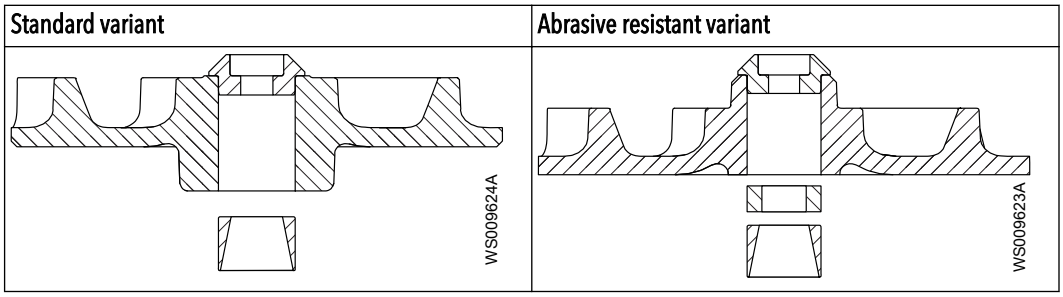


      The proper lubrication is grease for bearings, for example Exxon Mobil Unirex N3, Mobil Mobilith SHC 220 or equivalent.

NOTICE:

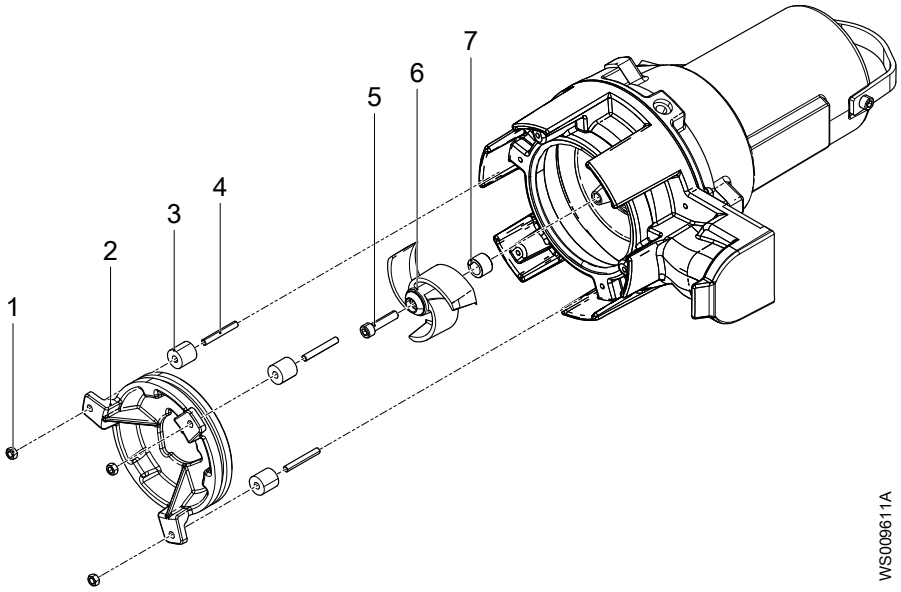
Surplus grease can cause the impeller to become loose. Remove surplus grease from conical and/or cylindrical surfaces of shafts and/or sleeves.

2. Prepare the impeller:
   - For the standard variant, insert the sleeve into the impeller.
   - For the abrasive resistant variant, insert the spacer and the sleeve into the impeller.



3. Mount the impeller:
   a) Lubricate the threads of the impeller screw.
      Always use a new screw.
   b) Fit the impeller to the shaft.
   c) Fit the impeller screw to the shaft.
   d) Tighten the impeller screw.
      Prevent the impeller from rotating.
      For tightening torque, see *Torque values* on page 35 .
4. Cover the impeller:
   - For the standard variant, install the suction cover and tighten the screws.
   - For the abrasive resistant variant, install the pump housing. Tighten the screws.

6.5 Replace the F-impeller



1. Nuts
2. Suction cover
3. Seal sleeves
4. Studs
5. Impeller screw
6. Impeller
7. Sleeve

6.5.1 Remove the F-impeller

CAUTION: Cutting Hazard

Worn parts can have sharp edges. Wear protective clothing.

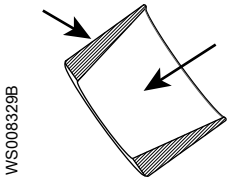
1. Remove the nuts, the suction cover, and the seal sleeves.
2. Remove the impeller screw.

   Prevent the impeller from rotating.
3. Remove the impeller and the sleeve.

6.5.2 Install the F-impeller

1. Prepare the shaft:
   a) Polish off any flaws with a fine emery cloth.

      The end of the shaft must be clean and free from burrs.
   b) Coat the inner conic and the outer cylindrical surfaces of the sleeve with a thin layer of grease.



      The proper lubrication is grease for bearings, for example Exxon Mobil Unirex N3, Mobil Mobilith SHC 220 or equivalent.

      NOTICE:

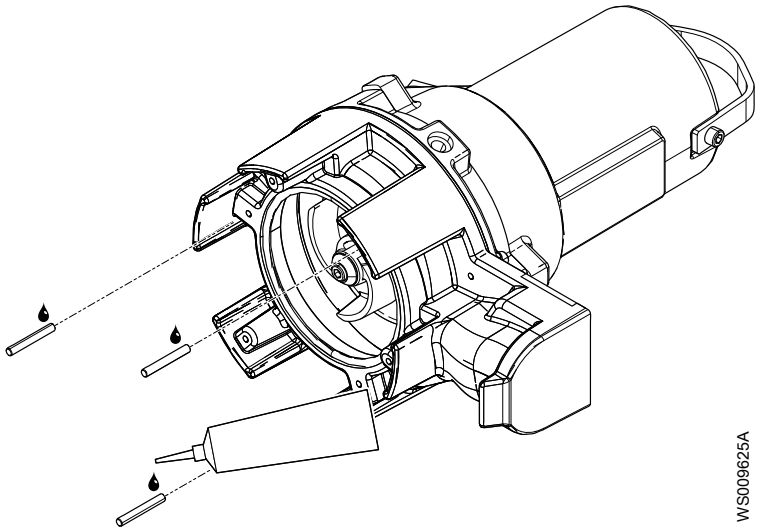
      Surplus grease can cause the impeller to become loose. Remove surplus grease from conical and/or cylindrical surfaces of shafts and/or sleeves.
2. Mount the impeller:
   a) Insert the sleeve into the impeller.
   b) Lubricate the threads of the impeller screw.

      Always use a new screw.
   c) Fit the impeller to the shaft.
   d) Fit the impeller screw to the shaft.
   e) Tighten the impeller screw.

      Prevent the impeller from rotating.

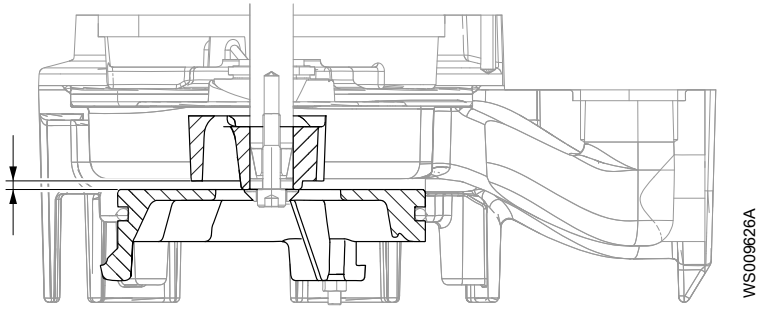
      For tightening torque, see *Torque values* on page 35 .
3. Install the suction cover:
   a) Fit the studs on the pump housing.

      Use Loctite™ 603 locking liquid to secure the studs.

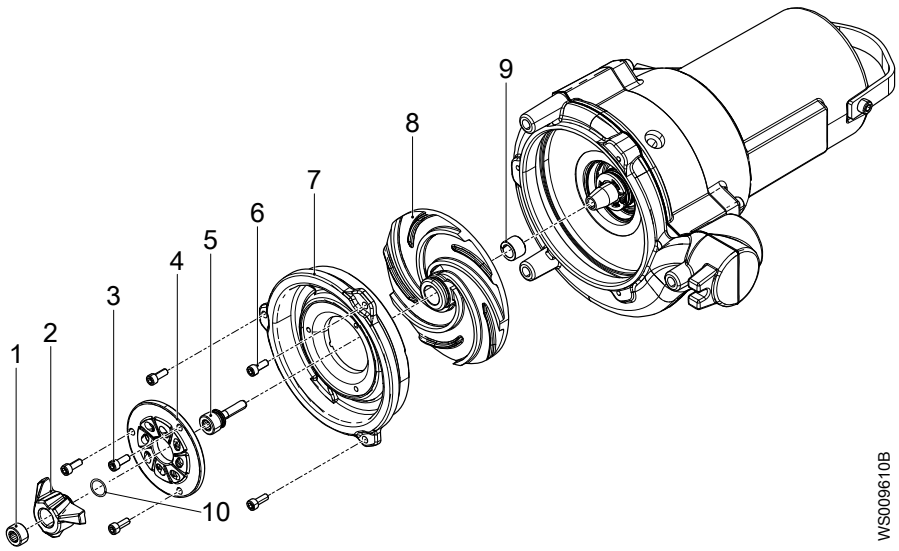


b) Fit the seal sleeves, the suction cover, and the nuts on the studs.
c) Tighten the nuts gradually until the suction cover touches the impeller.
Alternate between the nuts in a circular pattern.

4. Adjust the suction cover:
   a) Raise the pump to an upright position.
   b) Check that the impeller can rotate freely.
   If necessary, then loosen the nuts.
   c) Measure the clearance.
   Final clearance: 0.2–0.8 mm (0.008–0.03 in)



6.6 Replace the M-impeller and the cutting wheel



1. Set screw
2. Cutting wheel
3. Screws
4. Cutting ring
5. Adjustment screw
6. Screws
7. Suction cover
8. Impeller
9. Sleeve
10. Adjustment washer, plastic shim

6.6.1 Remove the cutting wheel

DANGER: Crush Hazard

Moving parts can entangle or crush. Always disconnect and lock out power before servicing to prevent unexpected startup. Failure to do so could result in death or serious injury.

CAUTION: Cutting Hazard

Worn parts can have sharp edges. Wear protective clothing.

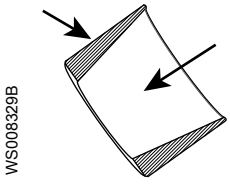
1. Prevent the cutting wheel from rotating, and remove the set screw.
2. Prevent the adjustment screw from rotating, and remove the cutting wheel from the adjustment screw.

6.6.2 Remove the M-impeller

1. Remove the screws and the cutting ring.
2. Remove the screws and the suction cover.
3. Remove the adjustment screw.
4. Remove the impeller and the sleeve.

6.6.3 Install the M-impeller

1. Prepare the shaft:
   a) Polish off any flaws with a fine emery cloth.
      The end of the shaft must be clean and free from burrs.
   b) Coat the inner conic and the outer cylindrical surfaces of the sleeve with a thin layer of grease.



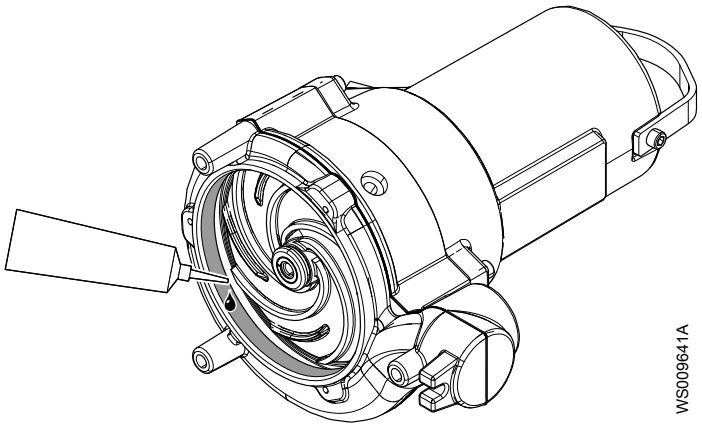
The proper lubrication is grease for bearings, for example Exxon Mobil Unirex N3, Mobil Mobilith SHC 220 or equivalent.

NOTICE:

Surplus grease can cause the impeller to become loose. Remove surplus grease from conical and/or cylindrical surfaces of shafts and/or sleeves.

2. Mount the impeller:
   a) Insert the sleeve into the impeller.
   b) Fit the impeller to the shaft.
   c) Coat the cylindrical surface of the pump housing with a thin layer of grease.

      The proper lubrication is grease for bearings, for example Exxon Mobil Unirex N3, Mobil Mobilith SHC 220 or equivalent.

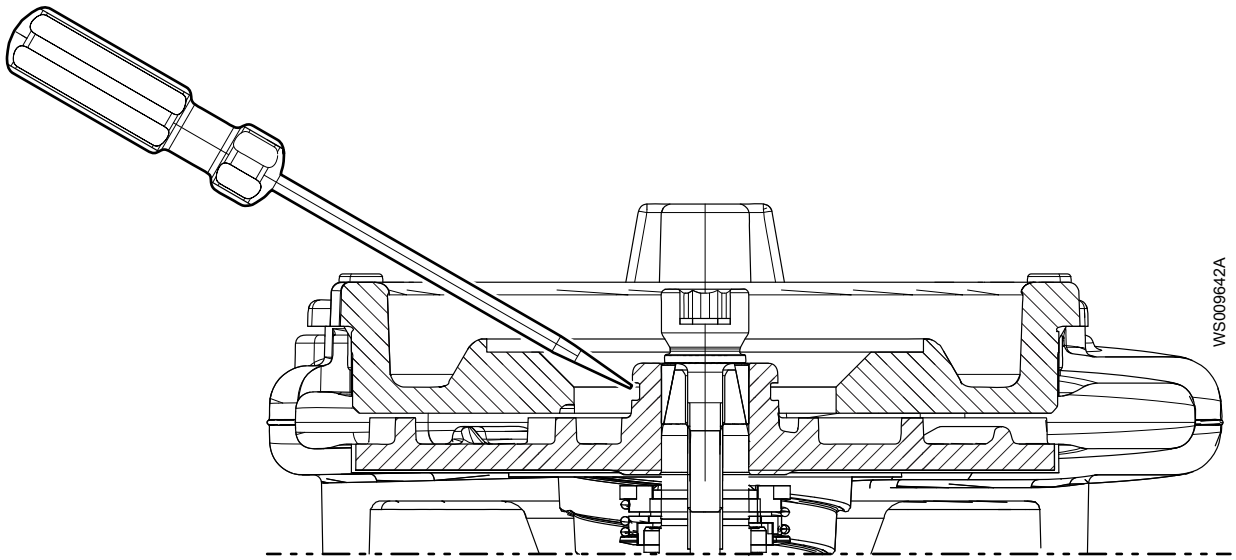


   d) Fit the suction cover and tighten the screws.
   e) Lubricate both threads of the adjustment screw.

      Always use a new screw.
   f) Fit the adjustment screw into the shaft.

      Do not tighten the screw.
   g) Adjust the impeller towards the suction cover until the parts touch.

      Use a screwdriver or similar in the groove of the impeller.

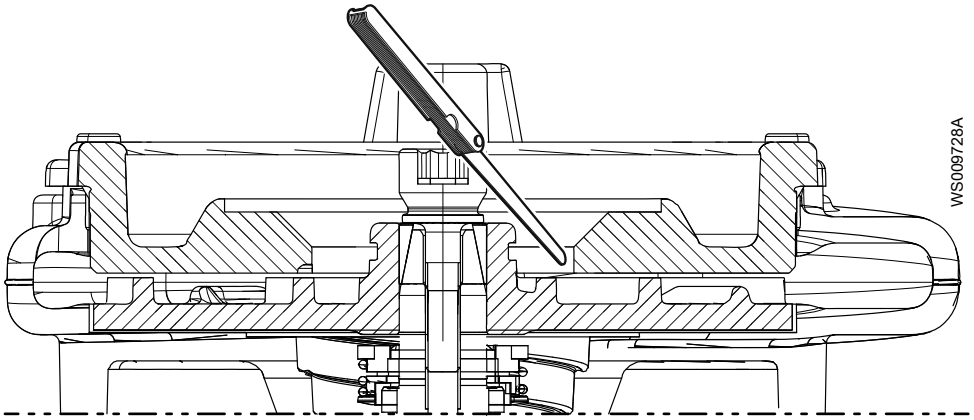


   h) Tighten the adjustment screw.

      Prevent the impeller from rotating.

      Tightening torque: 22 Nm (16 ft-lb)
   i) Tighten the screw a further 1/8 turn (45°).
   j) Check that the impeller can rotate freely.
3. Measure the clearance.

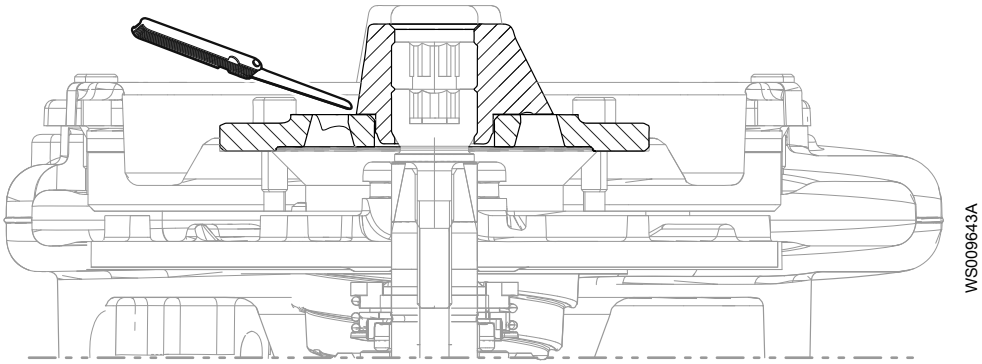
Final clearance: 0.1–0.5 mm (0.004–0.02 in)



4. Fit the cutting ring and tighten the screws.

6.6.4 Install the cutting wheel

1. Fit the plastic shim between the cutting ring and the cutting wheel.
   The 0.19 mm (0.007 in.) thick plastic shim is a spare part: Adjustment washer 811 62 50.
2. Fit the cutting wheel to the adjustment screw until the wheel touches the plastic shim.
3. Fit and tighten the set screw.
   Tightening torque: 55 Nm (41 ft-lb).
4. Make sure that the impeller and cutting wheel can rotate freely.
5. If the cutting wheel does not rotate freely, then adjust it:
   a) Prevent the cutting wheel from rotating, and loosen the set screw.
   b) To increase the clearance, prevent the adjustment screw from rotating and turn the cutting wheel counterclockwise.
   c) Make sure that the impeller and cutting wheel can rotate freely.
   d) Measure the distance between the cutting wheel and the cutting ring.
      Measure for every wing on the cutting wheel. The distance must be less than 0.25 mm (0.010 in) for at least one of the wings.
   e) When the clearance is correct, tighten the set screw.
      Tightening torque: 55 Nm (41 ft-lb).



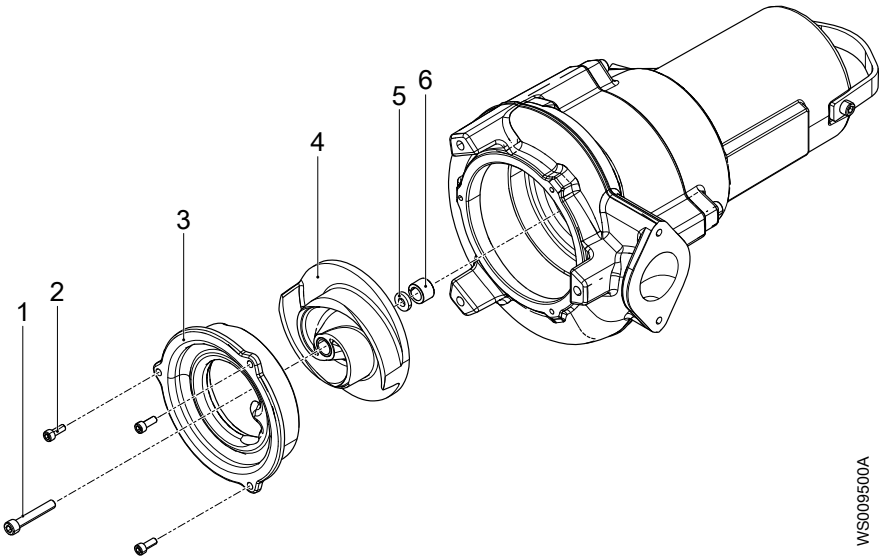
6.7 Replace the N-impeller

CAUTION: Cutting Hazard

Worn parts can have sharp edges. Wear protective clothing.

NOTICE:

When laying the pump on its side, do not allow the weight of the pump to rest on any portion of the impeller. The impeller must not be allowed to make contact with the concrete floor or other hard and rough surfaces.

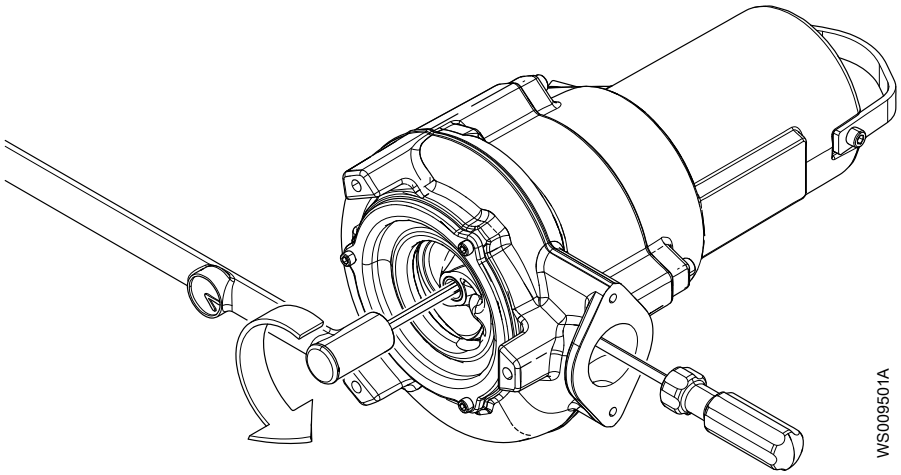


1. Impeller screw
2. Screws
3. Suction cover
4. Impeller
5. Supporting washer
6. Sleeve

6.7.1 Remove the N-impeller

1. Loosen the impeller screw.

   Prevent the impeller from rotating. Insert a screwdriver or similar through the pump housing outlet.



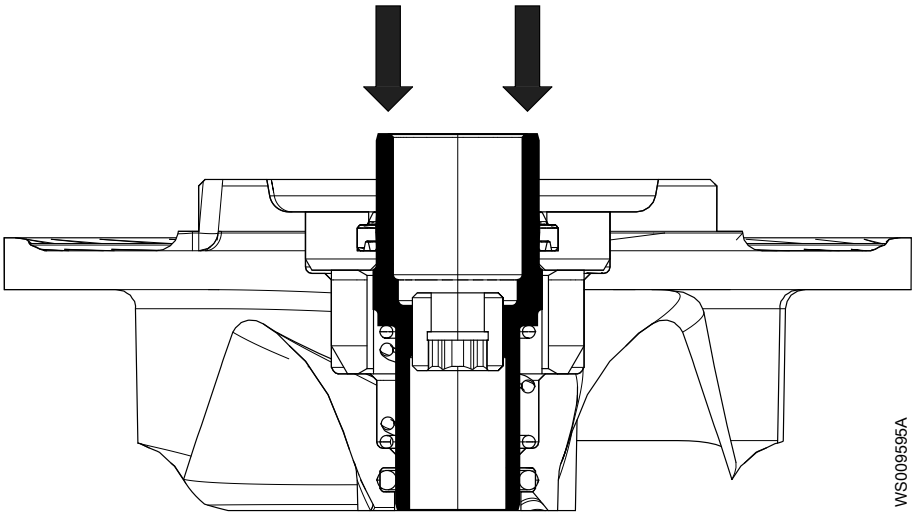
2. Remove and discard the impeller screw.
3. Remove the suction cover.

   If necessary, then pry off the suction cover.
4. Remove the impeller, the supporting washer, and the sleeve.

6.7.2 Install the N-impeller

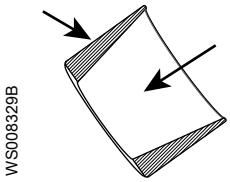
1. Before installation of the impeller, push the sleeve to check that it moves freely up and down.

When the sleeve is released, it must be fully pushed out again. If the sleeve does not move freely, or does not come fully out, then replace the impeller unit.



2. Prepare the shaft:
   a) Polish off any flaws with a fine emery cloth.

      The end of the shaft must be clean and free from burrs.
   b) Coat the inner conic and the outer cylindrical surfaces of the sleeve with a thin layer of grease.



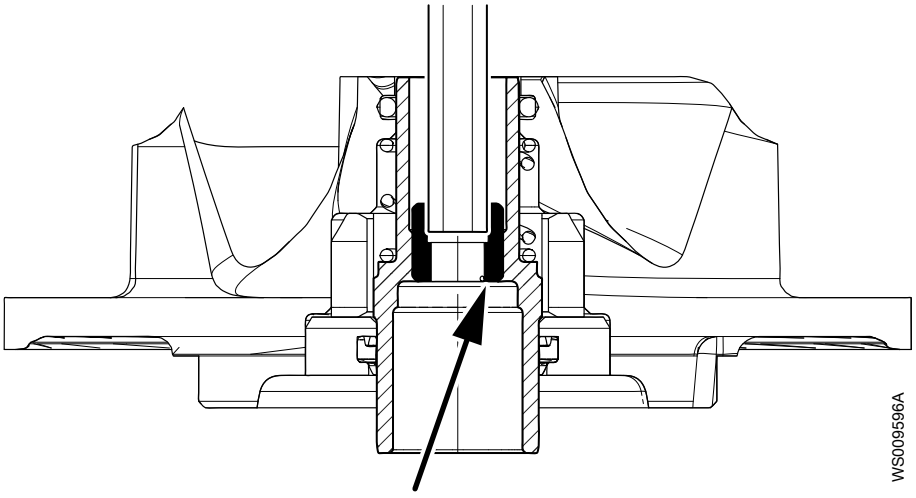
      The proper lubrication is grease for bearings, for example Exxon Mobil Unirex N3, Mobil Mobilith SHC 220 or equivalent.

      NOTICE:

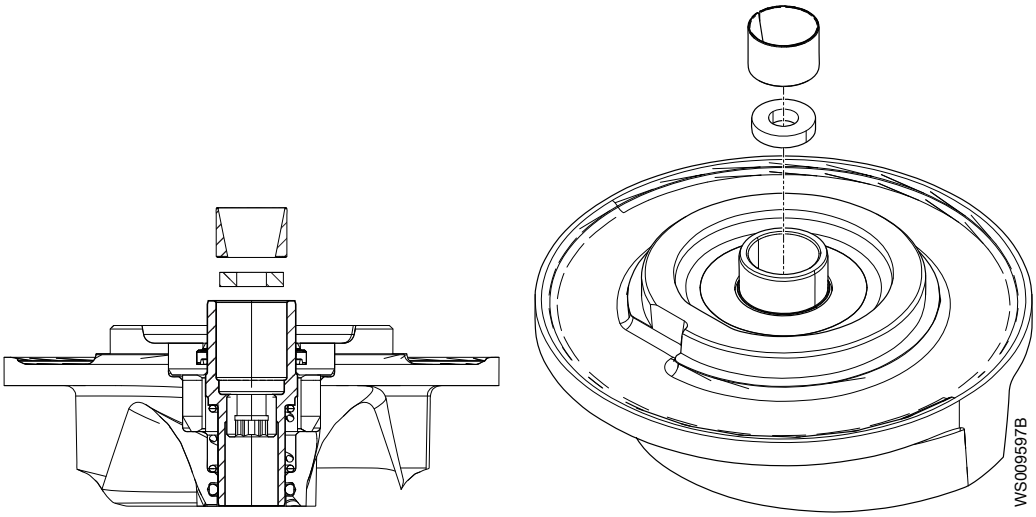
      Surplus grease can cause the impeller to become loose. Remove surplus grease from conical and/or cylindrical surfaces of shafts and/or sleeves.

3. Mount the impeller:
   a) Lubricate the threads of the impeller screw.

      Always use a new screw.
   b) Adjust the adjustment screw so that it is flush in the sleeve.

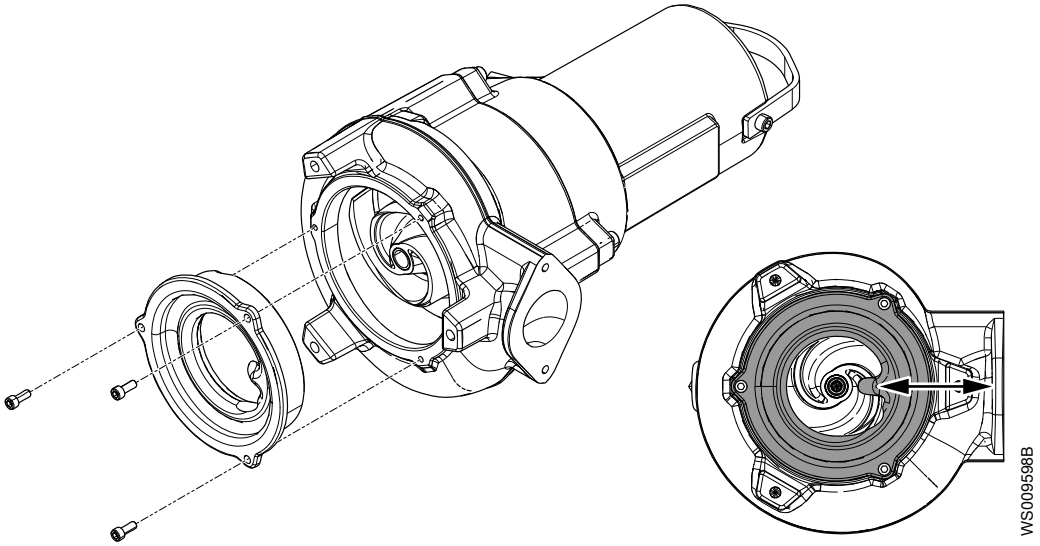


c) Insert the supporting washer and the sleeve into the impeller.



d) Fit the arrangement onto the shaft.

4. Fit the suction cover and tighten the screws.
   Point the guide pin towards the outlet.

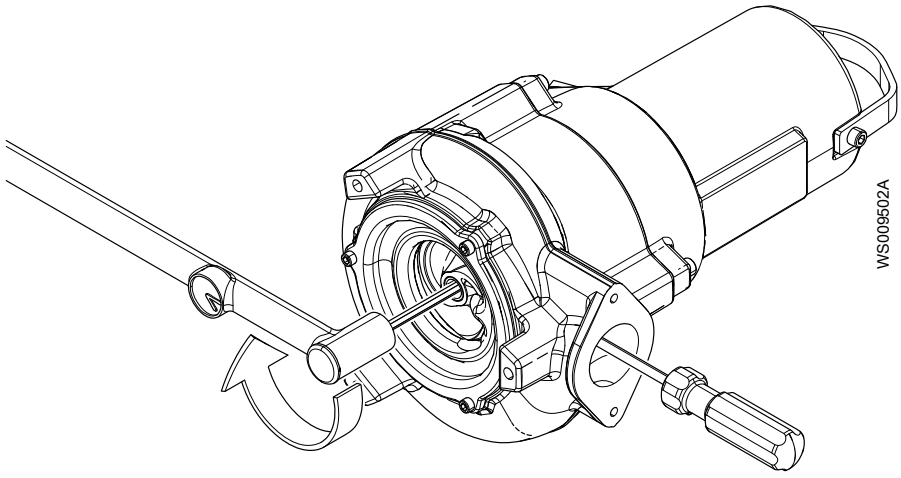


5. Check that the impeller can rotate freely.

WARNING: Crush Hazard

Beware of the pinch point hazard between the rotating impeller and the guide pin.

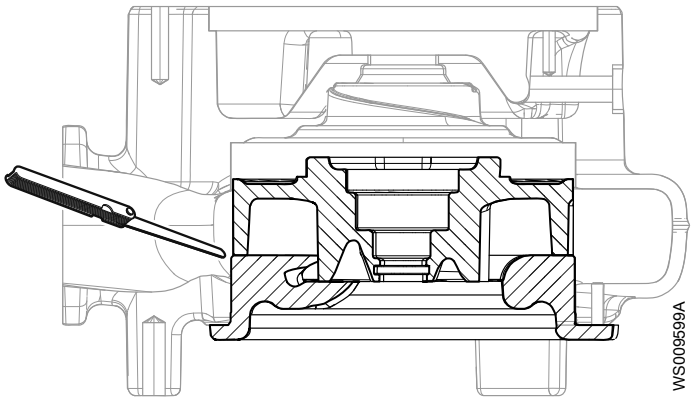
6. Adjust the impeller:
   a) Turn the adjustment screw clockwise until the impeller touches the pump housing.
7. Fasten the impeller:
   a) Fit the lubricated impeller screw.
   b) Tighten the impeller screw.
      For tightening torque, see *Torque values* on page 35 .
      Prevent the impeller from rotating. Insert a screwdriver or similar through the pump housing outlet.



c) Tighten the screw a further 1/8 turn (45°).
d) Check that the impeller can rotate freely.
e) Check that the impeller moves freely up and down by pushing on it.

   When the sleeve is released, it should be fully pushed out again. If the sleeve does not move freely, or does not come fully out, then replace the impeller unit.

8. Check with a feeler gauge that the impeller clearance is 0.1 – 0.6 mm (0.004–0.02 in).



7 Troubleshooting

Introduction

DANGER: Electrical Hazard

Troubleshooting a live control panel exposes personnel to hazardous voltages. Electrical troubleshooting must be done by a qualified electrician.

Follow these guidelines when troubleshooting:

- Disconnect and lock out the power supply except when conducting checks that require voltage.
- Make sure that no one is near the unit when the power supply is reconnected.
- When troubleshooting electrical equipment, use the following:
  - Universal instrument multimeter
  - Test lamp (continuity tester)
  - Wiring diagram

7.1 The pump does not start

DANGER: Crush Hazard

Moving parts can entangle or crush. Always disconnect and lock out power before servicing to prevent unexpected startup. Failure to do so could result in death or serious injury.

NOTICE:

Do NOT override the motor protection repeatedly if it has tripped. Doing so may result in equipment damage.

Cause	Remedy
An alarm signal has been triggered on the control panel.	Check that: • The impeller rotates freely. • The sensor indicators do not indicate an alarm. • The overload protection is not tripped.
The pump does not start automatically, but can be started manually.	Check that: • The start level regulator is functioning. Clean or replace if necessary. • All connections are intact. • The relay and contactor coils are intact. • The control switch (Man/Auto) makes contact in both positions. Check the control circuit and functions.

Cause	Remedy
The installation is not receiving voltage.	Check that: • The main power switch is on. • There is control voltage to the start equipment. • The fuses are intact. • There is voltage in all phases of the supply line. • All fuses have power and that they are securely fastened to the fuse holders. • The overload protection is not tripped. • The motor cable is not damaged.
The impeller is stuck.	Clean: • The impeller • The sump in order to prevent the impeller from clogging again.

If the problem persists, then contact a sales or authorized service representative.

Always state the serial number of the product, see *Product Description* on page 10 .

7.2 The pump does not stop when a level sensor is used

DANGER: Crush Hazard

Moving parts can entangle or crush. Always disconnect and lock out power before servicing to prevent unexpected startup. Failure to do so could result in death or serious injury.

Cause	Remedy
The pump is unable to empty the sump to the stop level.	Check that: • There are no leaks from the piping and/or discharge connection. • The impeller is not clogged. • The non-return valve(s) are functioning properly. • The pump has adequate capacity. For information: Contact a sales or authorized service representative.
There is a malfunction in the level-sensing equipment.	• Clean the level regulators. • Check the functioning of the level regulators. • Check the contactor and the control circuit. • Replace all defective items.
The stop level is set too low.	Raise the stop level.

If the problem persists, then contact a sales or authorized service representative.

Always state the serial number of the product, see *Product Description* on page 10 .

7.3 The pump starts-stops-starts in rapid sequence

Cause	Remedy
The pump starts due to back-flow which fills the sump to the start level again.	Check that: • The distance between the start and stop levels is sufficient. • The non-return valve(s) work(s) properly. • The length of the discharge pipe between the pump and the first non-return valve is sufficiently short.
The self-holding function of the contactor malfunctions.	Check: • The contactor connections. • The voltage in the control circuit in relation to the rated voltages on the coil. • The functioning of the stop-level regulator. • Whether the voltage drop in the line at the starting surge causes the contactor's self-holding malfunction.

If the problem persists, then contact a sales or authorized service representative.

Always state the serial number of the product, see *Product Description* on page 10 .

7.4 The pump runs but the motor protection trips

DANGER: Crush Hazard

Moving parts can entangle or crush. Always disconnect and lock out power before servicing to prevent unexpected startup. Failure to do so could result in death or serious injury.

NOTICE:

Do NOT override the motor protection repeatedly if it has tripped. Doing so may result in equipment damage.

Cause	Remedy
The motor protection is set too low.	Set the motor protection according to the data plate and if applicable the cable chart.
The impeller is difficult to rotate by hand.	• Clean the impeller. • Clean out the sump. • Check that the impeller is properly trimmed.
The drive unit is not receiving full voltage on all three phases.	• Check the fuses. Replace fuses that have tripped. • If the fuses are intact, then notify a certified electrician.
The phase currents vary, or they are too high.	Contact a sales or authorized service representative.

Cause	Remedy
The insulation between the phases and ground in the stator is defective.	1. Use an insulation tester. With a 1000 V DC megger, check that the insulation between the phases and between any phase and ground is > 5 megaohms. 2. If the insulation is less, then do the following: Contact a sales or authorized service representative.
The density of the pumped fluid is too high.	Make sure that the maximum density is 1100 kg/m3 (9.2 lb/US gal) • Change to a more suitable pump • Contact a sales or authorized service representative.
There is a malfunction in the overload protection.	Replace the overload protection.

If the problem persists, then contact a sales or authorized service representative.

Always state the serial number of the product, see *Product Description* on page 10 .

7.5 The pump delivers too little or no water

DANGER: Crush Hazard

Moving parts can entangle or crush. Always disconnect and lock out power before servicing to prevent unexpected startup. Failure to do so could result in death or serious injury.

NOTICE:

Do NOT override the motor protection repeatedly if it has tripped. Doing so may result in equipment damage.

Cause	Remedy
The impeller rotates in the wrong direction.	• If it is a 3-phase pump, then transpose two phase leads. • If it is a 1-phase pump, then do the following: Contact a sales or authorized service representative.
One or more of the valves are set in the wrong positions.	• Reset the valves that are set in the wrong position. • Replace the valves, if necessary. • Check that all valves are correctly installed according to media flow. • Check that all valves open correctly.
The impeller is difficult to rotate by hand.	• Clean the impeller. • Clean out the sump. • Check that the impeller is properly trimmed.
The pipes are obstructed.	To ensure a free flow, clean out the pipes.
The pipes and joints leak.	Find the leaks and seal them.
There are signs of wear on the impeller, pump, and casing.	Replace the worn parts.

Cause	Remedy
The liquid level is too low.	• Check that the level sensor is set correctly. • Depending on the installation type, add a means for priming the pump, such as a foot valve.

If the problem persists, then contact a sales or authorized service representative.
Always state the serial number of the product, see *Product Description* on page 10 .

8 Technical Reference

8.1 Motor data

Feature	Description
Motor type	Squirrel-cage induction motor
Frequency	50 Hz or 60 Hz
Supply	1-phase or 3-phase
Starting method	• Direct on-line • Star-delta • Soft starter
Maximum starts per hour	15 evenly-spaced starts per hour
Code compliance	IEC 60034-1
Voltage variation without overheating	±10%, if it does not run continuously at full load
Voltage imbalance tolerance	2%
Stator insulation class	F (155°C [311°F])

Motor encapsulation

Motor encapsulation is in accordance with IP68.

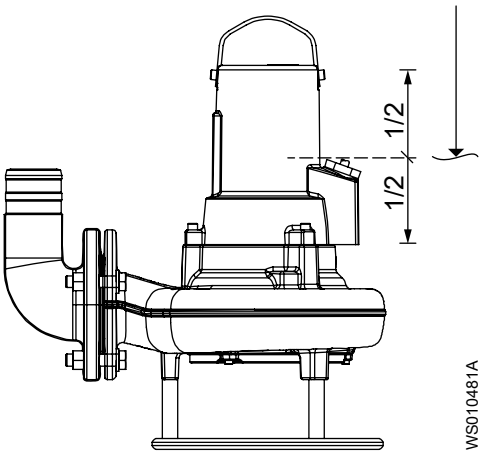
8.2 Application limits

Data	Description
Liquid temperature	Maximum 40°C (104°F) Warm-liquid version: 70°C (158°F) maximum Ex-approved pumps: 40°C (104°F) maximum The pump can be operated at full load only if at least half the stator housing is submerged.
Liquid density	1100 kg/m³ (9.2 lb per US gal) maximum
pH of the pumped media	5.5–14
Depth of immersion	Maximum 20 m (65 ft)
Other	For the specific weight, current, voltage, power ratings, and speed of the pump, see the data plate of the pump.

8.3 Minimum permitted liquid level

In hazardous areas, this information is critical for the safety of the installation of this product.

This pump can be partly submerged during operation, but it must be submerged to half the drive unit length.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Xylem |'zīləm|

1) The tissue in plants that brings water upward from the roots;
2) a leading global water technology company.

We're a global team unified in a common purpose: creating advanced technology solutions to the world's water challenges. Developing new technologies that will improve the way water is used, conserved, and re-used in the future is central to our work. Our products and services move, treat, analyze, monitor and return water to the environment, in public utility, industrial, residential and commercial building services, and agricultural settings. With its October 2016 acquisition of Sensus, Xylem added smart metering, network technologies and advanced data analytics for water, gas and electric utilities to its portfolio of solutions. In more than 150 countries, we have strong, long-standing relationships with customers who know us for our powerful combination of leading product brands and applications expertise with a strong focus on developing comprehensive, sustainable solutions.

For more information on how Xylem can help you, go to www.xylem.com

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Visit our Web site for the latest version of this document and more information

The original instruction is in English. All non-English instructions are translations of the original instruction.

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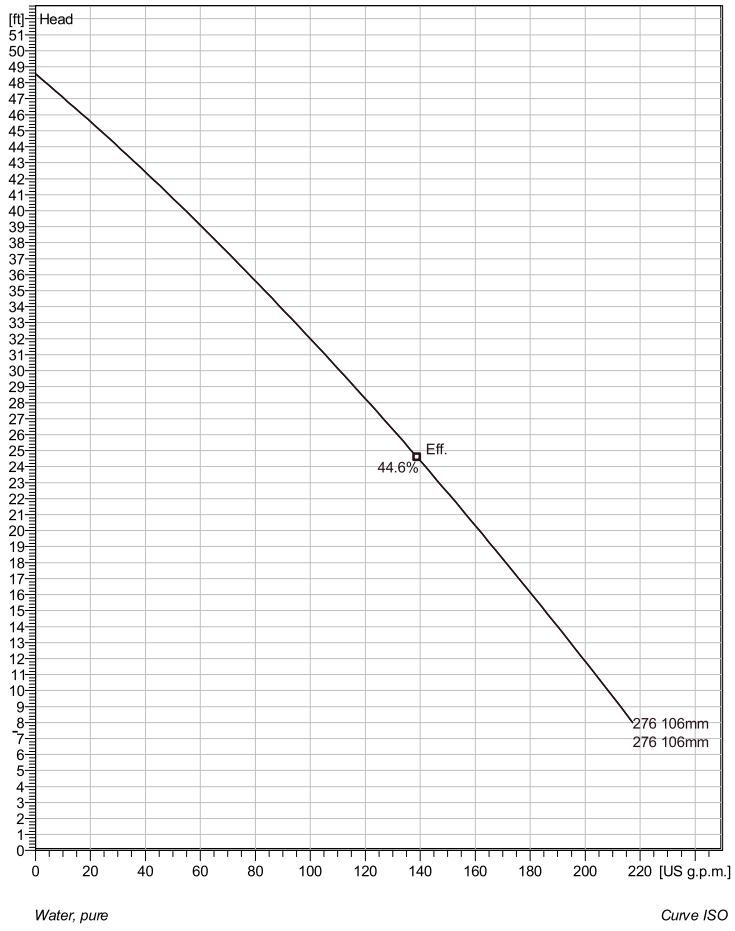
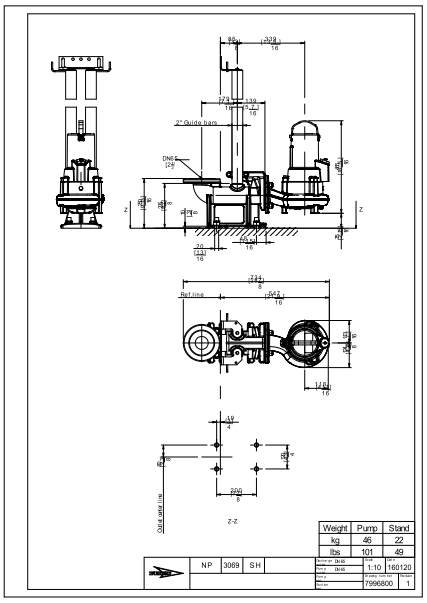
Technical specification



Note: Picture might not correspond to the current configuration.

Installation: P - Semi permanent, Wet



General

Patented self cleaning semi-open channel impeller, ideal for pumping in waste water applications. Possible to be upgraded with Guide-pin® for even better clogging resistance. Modular based design with high adaptation grade.

Impeller

Impeller material	Hard-Iron ™
Discharge Flange Diameter	2 9/16 inch
Suction Flange Diameter	3 15/16 inch
Impeller diameter	106 mm
Number of blades	2

Motor

Motor #	N3069.060 13-10-2BZ-W 2.3hp Standard
Stator variant	3
Frequency	60 Hz
Rated voltage	230 V
Number of poles	2
Phases	1~
Rated power	2.3 hp
Rated current	10 A
Starting current	35 A
Rated speed	3320 rpm
Power factor	
1/1 Load	0.97
3/4 Load	0.97
1/2 Load	0.96
Motor efficiency	
1/1 Load	74.7 %
3/4 Load	76.3 %
1/2 Load	73.5 %

Configuration

Project	Project ID	Created by	Created on	Last update
			4/24/2018	

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Performance curve

Pump

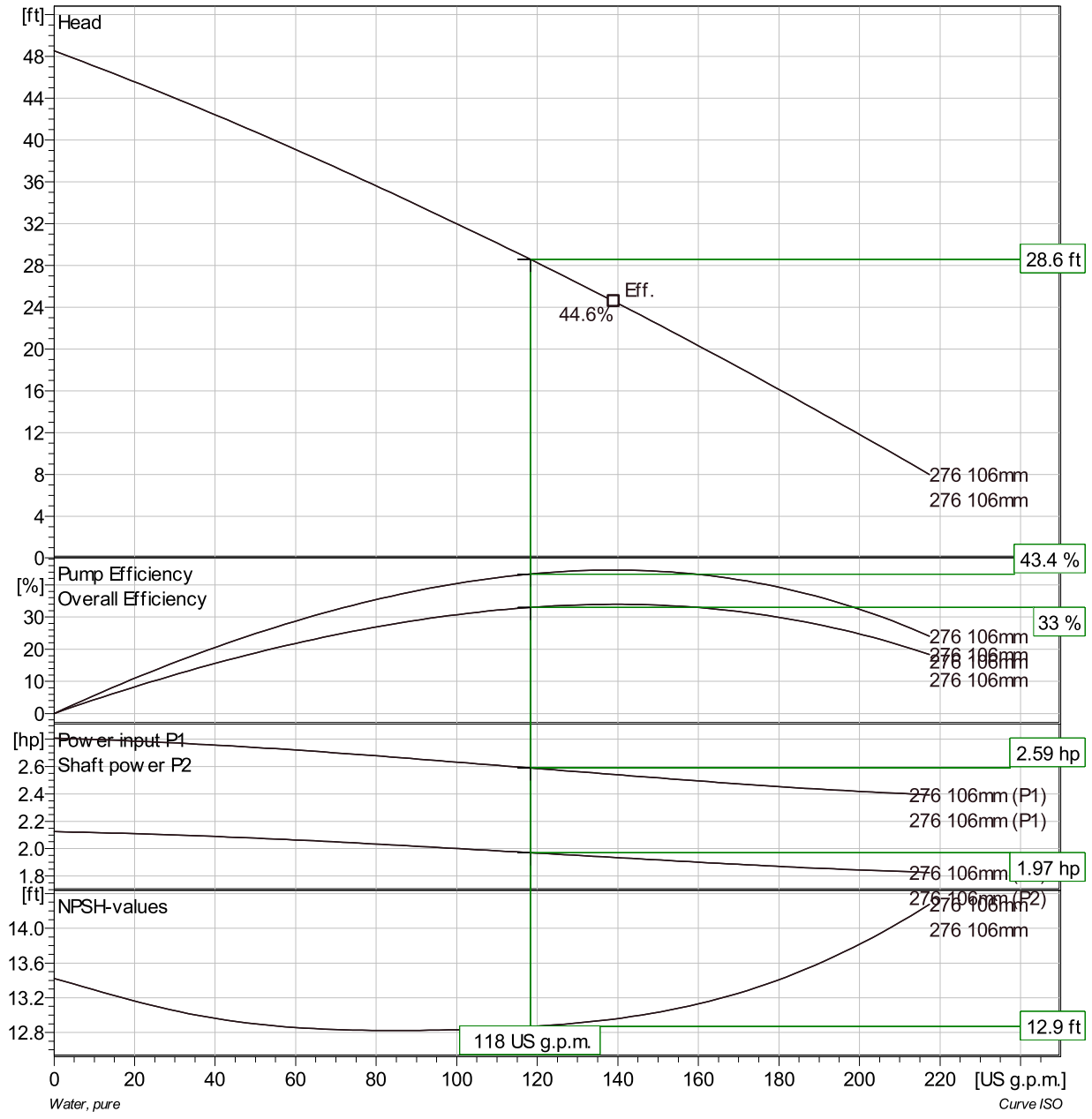
Discharge Flange Diameter	2 9/16 inch
Suction Flange Diameter	100 mm
Impeller diameter	$4^{3}/_{16}$"
Number of blades	2

Motor

Motor #	N3069.060 13-10-2BZ-W 2.3hp
Stator variant	3
Frequency	60 Hz
Rated voltage	230 V
Number of poles	2
Phases	1~
Rated power	2.3 hp
Rated current	10 A
Starting current	35 A
Rated speed	3320 rpm

Power factor	
1/1 Load	0.97
3/4 Load	0.97
1/2 Load	0.96

Motor efficiency	
1/1 Load	74.7 %
3/4 Load	76.3 %
1/2 Load	73.5 %



Duty point		Guarantee
Flow	Head	
120 US g.p.m.	29 ft	No

Project	Project ID	Created by	Created on	Last update
			4/24/2018	

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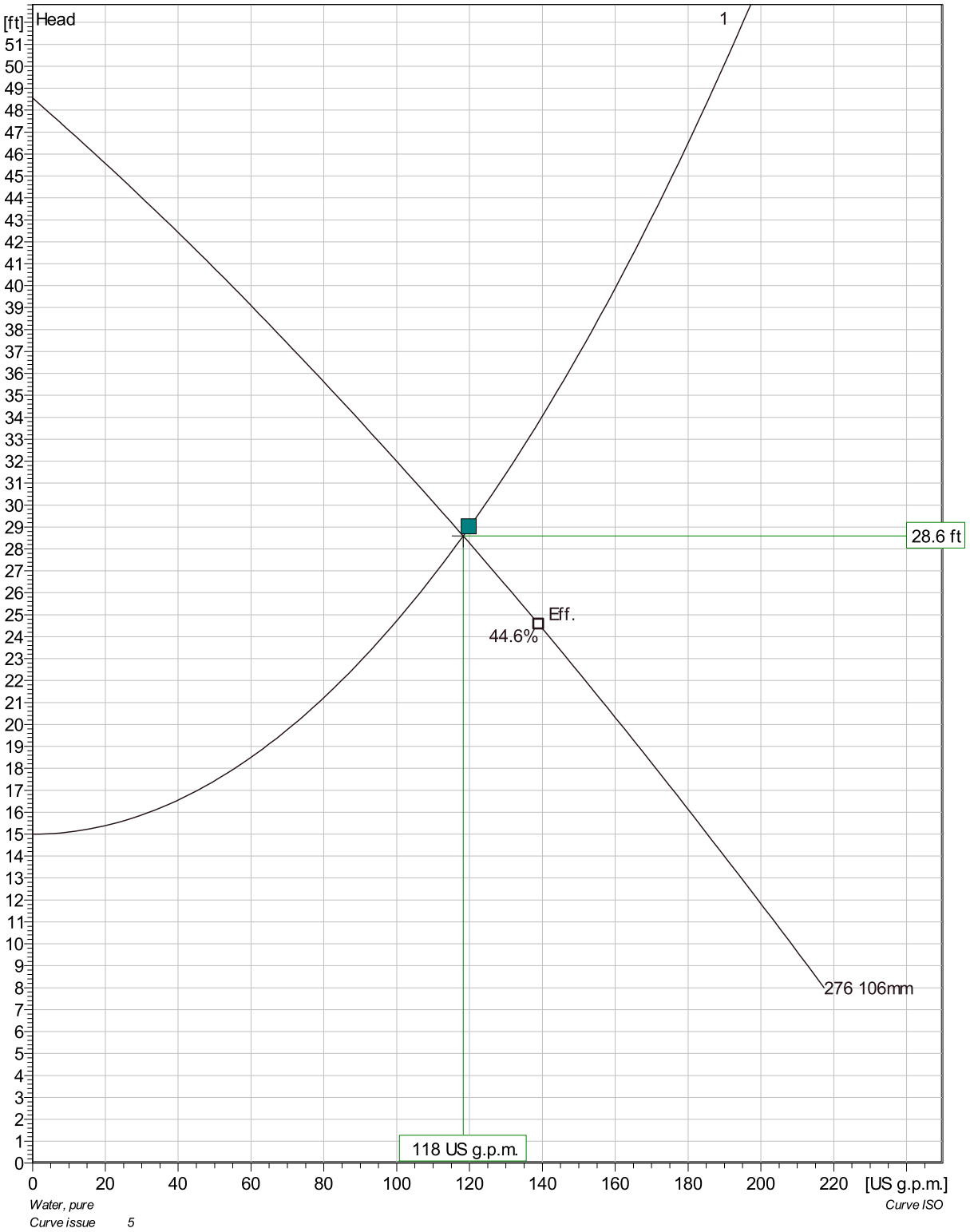
Duty Analysis

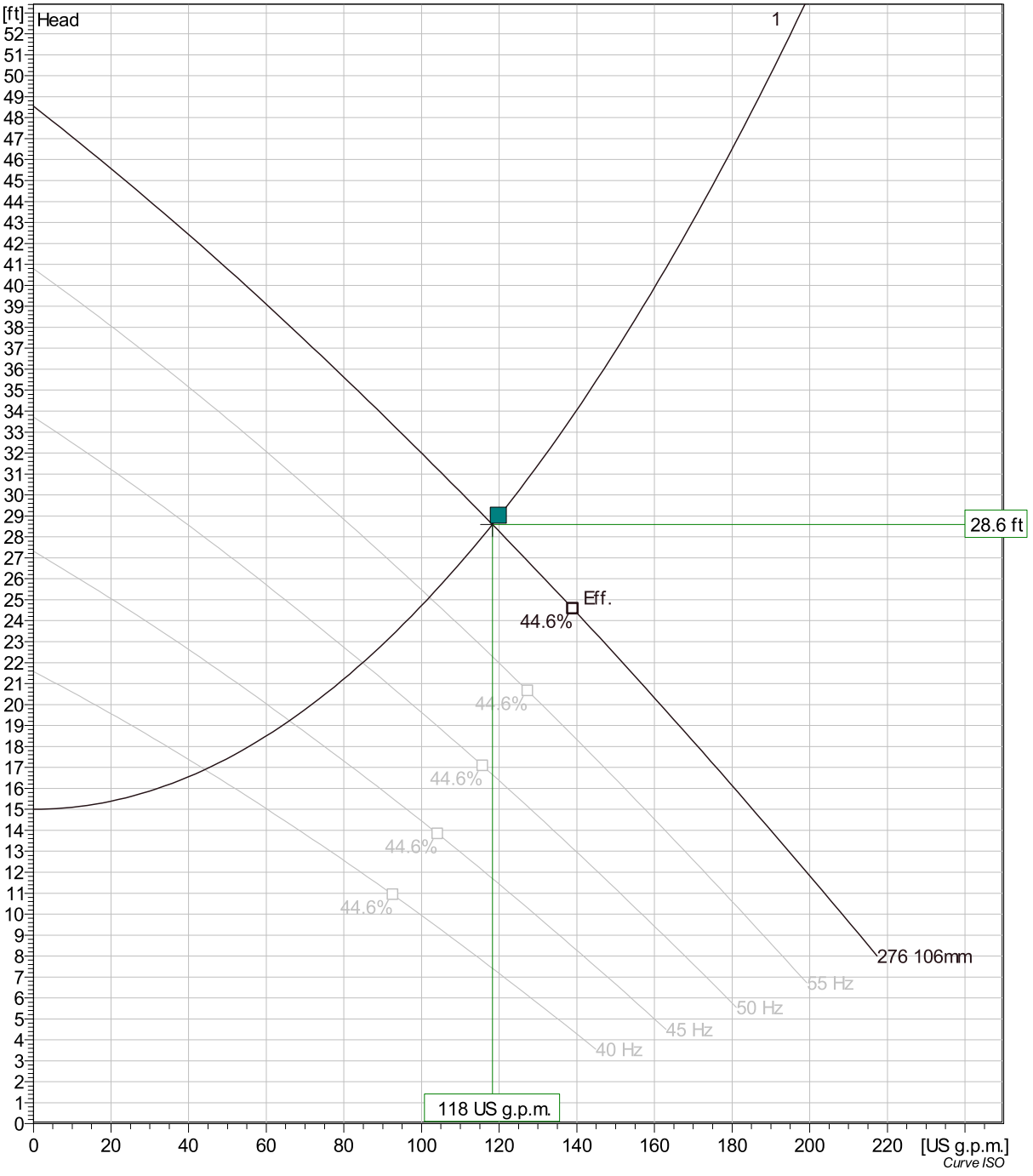


Pumps running /System	Individual pump			Total					
	Flow	Head	Shaft power	Flow	Head	Shaft power	Pump eff.	Specific energy	NPSHre
1	118 US g.p.m.	28.6 ft	1.97 hp	118 US g.p.m.	28.6 ft	1.97 hp	43.4 %	272 kWh/US MG	12.9 ft

Project	Project ID	Created by	Created on	Last update
			4/24/2018	

NP 3069 SH 1~ Adaptive 276

VFD Analysis



Pumps running /System	Frequency	Flow	Head	Shaft power	Flow	Head	Shaft power	Hyd eff.	Specific energy	NPSHre
1	60 Hz	118 US g.p.m.	28.6 ft	1.97 hp	118 US g.p.m.	28.6 ft	1.97 hp	43.4 %	272 kWh/US MG	12.9 ft
1	55 Hz	102 US g.p.m.	25.1 ft	1.53 hp	102 US g.p.m.	25.1 ft	1.53 hp	42.5 %	245 kWh/US MG	11.2 ft
1	50 Hz	84.8 US g.p.m.	22 ft	1.16 hp	84.8 US g.p.m.	22 ft	1.16 hp	40.8 %	230 kWh/US MG	9.59 ft
1	45 Hz	66 US g.p.m.	19.2 ft	0.853 hp	66 US g.p.m.	19.2 ft	0.853 hp	37.6 %	233 kWh/US MG	8.09 ft
1	40 Hz	44.2 US g.p.m.	16.9 ft	0.609 hp	44.2 US g.p.m.	16.9 ft	0.609 hp	31 %	277 kWh/US MG	6.71 ft

Project	Project ID	Created by	Created on	Last update
			4/24/2018	

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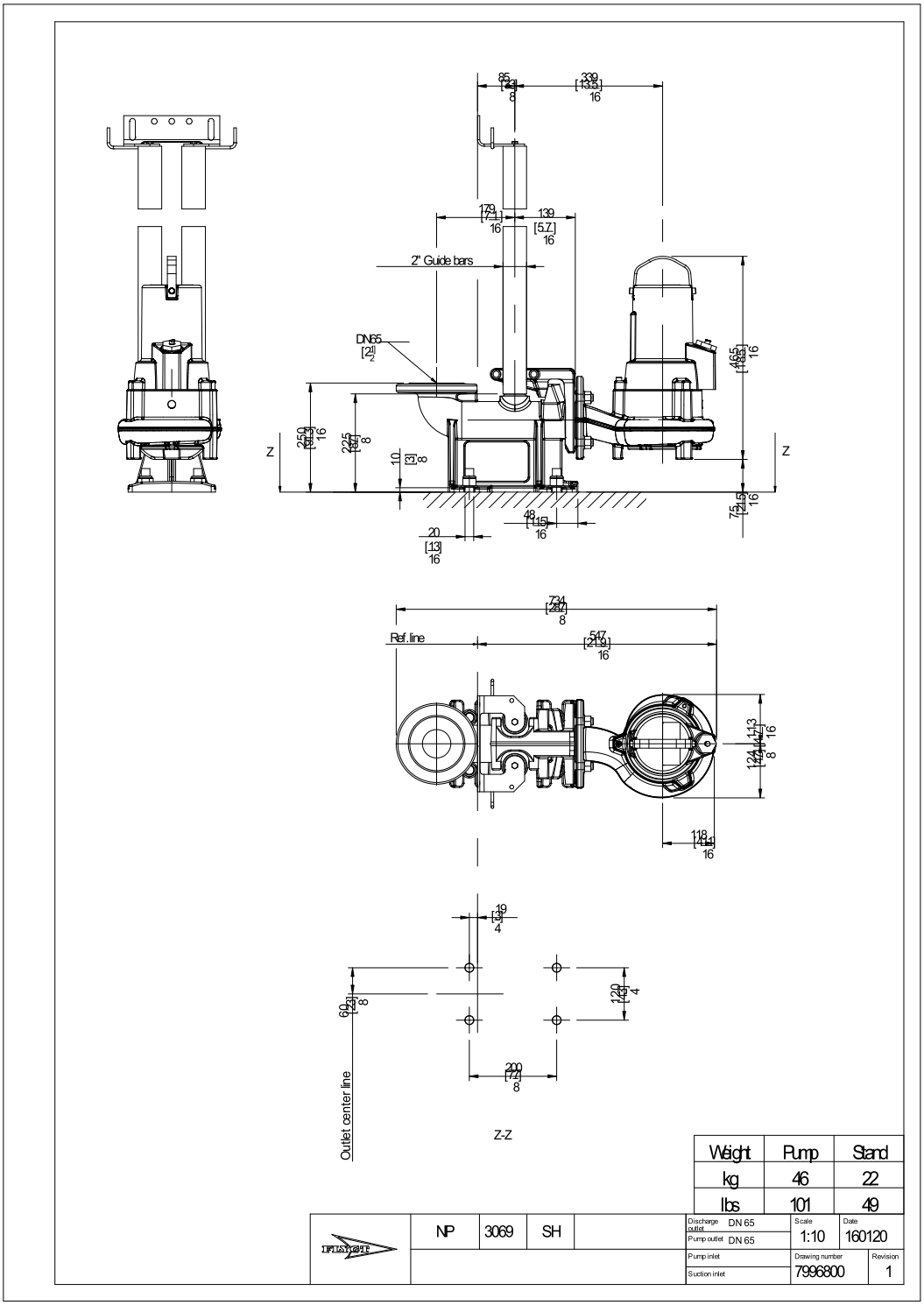
Dimensional drawing



Project	Project ID	Created by	Created on	Last update
			4/24/2018	

PART 3

World Water Works Operation and Maintenance Manual

World water works

Clean Water and Energy from Wastewater

Moving Bed Biofilm Reactor (MBBR)
Installation, Operation, and Maintenance Manual

Submittal Cover Sheet

CUSTOMER: Oceanic Companies
PROJECT: Heeia Kea Boat Harbor HI

Contract Number:	23-880-2
Installation Contractor:	Oceanic Companies
Supplier:	World Water Works
Manufacturer:	World Water Works
Submittal Identification:	MBBR
Date of Submission:	
Date of Previous Submission:	N/A
Section:	11400
Submittal Item:	MBBR Package Plant IOM Manual

1-800-607-PURE | 4000 SW 113TH STREET, OKLAHOMA CITY, OK 73173 | WWW.WORLDWATERWORKS.COM

PROJECT OWNER AND LOCATION

HEEIA KEA SMALL BOAT HARBOR WWTR IMPROVEMENT

PROJECT # 23-053

INSTALLATION CONTRACTOR

OCEANIC COMPANIES, INC.

P.O. BOX 700669

KAPOLEI, HAWAII 96709

PHONE: (808) 682-0113

SYSTEM SUPPLIER

World Water Works, Inc.

4061 NW 3rd Street

Oklahoma City, OK 73107

Phone: 1-800-607-PURE

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1. PREFACE

This manual covers the World Water Works' Ideal MBBR™ (Moving Bed Biofilm Reactor) system. The MBBR process is a state-of-the-art fixed-film (or attached growth) biological process used for wastewater treatment both municipally and industrially for Biological/Biochemical Oxygen Demand (BOD) removal, nitrification, and denitrification. The process provides the smallest footprint biological system, which is tolerant in both load swings and temporary load deprivation.

This manual has been developed to provide the operator with a conceptual background of biological treatment, a general overview of the system operation controls and procedures, list of components, and an avenue to responsive customer service.

2. SAFETY

Operators of this equipment should follow all local safety requirements

To ensure maximum safety, it is important that all operators of the World Water Works' Treatment systems read and understands the contents of the manual before any equipment is operated. Special attention to paid to all caution or warning labels or symbols placed on the equipment. Failure to comply with the instructions can result in damage to the system or personal injury

The safety requirements mentioned in this manual are not intended to cover all warnings or hazards. Additional site specific safety reviews and procedures may be needed.

Review all individual equipment manuals thoroughly before attempting to install, operate or maintain this system. Only trained operators should attempt to operate or maintain this system.

3. GLOSSARY OF TERMS

To understand the Moving Bed Biofilm Reactor (MBBR) process, it is good to have an understanding of traditional biological wastewater treatment processes.

Glossary of Terms:

AOB	Ammonia oxidizing bacteria
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
Degree C (°C)	Degree Celsius
DO	Dissolved Oxygen
ft^2/ft^3	Square feet surface area per cubic feet volume of media
Ft^3	cubic feet volume
Degree F (°F)	Degree Fahrenheit
HDPE	High Density Polyethylene
IFAS	Integrated Fixed Film Activated Sludge
IR	Internal Recycle
m^2/m^3	Square meters surface area per cubic meter volume of media
M^3	cubic meter volume
MBBR	Moving Bed Biofilm Reactor
Mgallons	Million Gallons
MGD	Million Gallons per Day
MLSS	Mixed Liquor Activated Sludge
N_2	Di-nitrogen gas
NH_3-N	Ammonia-nitrogen
NO_2-N	Nitrite-nitrogen
NO_3-N	Nitrate-nitrogen
NOB	Nitrite oxidizing bacteria
O_2	Oxygen
P	Phosphorus
PAO	Phosphate accumulating organisms
PO_4-P	Ortho-Phosphate
RAS	Return Activated Sludge
SRT	Solids Retention Time
SWD	Side Water Depth
Temp	Temperature
TKN	Total Kjeldahl Nitrogen
TSS	Total Suspended Solids
VSS	Volatile Suspended Solids
WAS	Waste Activated Sludge

4. MBBR FUNCTIONAL DESCRIPTION

The Moving Bed Biofilm Reactor (MBBR) process is a state-of-the-art fixed-film (or attached growth) biological process used for wastewater treatment both municipally and industrially for BOD removal, nitrification, and denitrification.

A MBBR reactor consists of a tank with submerged but floating plastic usually High Density Polyethylene (HDPE) media having specific gravity less than 1.0. The large surface area of the media provides for abundant surface for bacterial growth. Biomass grows on the surface as a thin film whose thickness usually varies between 50-300 microns. World Water Works (WWW) medium bubble aeration diffusers uniformly placed at the bottom of the reactor maintains a dissolved oxygen (DO) concentration of > 2.5-3.0 mg/L for BOD removal. Higher DO concentrations are maintained for nitrification. To retain the media flowing out of the tank, screens are placed on the downstream walls.

FIGURE 1 - Variety of MBBR Treatment Schemes, shows a schematic of the MBBR processes for BOD removal, nitrification and denitrification.

Unlike in conventional activated sludge systems, NO sludge recycle is required for the MBBR process.

For denitrification, anoxic MBBR tanks are used. The anoxic tank is similar to the aerobic MBBR tank described above except that no oxygen is supplied. The tank contains no diffusers and the media is kept in suspension in the reactor utilizing side mounted submersible mixers. Other features, such as the media retention screen, are the same type (wedgewire or perforated plate) as aerobic reactor although the design is flat vs circular.

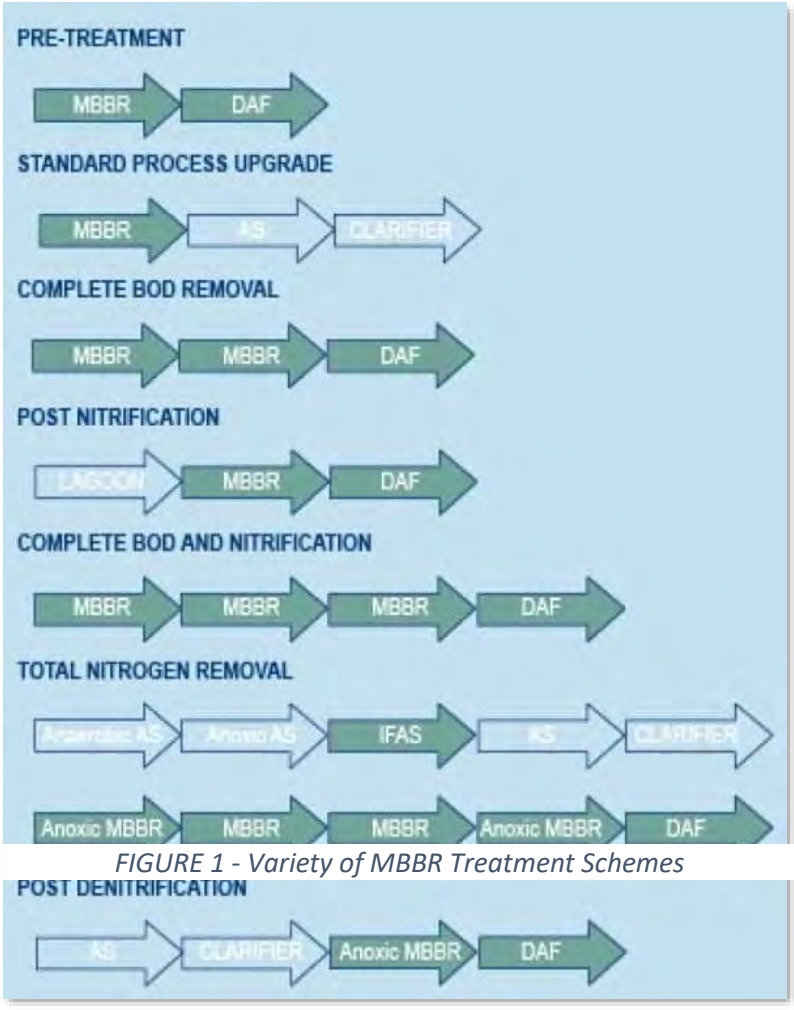


FIGURE 1 - Variety of MBBR Treatment Schemes

Wastewater enters the MBBR where the biomass attached to the surface of the media degrades organic matter resulting in BOD removal. Organic carbon is converted to carbon dioxide and excess biomass. Oxygen required for the process is provided through the WWW medium bubble aeration diffusers installed at the bottom of the reactor. The treated wastewater and excess solids generated and sloughed biomass then flow through the media retention screens to the downstream clarifier where the biomass and solids are separated from the wastewater. A final Disc Filter is used to remove any remaining TSS from the clarifier prior to discharge from the system.

There are more than a thousand MBBR installations worldwide. MBBR technology can be used for wastewater treatment for the following industries: food and beverage plants, steel mills, oil refineries, petrochemicals, chemical plants, paper mills and any industries requiring wastewater treatment for BOD removal, nitrification and denitrification.

MBBR technology has become the preferred biological treatment technology because it offers several advantages over the traditional Activated Sludge Process. One of the sweet spots for the MBBR technology is in its use as a roughing reactor placed before activated sludge process for high BOD wastewaters. The MBBR reactor shaves off 60-80% BOD and reduces the load to downstream activated sludge process significantly resulting in a very efficient treatment with a lower footprint. Some of the key features of MBBR process are provided below:

1. Robust – It is stable under load variations, insensitive to temporary limitation and provides consistent treatment results.
2. Efficient – It generates low solids and requires no or minimum polymer for solid/liquid separation.
3. Compact – It requires a small footprint. Typically, it requires one-third the space required for Activated Sludge Process.
4. Cost – It requires a low capital cost and is comparable to cost of Activated Sludge Process. It is cheaper than the Membrane Bio Reactor (MBR) process.
5. Flexible – Existing plants can be upgraded easily with MBBR. New MBBR plants can be upgraded to handle higher loads with no or minimum cost and construction.
6. Trouble Free – It is easy to operate, has automatic sludge wasting, has no sludge Return and no Mixed Liquor Activated Sludge (MLSS), and there no issue of media clogging.

World Water Works is a leader in MBBR technology and has installed numerous wastewater treatment plants using MBBR technology. World Water Works specializes in the combination of Moving Bed Biofilm Reactor technology and Dissolved Air Flotation technology for advanced wastewater treatment.

5. MBBR MAJOR EQUIPMENT OVERVIEW

The following equipment may or may not be included in your WWW treatment solution.

Media

The biomedia provides the surface area to allow for fixed-film bacterial growth in the BOD removal. The small plastic media is key to the MBBR process, as the fixed-film process is what replaces traditional CAS treatment scheme. As shown on the right, you can see the film growth on the internal area of the media. World Water Works Media is traditionally constructed of HDPE and contains 650 m^2 of film surface area for every cubic meter of bagged media. Every individual piece of media is roughly 25 mm x 8 mm and has a specific gravity of 0.95 ± 0.02.

(WWW-01V) Media with fixed-film Bacterial Growth

Circular Media Retaining Sieves

The purpose of the circular sieves is to keep the Media from flowing from one reactor to another. They are only used in aerobic reactors.

Circular sieves are constructed of SS304L. The sieves are made out of perforated plate with an opening of 12 mm diameter. Since the Media used by WWW has dimensions of 25 mm x 8 mm, there will be no pass-through or plugging so long as the sieves are installed correctly.

Circular Sieves with Angle Supports

Sieve sizes and quantities can vary based on peak flowrates, with a maximum single sieve size of twelve inch (12”) diameter x eighteen feet (18’-0”) long. Sieves are designed to accommodate for less than two inches (2”) of head loss per reactor at peak flowrate. A support structure is necessary for this equipment. The “Circular Sieve with Angle Support” & “Circular Sieve with Floor Support” shown, display different methods of supporting the media retention sieves in the MBBR reactors. Either angle iron support or vertical support members are used for supporting the media retention sieves. The type to be used will be based on reactor configuration and number of sieves required for a project.

Circular Sieves with Floor Supports

Overflow Sieves

The overflow sieves are installed in each MBBR reactor and are 6” dia x 12” long. These circular sieves are installed for any foam / overflow in the reactor.

Drain Sieves

Drain sieves are installed in each MBBR reactor and are 4” dia x 12” long. They require no support brackets and will be anchored to the reactor wall and cover the drain hole.

Aeration Blowers (Supplied by Others)

In order to introduce oxygen to the MBBR reactors, blowers are used. Aerobic zones will need the blower air at varying DO levels depending on the type of treatment. The figure on the right, shows positive displacement (PD) type blowers used on MBBR systems. Complete BOD removal will require 2.5 – 3.0 mg/L. Blowers are always installed with Variable Frequency Drives (VFD).

Aeration Blowers

Aeration Grids

All aerobic reactors have coarse bubble diffusers. These are made of SS316. The figure on the right, shows how the grids supplied are designed to cover maximum floor area. They consist of drop pipes, aeration grids (which are made up from center manifolds & outside diffusers), and the multiple support structure items. It is key that the grid is installed completely level to the ground. Grid design including number of manifolds, number of outside diffusers, and number of holes per diffuser aims to achieve complete mixing of Media in the aerobic reactors. Grids are installed perpendicular to wastewater flow.

Aeration Grids

DO Probes

Dissolved oxygen probes are a key piece of instrumentation for the MBBR process. Blower speed can be regulated based off of the target DO.

6. MBBR IN BASIN EQUIPMENT INSTALLATION/TESTING

Aeration Grid Installation

FOR INSTALLATION, THE ENTIRE AERATION SYSTEM MUST BE LOOSLY PLACED TOGETHER TO ALIGN ALL THE SUPPORTS. ONLY AFTER THE SUPPORTS ARE ALIGNED CAN THEY BE WELDED OR ANCHORED TO THE REACTOR FLOOR.

ANTI-SIEZE COMPOUND BY LOCKTITE IS HIGHLY RECOMMENDED FOR USE ON THE STAINLESS STEEL THREADED RODS TO MINIMIZE PROBLEMS WHEN SECURING THE NUTS TO THE RODS.

The aeration grid system is made up of the following equipment:

- Aeration Grids
- Drop Pipes
- Outside Diffuser Supports
- Aeration Grid Manifold Supports
- Vertical (Drop Pipe) Supports

The entire aeration grid systems are assembled with either flange connection (drop pipe to aeration grids) or supports (outside diffuser support, manifold support & vertical support). The tolerance for aeration grid installation within a tank is 1/8 inch (3 mm) to ensure proper distribution of air throughout the tank floor area.

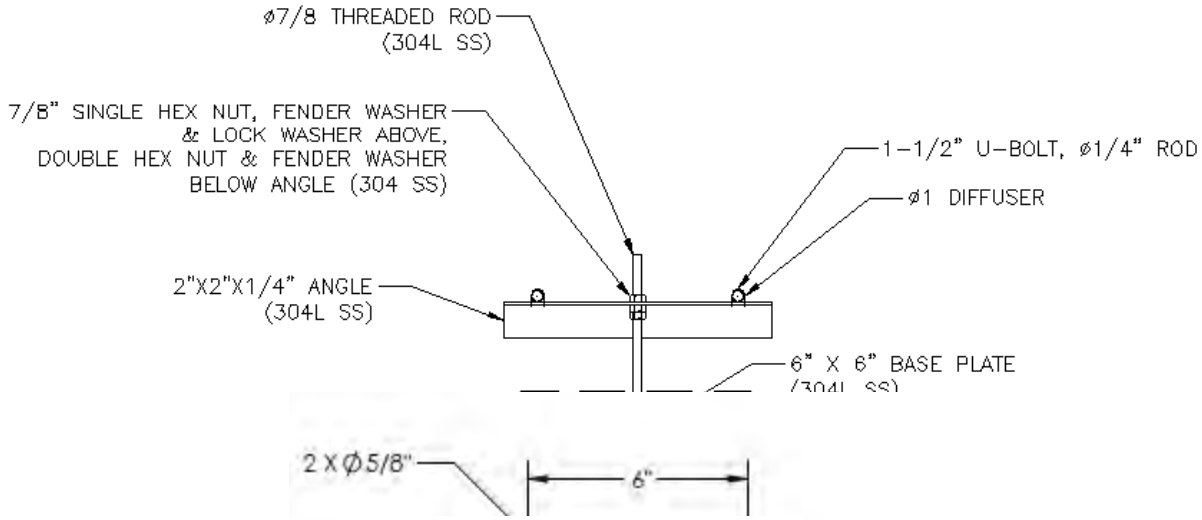
OUTSIDE DIFFUSER SUPPORT

- The diffuser support will have two (2) bolt holes for anchoring to the reactor floor (see “Outside Diffuser Support” on the following page) or a support base for welding to the reactor floor. The anchoring system uses a threaded rod to support the base and aeration grid. The support is then tightened down using a half inch (1/2”) fender washer, half inch (1/2”) lock washer and half inch (1/2”) Hex Nut.

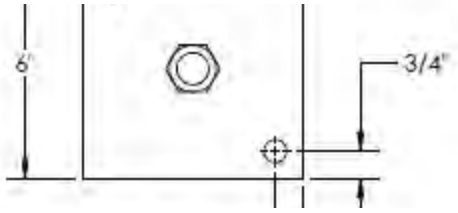
- The diffuser support is anchored to the aeration grid through the 1-inch (1”) diameter holes provided in the two inch (2”) x two inch (2”) angle support located on the outside portion of each grid (see “OSD: Side View Installed” on the following page). Each aeration grid has a specified

number of holes per side provided for the outside diffuser support rods, typically spaced every six – nine (6-9) feet apart. Due to the support rod being 7/8" diameter and the hole in the angle iron being 1" diameter, there is no room for movement. Figure below shows how the anchor system includes a 7/8" Hex Nut, flat washer & lock washer above and flat washer with double 7/8" Hex Nut below.

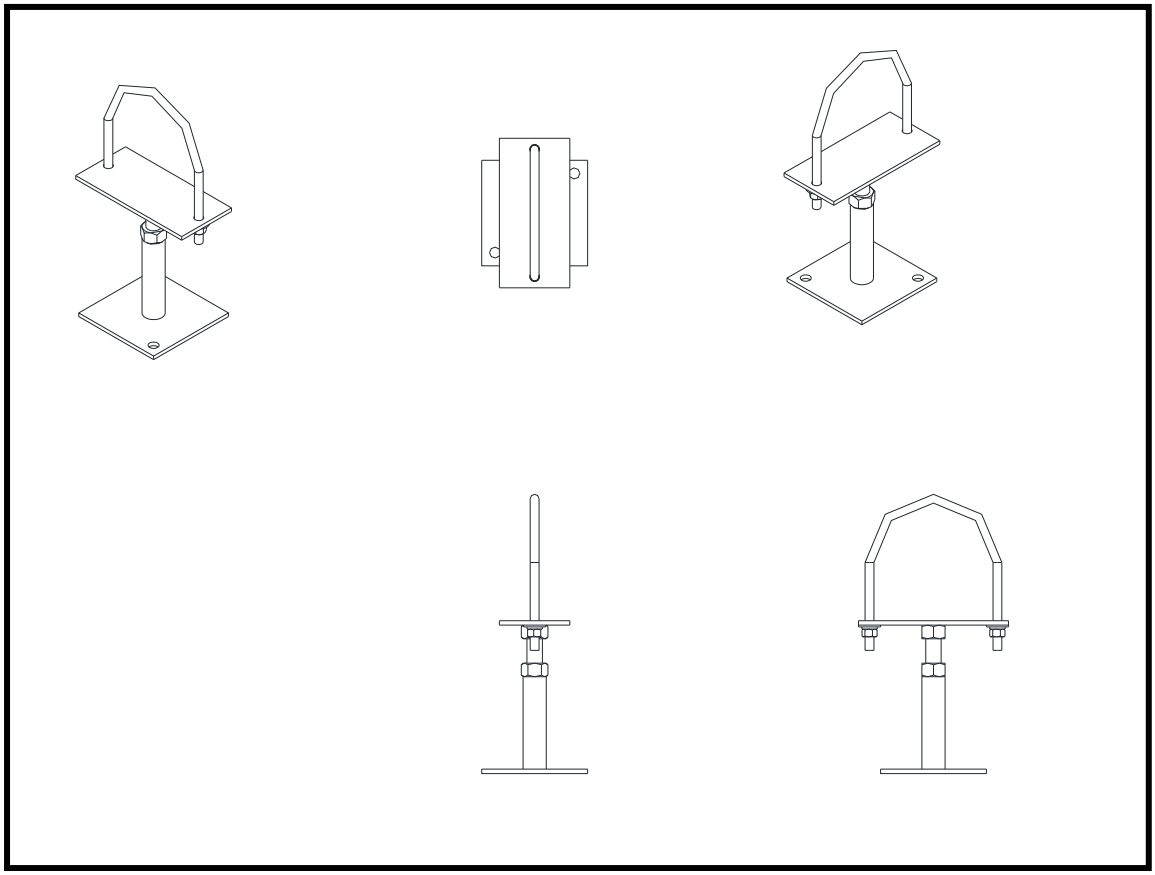
Outside Diffuser Support



ODS: Side View Installed



ODS: Base Plate



Aeration Manifold / Drop Pipe Support

AERATION MANIFOLD / DROP PIPE SUPPORT

- The vertical (drop pipe) supports and aeration manifold supports are identical. Each has two (2) holes for mounting to the reactor floor / tank wall.

- The aeration grid center manifold is then anchored to the manifold support / drop pipe support via a ½" diameter U-bolt and ½" flat fender washer, ½" lock washer and ½" hex nut on each side of the U-bolt. See Figure 20 above for details on the Aeration Manifold / Drop Pipe support.

DROP PIPES

- The drop pipes feeding the main manifolds require anchoring to the reactor wall via the vertical supports.

- As described above, the drop pipes are anchored to the wall in the same manner as the manifold supports.

Sieve Assembly Installation

NOTE: Please refer to the drawings in the 0700 section of the Drawings Package for a visual description of the sieve assembly installation.

Aeration Grid Air Testing

Preparation

1. Check that the outlet sieve supports are sufficiently secured to reactor wall & the U-bolt brackets are anchoring the sieve assembly to the supports and that there are no openings in the sieve flange connections where the carrier elements can penetrate. Gaps should be less than 3/16 inch (5 mm).
2. Check the reactor wall drain sieves and scum flat sieves at the top of the reactor for any gaps. There should not be any openings and any gaps should be less than 3/16 inch (5 mm).
3. Check that the aeration system is levelled and secured to reactor bottom. All supports should be tightened. In order to obtain an even distribution of air the diffuser manifolds in a reactor should be level to within a maximum of 1/8 inch (3 mm) tolerance.

   Procedures for the following are described:

   a. Visual inspections
   b. Testing of aeration system
   c. MBBR Outlet Sieves

Visual Inspection – Biological Reactors

1. Inspections according to World Water Works procedure will be performed for equipment installed in each of the tanks prior to filling of water. These inspections include the following major elements.
   a. The reactor floor will be checked for any remaining loose objects that might be missed during final cleaning.
   b. The aeration grids, sieves and pipe work will be checked for any visual damages.
   c. The bolts and nuts holding the aeration grids, pipe work, sieves and supports will be checked to ensure bolts and nuts are all tightened correctly.
   d. The installation of the sieves will be checked to ensure no openings are big enough for any media to escape.
   e. After approved visual inspection of the mechanical installation a functional test of the aeration system, media retention sieves and structure test of the baffle walls will be performed.

Testing of Aeration Systems

i. General

The test will be supervised by personnel from World Water Works and the result of the testing will be documented according to World Water Works Documentation (see **MBBR Documentation).** The purpose of the testing is to:

a. Check that air is evenly distributed over the reactor floor. Page 17 shows improper and proper installation of how air flow patterns should look in the reactor.
b. Verify that there is no leakage on the flange connections, diffusers or distribution pipes.
c. If necessary, verify that the baffle walls can withstand single side pressure (Not all MBBR reactors have baffle walls).
d. If necessary, check the baffle wall for major leaks.

ii. Preparations

a. All mechanical installations in the aeration tanks are finished and the visual inspection has been made.

iii. Test Procedure

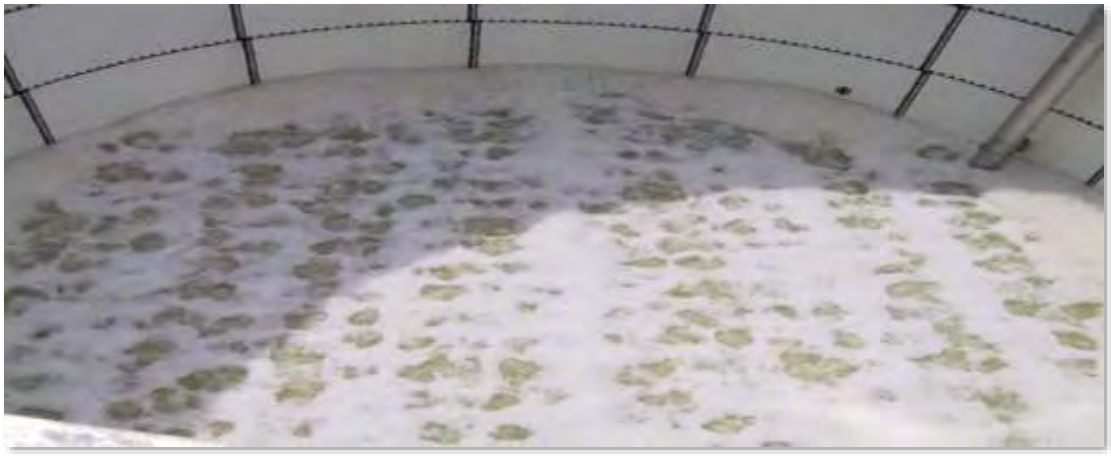
a. Start filling water (treated wastewater or non-potable water) and stop filling when the water level has reached 3 ft SWD inside the MBBR reactor or 1 ft. above the drop leg submerged flange connections (whichever is higher).
b. Improper installation and aeration grids which are not leveled, as shown in Red on the bottom left-hand corner of first image on page 17. An easy visual test to see if the aeration system is level or not is by having the operator/technician watch the water level rise in the reactor. As the water level starts to touch the diffusers is the best visual indicator about the aeration grids levelness.
c. Once the water reaches the necessary level, start one blower and aerate the reactor at 50% capacity with all valves in the open position. Observe the aeration pattern of the tank. The entire tank floor should have good distribution of air from the grid system across the entire tank floor. Due to spacing between the aeration grids, you should easily see the areas of minimal air flow during the aeration grid test, but it will be difficult to see when operating at the normal water level in the reactor.

Improper Leveling of Aeration Grids in Aeration Basin

d. Carefully open the manual drop leg valves one by one for each aeration grid. Visually search the system for leakages and/or uniform distribution throughout the pipes.

e. If uneven distribution is observed, the water will have to be pumped out of the reactor so modifications can be made. Corrections will be performed and a new aeration pattern test performed.

f. The image below shows proper aeration distribution pattern in the tank.



Proper Aeration Patterns

g. After testing the first blower, it's recommended to test the other blower(s) supplied for the treatment system. Depending on how the blowers operate, the operator/contractor may want to test the valves on the blowers to restrict air out of the blower. The valves located in the process air lines can also be checked. Decrease the amount of air to each grid section using the valves and observe the air flow pattern within the tank. Also notice the surge protection on the blower and at what valve positions would create the blower going into surge.

h. Verify the observations with photographs and video recording.

i. Continue filling of water while aerating until the water level has reached the topside of the outlet sieves then stop filling.

MBBR Outlet Sieve Testing (if required)

I. General
   a. The test may be supervised by personnel from World Water Works and the result of the testing will be documented according to World Water Works Documentation (see **MBBR documentation**). The purpose of the testing is to:
   b. Check that media retention sieves are anchored securely to the wall and support structure.
      i. Check that the air Sparge piping (if provided) is installed and operating correctly.
   c. Sieve Hydraulic testing (if required) will be conducted separately after the system has been fully operational with media and the procedure can be found later in this document.

II. Preparations
   a. Conclusion that the aeration grid test is finished and was deemed successful.

III. Test Procedure
   a. Start filling water (treated wastewater or non-potable water) and stop filling when the water level has reached centerline of the effluent inside the MBBR reactor. Water should just be flowing out of the last MBBR reactor.
   b. If necessary, open the Sieve Sparge header valve to visually see how the sieves are aerated.
   c. Visually inspect for uniform distribution across the length of the tank. Bubbling should occur at each location where a sieve is located 1 per reactor.
   d. Verify the observations with photographs and video recording. Adjust the sieve Sparge header valve to multiple % open to see what is best Sparge pattern.
   e. Continue filling with water until the water starts flowing out of the last MBBR reactor.

Media Unloading / Storage / Installation

WWW MEDIA UNLOADING & STORAGE

Two (2) 1m3 supersack bags of Media will ship with remainder of equipment.

Media Sacks (1 Cubic Meters Each)

As the Media Sacks are not designed to be in direct sunlight for extended periods of time, it is recommended that the media be stored out of direct sunlight. If they are stored outside, tarp covering will be required. Media, if properly stored, will show no signs of degradation and can be stored indefinitely. If the period of storage is >1 year, tarp covering should be monitored and replaced when necessary.

Assuming four (4) laborers, one (1) forklift (standard straight mast type for warehouse deliveries and variable reach type of construction/other site deliveries).

Storage of Media Bags shows how the media is stored on site prior to adding blue tarps. The 1 m3 bags can be stacked 2 high.

Storage of Media Bags

INSTALLATION OF WWW MEDIA

Prior to installation of the media, the inspections and testing of the aeration grids and media retention sieves should be performed and deemed ready for operation. See **MBBR Documentation** section for testing requirements. Typically, a contractor can install roughly 12 bags per hour at 1 per time (1 every 5 minutes) using 6 people (2 for storage area, 2 for unloading in basin, 1 spotter and 1 crane operator).

The basin should be filled to the 50% mark with wastewater prior to loading the carrier elements. The bags can be cut open from the bottom to allow the media to flow into the basin. Please ensure the bags are empty.

If access does not allow for the basins to be filled in this manner, the media can be blown into the basins. Please let World Water Works know if this is the desired means of unloading the media.

Media Installation into Reactor & Pouring Media into Reactor

Pouring Procedure

- The bags are hoisted over the reactor where at least three (3) people are waiting. They are usually positioned from left to right: stabilizer, assister, cutter (4th person is there to keep the count and provide additional assistance when necessary)
- To open the bags, you need one to two (1-2) people to keep the bags steady. The other person will cut the rope. (Harness must be used and clipped to rail in order to reach the bag over the railing). (Knife needs to be tethered to wrist or harness in case knife falls into reactor).
- A flap is pulled out which reveals a crumpled up spout that must also be pulled out of the bottom of the bag. If spout is tied, it can either be untied or cut. Then the spout is open and media starts to pour into the reactor.
- Bags are now rotated counter clockwise so the cutter can start on the next bag as media empties the previous bag. The stabilizer and assister can also work to start opening the bags if knife is not required.
- After bags have been emptied, crane lowers the empty bags so the team can unhook and remove the bags and dispose of them appropriately.
- Shake the bags to remove straggler media pieces before rolling the bags and throwing them into a dumpster.
    - A 30-yard dumpster is required to hold all the empty bags unless other arrangements are made.

MBBR Commissioning - SOP

PROCEDURE FOR STARTING UP MBBR SYSTEM:

1) If system does not have media installed yet, aeration test is required.
2) Aeration Test:
    a. Fill tank with water (potable/non-potable) to three foot (3 ft.) level mark.
    b. Turn on blowers at minimum speed.
    c. Notice aeration pattern in the tank for levelness and adjust as needed.
3) Media Fill:
    a. Once aeration test is finished, fill tank to 75% level with wastewater.
    b. Fill in the media and turn blower on minimum speed to aid in the mixing of the media.
    c. Sometimes the media fill needs to be incremental in order to keep from overflowing media out of the reactor.
    d. Add Water to full water level if needed to aid in the media mixing.
4) Media Mixing:
    a. Allow system to aerate for a short period of time (few days to 1 week) to get all the media mixing in the tank. Once media is mixing well, forward flow can start to the system.
5) System feeding:
    a. Startup system if possible at 25% feed rate to feed system at a lower rate to grow the bacteria for degradation of the BOD. If not possible, feed system at 100% and system performance will grow over time.

PROCEDURE FOR SYSTEM MONITORING:

1) Monitor system for DO and temperature on a daily basis and log into data log sheet.
2) Take samples for Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), NH_3-N, PO_4-P and alkalinity on a routine basis and during startup watch how the system reacts to increase in flow/load and effluent performance.
3) See **MBBR Documentation** to track data progress at plant.

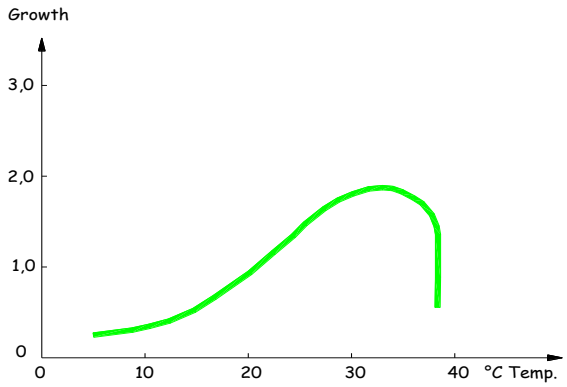
7. MBBR OPERATION

Process Basics

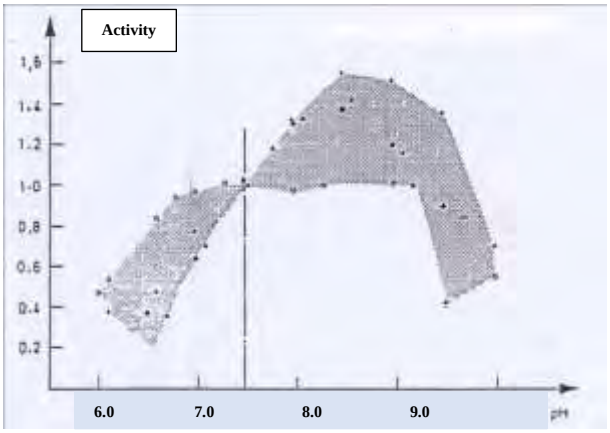
i. Bacteria Growth Rate

The charts shown below, show the relative growth rates & activity of bacteria with respect to temperature and pH. The design of the MBBR Treatment System is from 10C – 25C (59F – 77F) and looking at the curve for "Temp Growth Rate Graph for Bacteria", is within the middle of the line. Bacteria will start to die when the temperature hits close to 38C (100F). The design temperature for the MBBR Treatment System is 10C (50F) as the winter time low monthly average temperature. This would be when the bacteria exhibit the lowest growth rates.

With the MBBR Treatment system performing nitrification, conversion of ammonia to nitrate, the pH and alkalinity balance is affected during the operation of the system. Alkalinity is consumed by the bacteria (Ammonia Oxidizing Bacteria (AOB)) when converting ammonia to nitrite. The buffering capacity of a wastewater is based on how much alkalinity it has. For successful operations of the MBBR system, the effluent alkalinity should be >100 mg/L range so as not to depress the pH too much. As more ammonia is nitrified and alkalinity consumed, the pH will decrease across the process. Proper monitoring of alkalinity is recommended to ensure maintaining a healthy pH for the bacteria.



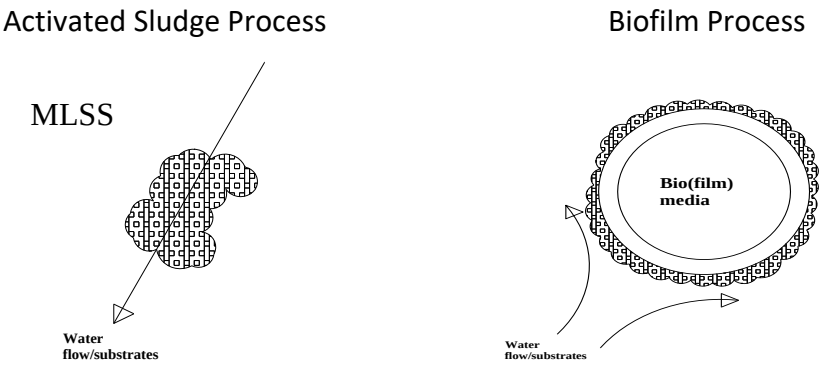
Temp Growth Rate Graph for Bacteria



Nitrification Bacteria Activity Vs. pH

ii. Biofilm Characteristics

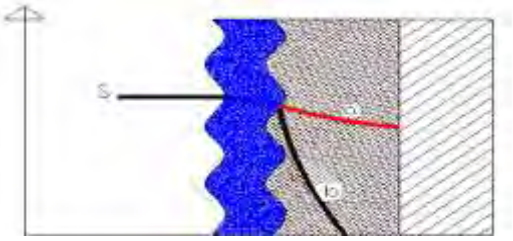
"Activated Sludge Floc Vs. Biofilm Comparison" figure, shows a depiction of an activated sludge floc, where the oxygen and substrates can penetrate the floc from any angle while the biofilm system has a layered effect, thus the transport of oxygen and substrates if through the biofilm in one (1) direction. Diffusion principles then are found to affect the biofilm system vs the activated sludge system



Activated Sludge Floc Vs. Biofilm Comparison

General Conditions of Biofilm systems

a. The porosity is greater in the outer layer of the biofilm due to it being a younger biology prone to sloughing. The sloughing of the biofilm is due to the agitation and mixing energy in the reactor. When a system exhibits higher air flows, the system will exhibit increased sloughing.
b. The biofilm density increases with the thickness of the biofilm. As the higher sludge age bacteria reside in the lower portions of the biofilm, it exhibits an increase in density vs the outer layers.
c. The ratio between living cells/total biomass is considerably higher in the outer layer of the biofilm.
d. MBBR & IFAS systems using the plastic carrier media have seen over time no predation by red worms.
e. The biofilm thickness is maintained by the degree of aeration in the aerobic reactors. Constant aeration will provide for stable and even sloughing of the biofilm, however, an increase in sloughing could be triggered when aeration is increased to the reactor.
f. One benefit of the Integrated Fixed-Film Activated Sludge (IFAS) system is that there is a continuous sloughing rate and seeding of nitrifiers into MLSS. This seeding effect contributes to roughly 12% of the nitrification capacity of the entire process.
g. The volatile suspended solids (VSS) content of the biofilm is 90-95% of the TSS value. This demonstrates the fact there is more active biomass per unit volume than traditional activated sludge systems.



Depiction of Biofilm

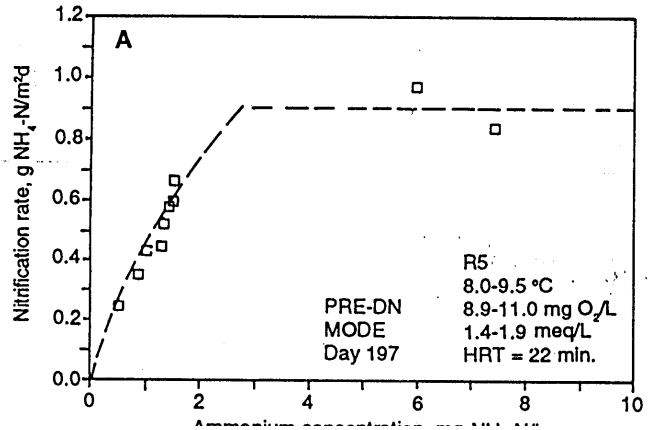
Stagnant Liquid Layer Biofilm Media

a) Shows a case that is metabolically limited

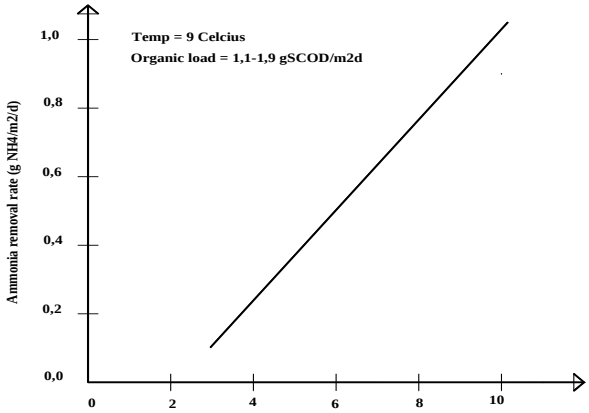
b) Shows a case that is substrate limited

h. The "Depiction of Biofilm" figure, is a depiction of the media (hatched portion), the biofilm growing on the media and the liquid layer of the system. What is shown is a system which is metabolically limited (excess food – Red Line - a) vs a system which is substrate limited (black line – b).

i. "Ammonia Concentration Vs. Removal Rate" chart, shows removal rates by biofilm based on the concentration in the reactor. Activity (removal rate of ammonia) is highest when the system is in the non-limiting zone (metabolically limited zone). As the concentration of ammonia drops in the reactor, the activity (removal rate) also drops as the biofilm is changing to the limiting zone (substrate limited zone).



Ammonia Concentration Vs. Removal Rate



Dissolved Oxygen Vs. Removal Rate

j. "Dissolved Oxygen Vs. Removal Rate" chart, shows the importance of dissolved oxygen and how it affects the removal rate of ammonia in a fixed film system. As the DO increases, the DO starts to penetrate more layers of the biofilm activating more bacteria, allowing for increase in ammonia removal. The same can be said for lowering the DO in a biofilm system. As the DO is lowered, you fail to penetrate the necessary layers of bacteria to aid in the removal of ammonia. The target DO concentrations for operations at the MBBR system.

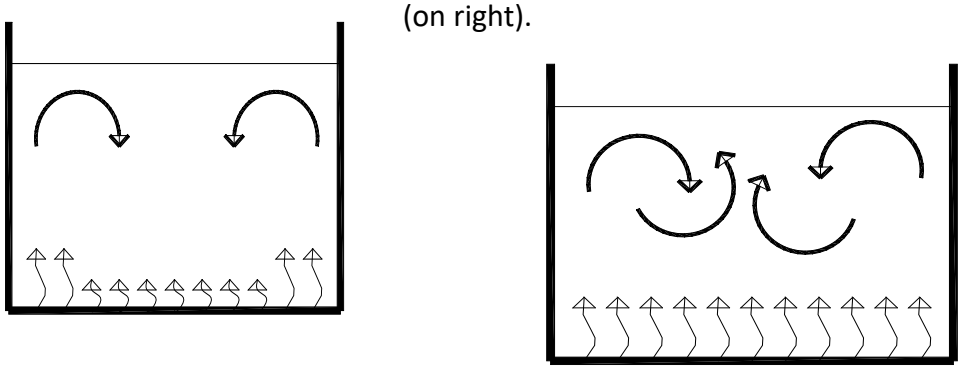
Operational Information

i. Hydraulic Throughput (Sieve Design)

The MBBR system is designed with one (1) media retention screens per zone. Peak hydraulic flow rates used for their design is 50,000 GPD per zone. Sieve sparge aeration is provided to increase the turbulence around the media retention sieves and minimize any head loss which could be generated based on any media migration taking place in the system. Use of the sieve sparge aeration should be based on visual inspection of the reactor. If media was gathering around the media retention sieves, then it can be tuned on. It is suggested to keep it on for the first 2 – 3 months of operation while the biofilm starts to grow on the media.

ii. Aeration System

MBBR System is designed with one (1) drop pipe per zone that provide balancing the aeration system by adjusting the valves. The aeration pattern should be even throughout the tank. The use of the manual valves on each drop pipe will allow for air flow distribution to maintain good mixing of the reactor. As shown on the examples of roll pattern mixing (on left) and complete mixing (on right).



Aeration Pattern with Roll Vs. Complete Mix Pattern

iii. Media Biomass Evaluation

The biofilm growing on the media can be tested for on a periodic basis. The test is similar to that of a TSS test, however one has to first dry and weigh the sample media pieces and then clean the media to remove the biofilm and dry and weigh the clean media to obtain the biomass per media values. Provided below is the procedure for testing this.

Media Characteristics

MBBR Media – Biomass Weight Procedure

Preparation and sample collection

1. Label aluminum pans to be used in the test.
2. Place small sample of media in a jar of water.
3. Move the media gently to remove any suspended solids from the elements. Drain the water from jar while keeping media in the jar.

Determination of media weight with biomass attached

4. Count out 10 - 50 media pieces and place in an aluminum pan in one layer. Record the number of media counted out.
5. Dry the pan with media to constant weight in an oven at 105°C (≥1 hour).
6. After drying to constant weight, place the pan with media in a desiccator to cool to room temperature (≥ 0.25 hours).
7. Accurately weigh and record the weight of the media.

$$\text{weight}_{\text{media with biomass}}\ (\text{g}) = \text{weight}_{\text{pan with media}}\ (\text{g}) - \text{Weight}_{\text{pan tare}}(\text{g})$$

Equation 1 – Determination of Media Weight with Biomass Attached

Removal of biomass from media

8. Place the media elements in a 500 mL wide-mouthed Erlenmeyer flask containing concentrated Hydrochloric Acid (HCl) to obtain pH of 2.
9. Soak the carriers for 15 min, shaking periodically. If one has an ultrasonic bath, that could be used instead of the acid and caustic method provided.
10. Pour off the hydrochloric acid solution while retaining the media elements. Rinse the elements with DI water by partially filling the flask.
11. Place the media in Erlenmeyer flask containing Sodium Hydroxide (NaOH) (pH of 10) for 15 min, shaking periodically.
12. Wash the carriers with DI water to remove the biomass from the media.
13. The media is clean now. If not, repeat step 7-9.

Determination of cleaned media weight

14. Dry the pan with media to constant weight in an oven at 105°C (≥1 hour).
15. After drying to constant weight, place the pan with media in a desiccator to cool to room temperature (≥ 0.25 hour).
16. Accurately weigh and record the weight of the clean media.

$$\text{weight}_{\text{cleaned media}}\ (\text{g}) = \text{weight}_{\text{pan with media}}\ (\text{g}) - \text{Weight}_{\text{pan tare}}(\text{g})$$

Equation 2 - Determination of Cleaned Media Weight

Total attached biomass calculations

17. Calculate the weight of the attached biomass as the difference between the weight of the media with biomass (Step 6) and the cleaned media without biomass (Step 15)

$$\text{weight}_{\text{attached biomass}}\ (\text{g}) = \text{weight}_{\text{media with biomass}}\ \ (\text{g}) - \text{Weight}_{\text{ cleaned media}}(\text{g})$$

Equation 3 –Total Attached Biomass

18. Calculate the unit biomass (biomass per m^2 surface area available) by dividing the biomass weight (Step 21) by the number of elements sampled (Step 5) & using standard conversions for number of elements per cubic meter and square meters of surface area per cubic meter:

$$Unit\ Biomass\ (g/m^2\ carrier) = \frac{Weight_{attached\ biomass}(g) * 1000\frac{mg}{g} * 210{,}000\frac{elements}{m^3}}{no.of\ elements\ sampled * \frac{800m^2}{1m^3}}$$

Equation 4 – Total Attached Biomass

iv. Process Control Set points

There are not a lot of process control set points for the operation of the MBBR system. Table of Process Control Points below provides for operational set points for operations to monitor.

Process Control Set Points

Parameter	MBBR Reactor
DO Concentration	3 mg/L
pH	>6.5 and < 8
Temperature	>10C and < 25C

WWW-01V Media Information

Product Specification

Product Name	World Water Works Biofilm Carrier
Product Code	WWW-01V
Application	Biological process for the treatment of Domestic and Industrial Wastewater Treatment called a Moving Bed Biofilm Reactor (MBBR)
Material of Construction	Virgin High Density Polyethylene (HDPE)
Media Dimension and Specifications	25 mm x 8 mm height - circular in shape w/ four (4) concentric rings
Total Surface Area (m2/m3)	800
Protected Surface Area (m2/m3)	650
Design	The biofilm carrier element has four (4) concentric rings with internal fins. Each element has: - Three (3) compartments in the innermost ring - Twelve (12) compartments in ring # 2 and 3 - Twenty-four (24) compartments in ring # 3
Specific Gravity of media	0.93 - 0.96
Weight of Media as shipped	275.6 lb/m3 +- 6.6 lbs (125+-3 kg/m3)

8. MBBR MAINTENANCE

Shutdown Procedure

i. All screens, aeration grids and other hardware in WWW reactors are designed in such a manner that minimum maintenance is required. Draining basins to inspect these installations are therefore not necessary unless a defect is suspected. Also, note that there is no attrition of the Media. Therefore, there is no shutdown required for removal and replacement.

ii. It may be necessary to shut down the MBBR system in order to perform maintenance on the tank or basin. If you need to drain the reactor for a long term shutdown (> 1 month), perform the following procedure:
- Stop flow to reactor.
- Aerate for 1 – 2 weeks to allow degradation of biomass in the system.
- Stop aeration to reactor.
- Drain the reactor while keeping the media in the reactor.

iii. If you need a temporary shut down without needing to drain the basins, use the following procedure:
- Stop flow to reactor.
- Lower aeration intensity to the reactor to allow mixing of the media.

iv. After shut down is over follow the below procedure:
- Begin filling reactor back after long term shut down and re-introduce wastewater
- Start aeration in the MBBR's first reactor after long term shut down, then proceed to turn the air on in MBBR's reactor 2 and so on.
- Keep aerating until all media is in good suspension
- Start flow to reactors at 50% (longer shut downs) and work up to full flow or if this was temporary, then allow flow to return to 100% immediately.

9. MBBR DOCUMENTATION

MBBR Monitoring Protocol - SOP

PURPOSE: To establish a set procedure that ensures that the sampling and daily and weekend checks for the MBBR process are performed properly and consistently.

PROCEDURE: The below schedule outlines the required process checks and sample tests for the MBBR system during the commissioning stage.

Target Time	Procedure: **Daily**
7 am-9 am	• Review the MBBR Daily Data Entry (DDE) Sheet from the previous day and confirm there are no outstanding actions. • Check for any faults/alarms. If there are any alarms/faults note in the DDE sheet. Rectify fault immediately if possible. • Monday through Friday collect daily samples from the IFAS and final clarifier. Analyze for soluble COD, NH_3-N, NO_3-N, TSS, Alkalinity. Record sample results in the MBBR DDE sheet. • Use Sludge Judge to measure sludge volume in the clarifier for wasting requirements • Record all information required in MBBR DDE.
9 am–11 am	• Do a visual inspection of each MBBR to observe color, foam/floating sludge, abnormal noise or vibration of equipment, aeration bubble pattern, etc. Record any abnormalities and inform supervisor as required. • Review system operation and check for any faults/alarms/EQ tank level. If there are any alarms/faults note in the MBBR daily data entry sheet. Rectify fault immediately if possible.
Continuously	• Keep an eye on influent feed quality and IFAS reactor level.
Weekend	• Saturday and Sunday monitor pH, DO, Temp and see how stable system is operating

Procedure: **Weekly**
Inspect pH, and DO probes in each MBBR and clean if not performed in past 7 days, or sooner if necessary. Inspect any other instrumentation provided to ensure properly working. Inspect Blower discharge pressure to see if any change • Record all information required in Notes.
Procedure: **Monthly**
Inspect blowers and oil levels. Inspect influent pumps for clogging and impeller wear. • Record all information required in Notes.

Samples to analyze

Sample	Sample location	How to analyze	How to interpret results
Ammonia NH3-N	Influent composite sample	Send sample to Lab for analysis	Monitor Ammonia level in influent sample. It should not vary more than 40 - 50 mg/L.
TSS	Influent and MBBR Effluent	Send sample to the Lab for analysis	Influent – less than 450 mg/L (Design Value).
sBOD and Total BOD	Influent and MBBR Effluent	Send sample to Lab for analysis	Max Influent BOD Design Concentration – < 450 mg/L Effluent soluble BOD Concentration – 10 mg/L
sCOD and Total COD	Influent and MBBR Effluent	Send sample to Lab for analysis	Max Influent Design Concentration – < 900 mg/L Effluent soluble COD Concentration – 30 - 50 mg/L
Total P / Ortho-P (PO4-P)	MBBR effluent	Send sample to Lab for analysis	MBBR effluent PO4-P should be > 1 mg/L

Red Flags / Troubleshooting - SOP

PURPOSE: To help the operators identify, response, troubleshoot, and mitigate "Red Flags" that indicate early warning signs of process failure or stable conditions that can lead to a process failure.

PROCEDURE: The below table outlines scenarios, trends, and performance data indicative of an unstable MBBR operation that can lead to a process failure. Likewise, the table has each Red Flag's corresponding responses, troubleshooting, and mitigating procedure.

"Red Flags" Response, Troubleshooting, and Plan to Mitigate				
Red Flag	**Target Value**	**Response**	**Troubleshooting**	**Plan to Mitigate**
Level in MBBR tank rising	Std. side water depth of 9 ft.	Monitor the system to see how the water level in the tank is normal to high.	Check effluent sieve to confirm no media blockage which would increase head loss in the tank. Either turn on or turn up air sparge system.	Keep good mixing in the tank so that the effluent sieve is not having any head loss. Keep air sparge system on.
Large foam layer	N/A	The MBBR usually has a foam layer during aeration. Visually inspect the foam layer in the MBBR tank to familiarize with the normal layer height, color, and type of foam (small or large bubbles)	Inspect tank for foam layer and if blower speed is too high.	If foam is excessive, use water based antifoam chemicals to aid in the reduction of their size. (2) turning down blower could also limit foaming if system is exhibiting high DO values.
Blower back Pressure to MBBR Zones	4.5 – 4.75	If pressure is lower – then water level in basin is low If the pressure is higher, investigate clogging of aeration system.	Check for any aeration pattern disturbances which would indicate clogging. Check for any air leaks which could be bleeding off air instead of going to the system. Check water level in the tank or aeration system could be clogged and look for non-uniform aeration in the tank.	Increase the water level in the tank, should pressure be too low or close any air leaks. Reduce water level should it be too high.

10. CUSTOMER SERVICE

Warranty

Please refer to signed Sales Agreement or previously agreed upon warranty in the contract documents.

Return Goods Policy & Procedure

Please refer to the RGA # Request Form appended to this manual.

Contact Information

World Water Works believes that responsive customer service is as important to customer satisfaction as is proficiency of the system design. Thus, we welcome customer calls.

WORLD WATER WORKS, INC.
CUSTOMER SERVICE DEPARTMENT

4000 SW 113th
Oklahoma City, OK 73173
or
P.O. Box 892050
Oklahoma City, OK 73189

Toll Free 1-800-607-PURE (7873)
Phone 1-405-943-9000
Email support@worldwaterworks.com

World water works

Clean Water and Energy from Wastewater

Moving Bed Biofilm Reactor (MBBR) Commissioning Plan

INSPECTIONS, TESTING, AND TRAINING

Inspection of equipment prior to placing any equipment or system into operation.

- Installation Contractor Installation Checklist
- Equipment Installation and Testing Inspection
    - Aeration
    - Screens
    - Media
- Conduct System Training

MBBR INSTALLATION INSPECTION BY INSTALLATION CONTRACTOR
PROJECT NAME:
PROJECT LOCATION:
DATE:

1. Aeration Grids **Manifold plus diffusers**	**Acceptable (Y/N)**	**Comments**
A. Physical Condition:		
B. Layout in Tank: Does the layout match the project drawing?		
C. Flange Connections: Are gaskets used at all flanged connections? Hardware tightened?		
D. Levelness: Is manifold level to within 1/8 inch?		
E. Hardware: Correct use and placement of hardware? Tight? (Diffusers - From floor: Double nut, flat washer, bar, flat washer, lock washer, nut)		
F. Supports: Correct number of supports, spaced correctly, and installed at the correct height? (Bottom of diffuser 1' off floor)		
G. Anchors: All anchors in place and installed correctly.		
2. Spool Pieces **(If applicable)**	**Acceptable (Y/N)**	**Comments**
A. Physical Condition:		
B. Layout in Tank:		

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C. Flange Connections: Are gaskets used at all flanged connections? Hardware tightened?		
D. Levelness: Is spool piece level to within 1/8 inch? (Level and tape measure)		
E. Hardware: Correct placement of hardware? Tight?		
3. Drop Pipes	**Acceptable (Y/N)**	**Comments**
A. Physical Condition:		
B. Layout in Tank: Does the layout match the project drawings?		
C. Flange Connections: Are gaskets used at all flanged connections? Hardware tightened?		
D. Proper distance from wall? Centerline of pipe is usually 1' from wall		
E. Hardware: Correct placement of hardware? Tight?		
F. Supports: Correct number of supports, spaced correctly, and installed correctly		
G. Anchors: All anchors in place?		
4. Effluent, overflow, and drain Sieves	**Acceptable (Y/N)**	**Comments**
A. Physical Condition:		
B. Layout in Tank: Confirm they are located correctly.		
C. Flange Connections: Are gaskets used? Confirm that there are no gaps which would allow media to escape.		
D. Levelness:		
E. Hardware: Correct placement of hardware? Tight?		

F. Supports: If sieve requires support, confirm correct installation (support required for 3' and above sizing)		

5. Flat Screens (if applicable)	**Acceptable (Y/N)**	**Comments**
A. Physical Condition:		
B. Layout in Tank: Confirm screens are located correctly.		
C. Firm against concrete: No gaps that could allow media to be lost.		
D. Hardware: Correct placement of hardware? Tight?		

6. Media	**Acceptable (Y/N)**	**Comments**
A. Correct Number of bags onsite?		
B. If bags are stored outside they are covered.		
C. Equipment available for placing media in tank when ready?		

Please note that signing and completing this inspection checklist is an indication that all equipment has been installed and ready for startup and commissioning. If WWW personnel arrive onsite and cannot complete startup and commissioning, additional charges may apply.

_____
NAME OF INSTALLATION CONTRACTOR:

_____
SIGNATURE OF INSTALLATION CONTRACTOR:

_____
DATE OF INSPECTION:

MBBR INSTALLATION INSPECTION

PROJECT NAME:
PROJECT NUMBER:
DATE:

1. Aeration Grids Manifold plus diffusers	**Acceptable (Y/N)**	**Comments**
A. Physical Condition: Confirm that no diffuser pipes are bent or damaged.		
B. Layout in Tank: Does the layout match the project drawings? Correct grids in correct placement? (# of holes can differ)		
C. Flange Connections: Are gaskets used at all flanged connections? Hardware tightened?		
D. Levelness: Is manifold level to within 1/8 inch?		
E. Hardware: Correct use and placement of hardware? Tight? (Diffusers - From floor: Double nut, flat washer, bar, flat washer, lock washer, nut)		
F. Supports: Correct number of supports, spaced correctly, and installed at the correct height? (Bottom of diffuser 1' off floor)		
G. Anchors: All anchors in place.		
2. Spool Pieces (If applicable)	**Acceptable (Y/N)**	**Comments**
A. Physical Condition:		
B. Layout in Tank: Does the layout match the project drawings?		
C. Flange Connections: Are gaskets used at all flanged connections?		
D. Levelness: Is spool piece level to within 1/8 inch?		
E. Hardware: Correct placement of hardware? Tight?		

3. Drop Pipes	Acceptable (Y/N)	Comments
A. Physical Condition:		
B. Layout in Tank: Does the layout match the project drawings?		
C. Flange Connections: Are gaskets used at all flanged connections?		
D. Proper distance from wall? Centerline of pipe is usually 1' from wall		
E. Hardware: Correct placement of hardware? Tight?		
F. Supports: Correct number of supports, spaced correctly, and installed correctly		
G. Anchors: All anchors in place?		
4. Effluent, overflow, and drain Sieves	**Acceptable (Y/N)**	**Comments**
A. Physical Condition:		
B. Layout in Tank: Confirm Sieves are installed at correct location. Confirm project drawings.		
C. Flange Connections: Are gaskets used on all sieves? Confirm that there are no gaps which would allow media to escape.		
D. Levelness:		
E. Hardware: Correct placement of hardware? Tight?		
F. Supports: If sieve requires support, confirm correct installation (support required for 3' and above sizing)		
G. Anchors: All anchors in place?		

5. Flat Screens	Acceptable (Y/N)	Comments
A. Physical Condition: Is there any damage?		

B. Layout in Tank: Confirm screens are located correctly. Confirm project drawings.		
C. Firm against concrete: No gaps that could allow media to be lost.		
D. Hardware: Correct placement of hardware? Tight?		
E. Anchors: All anchors in place?		

6. Media	**Acceptable (Y/N)**	**Comments**
A. Physical Condition:		
B. Correct Number of bags onsite and ready to be added to the tank.		

FOLLOW UP ITEMS:

TESTING OF AERATION SYSTEM:

The purpose of the testing is to:

a. Check that air is evenly distributed over the reactor floor.

b. Verify that there is no leakage on the flange connections, diffusers or distribution pipes.

Test Procedure

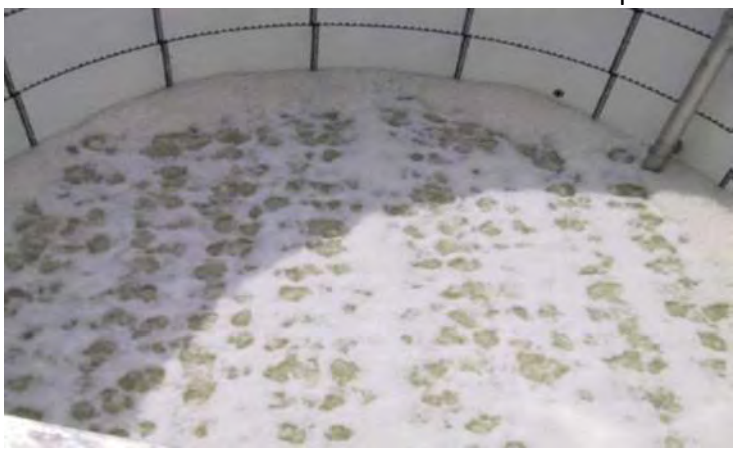
a. Start filling water (treated wastewater or non-potable water) and stop filling when the water level has reached 1 – 1.5 ft. above the diffuser pipes inside the MBBR reactor or 1 ft. above the drop leg submerged flange connections (whichever is higher).

b. Improper installation and aeration grids which are not leveled, are shown below. An easy visual test to see if the aeration system is level or not is by having the operator/technician watch the water level rise in the reactor. As the water level starts to touch the diffusers is the best visual indicator about the aeration grids levelness.

c. Once the water reaches the necessary level, start one blower and aerate the reactor at 50% capacity with all valves in the open position. Observe the aeration pattern of the tank. The entire tank floor should have good distribution of air from the grid system across the entire tank floor. Due to spacing between the aeration grids, you should easily see the areas of minimal air flow during the aeration grid test, but it will be difficult to see when operating at the normal water level in the reactor.

Improper Leveling of Aeration Grids in Aeration Basin

d. If uneven distribution is observed, the water will have to be pumped out of the reactor so modifications can be made. Corrections will be performed and a new aeration pattern test performed.



Proper Leveling of Aeration Grids in Aeration Basin

Photos of the Installation:

Aeration Grids
Aeration Manifolds
    Pipe Supports
    Anchorage Hardware
Aeration Drop Pipes
    Pipe Supports
    Anchorage Hardware
Flange Connections
Full Layout
Effluent Sieve and support
Overflow Sieve
Drain Sieve
Flat Screens
Aeration Testing
Water at level with grids before turning on blowers

Air distribution (Video and pictures)

I, the undersigned Manufacturer's Representative, hereby certify that I am a duly authorized representative of the manufacturer, empowered to inspect, approve, and operate the equipment and authorized to make recommendations required to ensure equipment furnished is complete and operational. I further certify that all information contained herein is true and accurate.

_____
NAME OF INSPECTOR:

_____
SIGNATURE OF INSPECTOR:

_____
DATE OF INSPECTION:

TRAINING

Schedule:

- MBBR Supplier shall supply one training session.
- Training Session
  - The training services shall be comprised of a qualified representative to instruct and train plant personnel in the proper startup, operation, shutdown, maintenance, repair and troubleshooting of the system. The O&M Manual shall be the primary training tool with supplemental training provided from a presentation.
- Training Time Per Session:
  - 3 Hours Total
    - Classroom 1.5 Hours
    - Hands On 1.5 Hours

Topics to be covered:

- Theory of Operation
- Actual Operation
- Mechanical Maintenance
- Electrical Maintenance
- Instrumentation
- Optimum Operation
- Troubleshooting
- Hands-on
- Question and Answer Session

MBBR TRAINING SIGN IN SHEET

INSTRUCTOR: _____

DATE: _____

	Department / Position	Name
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		

INITIAL OPERATION

- Start, test, and place equipment and systems into operation to allow the Owner to observe the operation and overall performance of the equipment and to determine that controls function as intended.
- Operate equipment which is used on a limited or part-time basis in the presence of the Owner for a period long enough to demonstrate that controls function as specified.
- Equipment and systems may be considered as substantially complete at the end of this initial operation period if the equipment is placed in continuous beneficial use by the Owner, unless specifically stated otherwise in the individual equipment Specifications.

SYSTEM RAMP UP

Basis of Design & Design Criteria

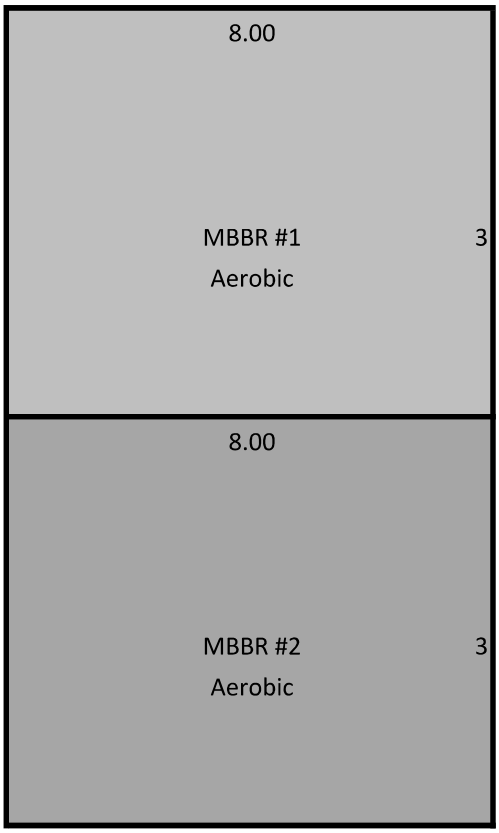
Project Location: Heeia Kea Boat Harbor
Project Subtitle: WWW MBBR Design Memo
Plant Name: Heeia Kea Boat Harbor WWTP

Influent Flows	Value	Units
Flow		
Average Day Flow (ADF) - Basis of Design	0.0050	MGD
Design Flow (DF)	0.0075	MGD

Loading		Value	Units
Influent Design			
BOD			
Loading @ Basis of Design		15.6	lb/day
Concentration		250.0	mg/L
TSS			
Loading @ Basis of Design		15.6	lb/day
Concentration		250.0	mg/L
TKN			
Loading @ Basis of Design		3.8	lb/day
Concentration		60.0	mg/L
Ammonia			
Loading @ Basis of Design		2.8	lb/day
Concentration		45.0	mg/L
Temperature			
Minimum		15.6	°C
Maximum	*Assumption*	24	°C
Effluent Design			
Total BOD @ 15.6 °C		20	mg/L
		1.3	lb/day
TSS @ 15.6 °C		20	mg/L
		1.3	lb/day

MBBR Tank Sizing (Per Train) 1 of **1**

		Value	Units
MBBR #1	Aerobic		
Width		8.00	ft
Length		3.00	ft
Side Water Depth		6.00	ft
Volume		*0.001*	*MG*
MBBR #2	Aerobic		
Width		8.00	ft
Length		3.00	ft
Side Water Depth		6.00	ft
Volume		*0.001*	*MG*
HRT @ Basis of Design			
MBBR #1		5.2	hr
MBBR #2		5.2	hr
Total/Train		10.3	hr
Total		10.3	hr



MBBR Media Calculations

	Value	Units
Dissolved Oxygen		
Minimum	2.5	mgO2/L
Maximum	3	mgO2/L
Media Volume Calculation		
Surface Area Loading Rate (SALR) @ 15.6 °C		
BOD SALR - MBBR #1	9	g BOD/m^2 day
BOD SALR - MBBR #2	2	g BOD/m^2 day
Removal Rates		
BOD Removed -MBBR #1	12.5	lbs/day
	5,675	g/day
BOD Removed - MBBR #2	3.1	lbs/day
	1,424	g/day
Surface Area Required		
MBBR #1	650	m^2
MBBR #2	650	m^2
Media Required		
Media Surface Area	650	m^2/m^3
MBBR #1	1.00	m^3
MBBR #2	1.00	m^3
Total Media	2	m^3
Media Fill		
MBBR #1	30%	
	1	m^3
MBBR #2	30%	
	1	m^3

Aeration Calculations

O_2 Required/BOD_{rem}	1.1	lbs O_2/lb BOD
O_2 Required/TKN_{rem}:	4.57	lbs O_2/lb TKN
O_2 DN Credit	2.86	lbs O_2/lb N
Influent BOD_5	15.6	lbs/day
Effluent BOD_5	1.3	lbs/day
BOD_5 Removed Total	14.4	lbs/day
AOR (BOD_5)	15.8	lbs O_2/day
SOR (BOD_5)	33.4	lbs O_2/day
SCFM (BOD_5)	24	SCFM
Discharge Pressure	2.9	psig

Sludge Yield Calculations

1	$Temp_{min}$	15.6	°C
2	BOD_5	250.0	mg/L
3	TSS	250.0	mg/L
4	$SRT_{Assumed}$	8.0	days
5	Yeild	0.98	kg TSS/kg BOD_5
6	Sludge Production	12	kg TS
7	Effluent TSS - MBBR	295	mg/L

Standard Operating Procedures

- SOP – Start up Operating Mode
- SOP – MBBR Sludge Wasting Protocol
- SOP – Red Flags
- SOP – Monitoring Protocol

- Operating Conditions
- Testing Methods and Sampling Requirements

MBBR COMMISSIONING

STANDARD OPERATING PROCEDURE

PROCEDURE	Start Up Operating Mode
PREPARED BY	Chandler Johnson
EFFECTIVE DATE	1 MAY, 2018
REVIEW DATE	1 MAY, 2018

PROCEDURE FOR STARTING UP MBBR SYSTEM:

1) If system does not have media installed yet, aeration test is required.
2) Aeration Test:
    a. Fill tank with water (potable / non-potable) to 3 ft level mark
    b. Turn on blowers minimum speed
    c. Notice aeration pattern in the tank for levelness and adjust as needed.
3) Media Fill:
    a. Once aeration test is finished, fill tank to 75% level with wastewater.
    b. Fill in the media and turn blower on minimum speed to aid in the mixing of the media.
    c. Add Water to full water level if needed to aid in the media mixing.
4) Media Mixing:
    a. Allow system to aerate for a short period of time (few days to 1 week) to get all the media mixing in the tank. Once media is mixing well, forward flow can start to the system.
5) System feeding:
    a. Start up system if possible at 25% feed rate to feed system at a lower rate to grow the bacteria for degradation of the BOD. If not possible, feed system at 100% and system performance will grow over time.

PROCEDURE FOR SYSTEM MONITORING:

1) Monitor system for pH, DO, temperature on a daily basis and log into data log sheet.

2) Take samples for COD, TSS, NH3-N and PO4-P on a routine basis and during startup watch how the system reacts to increase in flow / load and effluent performance.

MBBR COMMISSIONING

STANDARD OPERATING PROCEDURE

PROCEDURE Responses, troubleshooting, and plan to mitigate “Red Flags”

PREPARED BY Chandler Johnson

EFFECTIVE DATE 1 MAY, 2018

REVIEW DATE 1 MAY, 2018

PURPOSE: To help the operators identify, response, troubleshoot, and mitigate “Red Flags” that indicate early warning signs of process failure or stable conditions that can lead to a process failure.

PROCEDURE: The below table outlines scenarios, trends, and performance data indicative of an unstable MBBR operation that can lead to a process failure. Likewise, the table has each Red Flag’s corresponding responses, troubleshooting, and mitigating procedure.

“Red Flags” response, troubleshooting, and plan to mitigate				
Red Flags	**Target Value**	**Response**	**Troubleshooting**	**Plan to Mitigate**
pH	>6.7 < 8.0	(1) If pH is outside these limits than process is exhibiting some sort of process upset, (2) if the system is designed to nitrify and there is lack of alkalinity, then pH could drop.	(1) check if the Influent quality has changed. Check for excessive foaming in the MBBR tank. (2) Clean the pH probe. Check accuracy of pH probe using standards. (3) check effluent nitrate / nitrite values to confirm if nitrification is taking place	(1) Do not make large changes to influent feed rate to the system. (2) Check weekly the accuracy of the pH probe, recalibrate or replace if needed. (3) if system is lacking alkalinity, add sodium bicarbonate to aid in nitrification. If no nitrification is required, reduce blower air setpoint to reduce DO concentration.

"Red Flags" response, troubleshooting, and plan to mitigate				
Red Flags	**Target Value**	**Response**	**Troubleshooting**	**Plan to Mitigate**
DO goes up while no setpoint changes made	>2.5 - 3.0 mg/L (typical)	If DO is increasing with no setpoint changes, influent BOD load could be low and thus less food for the system to eat and have excess air / DO.	(1) Check influent flow and COD to the system to confirm load (2) Clean the DO and probe. Check accuracy of DO probe.	(1) System will exhibit low load periods - that is not a harm to the system and will operate with elevated DO at times. (2) Check weekly the accuracy of the DO probe, recalibrate or replace if needed.
Low DO Concentration	< 2.5 - 3.0 mg/L (typical)	If there is excess flow and COD the higher load could cause the system to exhibit lower DO concentrations at times.	(1) Check in fluent flow and COD to confirm if load is high, (2) Check DO probe for damage and clean probe. Notify Lead MBBR Operator.	Keep the DO probe clean. Adjust air to ensure you are maintaining adequate DO values.
Level in MBBR tank rising	Std Side Water Depth	Monitor the system to see how the water level in the tank is normal to high.	Check effluent sieve to confirm no media blockage which would increase headloss in the tank	Keep good mixing in the tank so that the effluent sieve is not having any headloss.
Large foam layer	n/a	The MBBR usually has a foam layer while in aeration step. Visually inspect the foam layer in the MBBR tank to familiarize with the normal layer height, color, and type of foam (small or large bubbles).	Inspect tank for foam layer and if blower speed is too high.	If foam is excessive, use water based antifoam chemicals to aid in the reduction of their size. (2) turning down blower could also limit foaming if system is exhibiting high DO values.

MBBR SLUDGE WASTING PROTOCOL

STANDARD OPERATING PROCEDURE

PROCEDURE	MBBR Sludge Wasting Protocol
PREPARED BY	Chandler Johnson
EFFECTIVE DATE	1 MAY, 2018
REVIEW DATE	1 MAY, 2018

PURPOSE: To establish a set procedure that ensures the wasting rate of biomass is done on a consistent basis for good operation.

PROCEDURE: The below checklist is provided for doing sludge wasting from the system.

Procedure:**Daily**
The MBBR produces excess sludge on a consistent basis and will settle out in the settling basin.
Typically the effluent TSS from the MBBR is in the 250 mg/L – 350 mg/L range
The Settled TSS is estimated at 2,500 mg/L to 5,000 mg/L in the settled zone.
It is suggested to pump settled sludge from the clarifier zone into the sludge holding tank where sludge will be held until disposed of off site
Use sludge judge to measure the depth of sludge in the clarifier to determine when it needs to be pumped out.

MBBR MONITORING PROTOCOL

STANDARD OPERATING PROCEDURE

PROCEDURE MBBR Monitoring Protocol

PREPARED BY Chandler Johnson

EFFECTIVE DATE 1 MAY, 2018

REVIEW DATE 1 MAY, 2018

PURPOSE: To establish a set procedure that ensures that the sampling and daily and weekend checks for the MBBR process are performed properly and consistently.

PROCEDURE: The below schedule outlines the required process checks and sample tests for the MBBR system during the commissioning stage.

Target Time	Procedure:**Daily**
7 am-9 am	Review the MBBR Daily Data Entry (DDE) Sheet from the previous day and confirm there are no outstanding actions. Check for any faults/alarms/Equalization (EQ) Tank level. If there are any alarms/faults note in the DDE sheet. Rectify fault immediately if possible. Monday through Friday collect daily samples from the MBBR and EQ. Analyze for soluble COD, NH3-N, TSS, Alkalinity (if system nitrifies). Record sample results in the MBBR DDE sheet. Use Sludge Judge to measure sludge volume in the clarifier for wasting requirements. Record all information required in MBBR DDE.
9 am–11 am	Do a visual inspection of each MBBR to observe color, foam/floating sludge, abnormal noise or vibration of equipment, aeration bubble pattern, etc. Record any abnormalities and inform supervisor as required. Review system operation and check for any faults/alarms/EQ tank level. If there are any alarms/faults note in the MBBR daily data entry sheet. Rectify fault immediately if possible.
Continuously	Keep an eye on influent feed quality and MBBR reactor level.
Weekend	Saturday and Sunday monitor pH, DO, Temp and see how stable system is operating

Procedure:**Weekly**
Inspect pH, and DO probes in each MBBR and clean if not performed in past 7 days, or sooner if necessary. Inspect any other instrumentation provided to ensure properly working. Inspect Blower discharge pressure to see if any change Record all information required in Notes.
Procedure: **Monthly**
Inspect blower belt and oil levels. Inspect influent pumps for clogging and impeller wear. Record all information required in Notes.

Samples to analyze

Sample	Sample location	How to analyze	How to interpret results
Ammonia NH3-N	EQ tank - gab or composite sample	Send sample to Lab for analysis	Monitor Ammonia level in EQ tank. It should not vary more than 40 - 50 mg/L.
Ammonia NH3-N	MBBR Reactor	Send sample to Lab for analysis	Target (if system provides nitrification): 90% of Influent Ammonia removal ~100 to 300 mg/L (residual requirement of < 5 mg/L) Cause: Deficient O2 Action: Increase aeration volume (Blower % VFD) Cause: Inhibition/Toxicity Action: Troubleshoot individual possibilities
Nitrite NO2-N	MBBR Reactor	Send sample to Lab for analysis	Target: <2 mg/L, > 3 to 5 mg/L Ok for startup,
Nitrate NO3-N	MBBR Reactor	Send sample to Lab for analysis	Target: 1:1 ratio for NO3-N/ NH3-N removed
TSS	EQ tank and MBBR reactor	Send sample to the Lab for analysis	EQ tank – less than 350 mg/L(maximum amount). MBBR Reactor at full load – 250 to 350 mg/L. This an average and each reactor/site is different.
Alkalinity	MBBR Reactor	Send sample to the Lab for analysis	Residual alkalinity in the reactor 100 – 150 mg/L as CaCO3
sCOD and Total COD	EQ tank (Reactor influent) and MBBR Reactor	Send sample to Lab for analysis	Max Influent Design Concentration – 600 - 700 mg/L Effluent soluble CO Concentration – 30 - 50 mg/L If effluent sCOD values fluctuate, a die off of heterotrophs can cause a large foaming event.
Ortho-P (PO4-P)	MBBR Reactor	Send sample to Lab for analysis	Per the biological requirements of PO4-P - WWW recommends having 1 ppm of PO4-P for every 200 ppm of degradable COD. It is also recommended to have 2 ppm of excess PO4-P leaving the MBBR treatment system to ensure the PO4-P is in excess for the biology.

TEST METHODS & SAMPLING REQUIREMENTS

1. The following Sampling and Analytical Parameters table provides the minimum parameters for sampling and analysis. Supplier reserves the right to witness the sampling and testing and to take portions of the samples for analysis in its own laboratories.
2. The publication, Standard Methods for Examination of Water and Wastewater, most recent edition, shall be used as the primary laboratory and analytical procedure source, unless otherwise agreed to by Supplier. All other analyses, data reduction or tests not specified in that publication or otherwise specified shall be carried out using procedures furnished or approved by Supplier.
3. In the case of continuous reading instrumentation, OWNERJCONTRACTOR shall calibrate instrumentation at least once per week during the entire test period. Calibration reports shall be available if requested by Supplier.

Sampling and Analytical Parameters		
Parameter	Sample Type	Frequency
Plant Flow, Influent/Effluent, gpd	Continuous	Daily
TSS, Influent/Effluent, mg!L	24 hr Composite	Daily
cBODS, Influent, mg/L	24 hr Composite	Daily
Soluble cBODS, Effluent, mg/L	24 hr Composite	Daily
Total Kjeldahl Nitrogen (1KN), Influent/Effluent, mg!L	24 hr Composite	Daily
NH3-N, Influent/Effluent, mg/L	24 hr Composite	Daily
Ortho-Phosphate (P04-P), Influent/Effluent, mg/L	24 hr Composite	Daily
pH, Influent/Effluent, SU	24 hr Composite	Daily
Alkalinity, Influent, mg!L as CaC03	24 hr Composite	Daily
Temperature, Influent/Effluent, °C	Continuous	Daily

12 APPENDIX A: Installation & Operation Manuals for Other Equipment

HYDROSTATIC LEVEL TRANSMITTER (QTY-1)

Prior to starting any work, read the operating instructions!
Keep for later use!

Vor Beginn aller Arbeiten Betriebsanleitung lesen!
Zum späteren Gebrauch aufbewahren!

Lire le mode d'emploi avant de commencer toute opération !
A conserver pour une utilisation ultérieure !

¡Leer el manual de instrucciones antes de comenzar cualquier trabajo!
¡Guardar el manual para una eventual consulta!

Contents

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Declarations of conformity can be found online at www.wika.com

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1. General information

EN

Safety instructions for hazardous locations:

- ▶ Take note of the safety instructions for Ex applications. These safety instructions are attached as “Additional instructions” to each instrument with Ex approval and are part of the operating instructions manual.

- The instrument described in the operating instructions has been designed and manufactured using state-of-the-art technology. All components are subject to stringent quality and environmental criteria during production. Our management systems are certified to ISO 9001 and ISO 14001.
- These operating instructions contain important information on handling the instrument. Working safely requires that all safety instructions and work instructions are observed.
- Observe the relevant local accident prevention regulations and general safety regulations for the instrument’s range of use.
- The operating instructions are part of the product and must be kept in the immediate vicinity of the instrument and readily accessible to skilled personnel at any time. Pass the operating instructions onto the next user or owner of the instrument.
- Skilled personnel must have carefully read and understood the operating instructions prior to beginning any work.
- The general terms and conditions contained in the sales documentation shall apply.
- Subject to technical modifications.
- Further information:
  - Internet address: www.wika.de / www.wika.com
  - Relevant data sheet: LM 40.04
  - Application consultant: Tel.: +49 9372 132-0
    Fax: +49 9372 132-406
    info@wika.com

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2. Design and function

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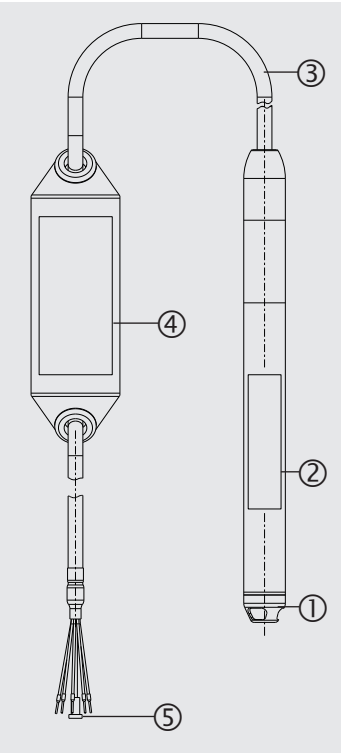
2.1 Overview



① Protection cap
② Product label
③ Connection cable
④ Measuring point tag with product label
⑤ Vent tube with filter element

EN

2.2 Functional description

The prevailing hydrostatic pressure is measured at the sensor element through the deformation of a diaphragm. By supplying power, this deformation of the diaphragm is converted into an electrical signal. The output signal from the submersible pressure sensor is amplified and standardised. The output signal is proportional to the measured hydrostatic pressure.

HART® (option)

The instrument version with HART® can communicate with a controller (master).

Measuring range scaling (turndown)

The start and end of the measuring range can be set within the measuring range.
Do not exceed a turndown of 10:1.

2.3 Scope of delivery

- Submersible pressure sensor
- Operating instructions
- Test report
- Measuring point tag for fixing to the cable end
- Further certificates (optional)

Cross-check scope of delivery with delivery note.

3. Safety

3.1 Explanation of symbols

WARNING!
... indicates a potentially dangerous situation that can result in serious injury or death, if not avoided.

CAUTION!
... indicates a potentially dangerous situation that can result in light injuries or damage to property or the environment, if not avoided.

Information
... points out useful tips, recommendations and information for efficient and trouble-free operation.

3.2 Intended use

The submersible pressure sensor is used to convert hydrostatic pressure into an electrical signal.

Only use the submersible pressure sensor in applications that lie within its technical performance limits (e.g. max. ambient temperature, material compatibility, ...).

→ For performance limits see chapter 9 “Specifications”.

For information on use in hazardous areas or with flammable media, refer to Additional Information 14209917.

The instrument has been designed and built solely for the intended use described here, and may only be used accordingly.

The manufacturer shall not be liable for claims of any type based on operation contrary to the intended use.

3.3 Personnel qualification

Skilled personnel
Skilled personnel, authorised by the operator, are understood to be personnel who, based on their technical training, knowledge of measurement and control technology and on their experience and knowledge of country-specific regulations, current standards and directives, are capable of carrying out the work described and independently recognising potential hazards.

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3.4 Labelling, safety marks

Product label

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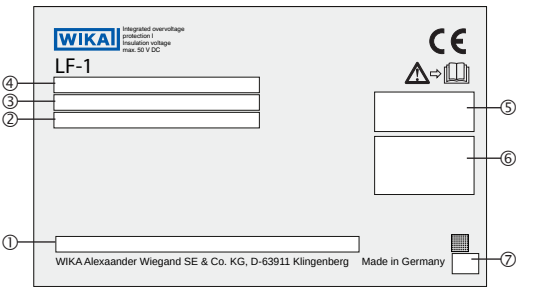

① Model code
② P# Article number / S# Serial number
③ Supply voltage / Total current consumption
④ Measuring range / Output signal
⑤ Approvals
⑥ Pin assignment
⑦ Date of manufacture

Before mounting and commissioning the instrument, ensure you read the operating instructions!

DC voltage

4. Transport, packaging and storage

4.1 Transport

Check the submersible pressure sensor for any damage that may have been caused by transport.
Obvious damage must be reported immediately.
Make sure that the connection contacts are not damaged.

4.2 Packaging and storage

Do not remove packaging until just before mounting.
Keep the packaging as it will provide optimum protection during transport (e.g. change in installation site, sending for repair).

Prior to storage, clean the submersible pressure sensor thoroughly (→ see chapter 7.3.2 “Cleaning”)

Permissible conditions at the place of storage:

- Storage temperature: -40 ... +80 °C [-40 ... +176 °F]
- Humidity: 45 ... 75 % relative humidity (no condensation)

Avoid exposure to the following factors:

- Direct sunlight or proximity to hot objects
- Mechanical vibration, mechanical shock (putting it down hard)
- Soot, vapour, dust and corrosive gases
- Humid or wet environment
- Hazardous environments, flammable atmospheres

5. Commissioning, operation

5.1 Unpacking

When unpacking, do not use any sharp objects (e.g. cutter knives), as this may damage the cable.

Submersible pressure sensors with cable lengths >100 m are wound on cable drums and wrapped with foil.
Unwind the foil manually. The end of the foil is marked with blue tape.

5.2 Suitability for the process conditions

All components of the instrument that are in contact with the process must be suitable for the process conditions that may exist. Included in this are particularly the process pressure, process temperature and also the chemical properties of the media. Prior to commissioning, the suitability of the instrument must be ensured (→ for specifications, see chapter 9 “Specifications” and the product label).

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5. Commissioning, operation

5.3 Requirements for mounting point

The mounting point must meet the following conditions:

- The diaphragm is protected from contact with abrasive media and against any impacts.
- The cable contains a capillary for the pressure compensation. Therefore, the cable must be connected in a dry space or a suitable terminal enclosure.
- Sufficient space for a safe electrical installation.
- Permissible ambient and medium temperatures remain within the performance limits.
  For performance limits see chapter 9 “Specifications”.

5.4 Connecting the instrument

5.4.1 Requirements for supply voltage

→ For supply voltage see product label

5.4.2 Requirements for electrical connection

- Cable diameter matches the cable bushing of the terminal enclosure.
- Cable gland and seals are correctly seated.
- No humidity can ingress at the cable end.

5.4.3 Requirement for shielding and grounding

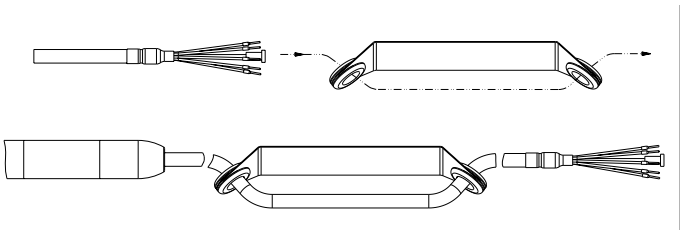
The submersible pressure sensor must be shielded and grounded in accordance with the grounding concept of the plant.

5.4.4 Fitting the measuring point tag

Before the submersible pressure sensor is wired, the measuring point tag must be attached to the cable. The measuring point tag acts to identify the submersed instrument and contains a copy of the product label.

1. Remove the packaging at the cable end

2. Thread the measuring point tag onto the cable.
   The rubber stops at the measuring point tag protect the cable and must be undamaged and correct mounted.
   Position the measuring point tag so that, in the mounted state, it is easily reachable and protected against harsh environmental conditions.



5.4.5 Shortening the cable

The cable can be shortened as required.
With submersible pressure sensors with voltage output, a shortening of the cable results in an offset error:
≤ 0.014 % / m of shortened cable.

After the shortening, provide the wire ends with end splices and position the filter element on the vent tube.

5.4.6 Connecting the instrument to the electric system

- Connect the cables to the terminals.
- For voltage outputs, the load must be specified so that the output current does not exceed 1 mA.

Load
Current output: ≤ (U_+ -(U_{+min} - 0.5 V)) / 0.023 A
Voltage output: ≤ 1 mA

Additional load of the cable:
≤ cable length in m x 0.084 Ω

Pin assignment

4 ... 20 mA, 4 ... 20 mA + HART® (2-wire)	
U+	Brown (BN)
U-	Blue (BU)
Shield	Grey (GY)

2 x 4 ... 20 mA (2 x 2-wire, galvanically isolated)	
U+ (pressure sensor)	Brown (BN)
U- (pressure sensor)	Blue (BU)
U+ (temperature sensor)	Green (GN)
U- (temperature sensor)	White (WH)
Shield	Grey (GY)

DC 0.1 ... 2.5 V (3-wire, low power)	
U+	Brown (BN)
U-	Blue (BU)
S+	Black (BK)
Shield	Grey (GY)

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2 x DC 0.1 ... 2.5 V (3-wire, low power)	
U+	Brown (BN)
U-	Blue (BU)
S+ (pressure sensor)	Black (BK)
S+ (temperature sensor)	Green (GN)
Shield	Grey (GY)

Legend
U+ Positive power supply terminal
U- Negative power supply terminal
S+ Analogue output

5.4.7 Mounting the instrument

Prior to commissioning, the submersible pressure sensor must be subjected to a visual inspection.

- Leaking fluid is indicative of damage.
- Only use the submersible pressure sensor if it is in perfect condition with respect to safety.

The protection cap protects the internal diaphragm from damage during transport and during the lowering of the probe. With viscous or contaminated media, the protection cap can be removed in order to ensure trouble-free operation.

When laying the cable, a minimum bending radius of 120 mm must be ensured.

5.5 Configuring via HART® interface

The HART® modem with RS232, USB or Bluetooth interface (→ see Accessories) enables the connection of communicating instruments to the respective interface of a PC. To parameterise these instruments, operating software with COMM DTM HART® and Device DTM Generic HART® (e.g. PACTware®) is needed.

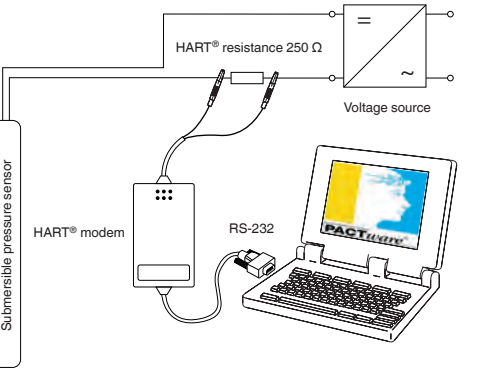
The PACTware® operating software and the required DTMs are available for download at www.wika.com.

EN

Connecting submersible pressure sensor to PC (HART®)
Any work should only be carried out in a non-hazardous area.

1. Connect HART® modem to submersible pressure sensor.
2. Connect HART® modem to PC or notebook.

With repeater power supplies with integrated HART® resistances (internal resistance approx. 250 Ω), no additional external resistance is necessary.



5.6 External display and control units

The DIH50 and DIH52 display and control units are suitable for measured value display and control of instruments with HART® protocol. The respective control unit is looped into the 4 … 20 mA + HART® signal line. For sensors without HART® protocol, the control units are suitable for measured value display.

For further information see the operating instructions of the respective display and control unit.

6. Faults

CAUTION!
Physical injuries and damage to property and the environment
If faults cannot be eliminated by means of the listed measures, the submersible pressure sensor must be taken out of operation immediately.

- ► Ensure that pressure or signal is no longer present and protect against accidental commissioning.
- ► Contact the manufacturer.
- ► If a return is needed, please follow the instructions given in chapter 8.2 “Return”.

6. Faults

WARNING!

Physical injuries and damage to property and the environment caused by hazardous media

Upon contact with hazardous media (e.g. oxygen, acetylene, flammable or toxic substances), harmful media (e.g. corrosive, toxic, carcinogenic, radioactive), and also with refrigeration plants and compressors, there is a danger of physical injuries and damage to property and the environment.

- ► Should a failure occur, aggressive media with extremely high temperature and under high pressure or vacuum may be present at the instrument.
- ► For these media, in addition to all standard regulations, the appropriate existing codes or regulations must also be followed.
- ► Wear the requisite protective equipment.

For contact details see chapter 1 “General information” or the back page of the operating instructions.

In the event of any faults, first check whether the submersible pressure sensor is mounted correctly, mechanically and electrically.

If complaint is unjustified, the handling costs will be charged.

Faults	Causes	Measures
No output signal	Cable break	Check the continuity
	Incorrect supply voltage connected	Rectify the supply voltage
Deviating zero point signal	Overpressure limit exceeded	Observe the permissible overpressure limit
	Too high/low working temperature	Observe the permissible temperatures
	Diaphragm damage	Replace instrument; if it fails repeatedly, contact the manufacturer
Zero point varies/inaccurate	Moisture has entered at the cable end	Fit the cable correctly
	Cable damaged	Replace instrument; if it fails repeatedly, contact the manufacturer
Signal span varies/inaccurate	Too high/low working temperature	Observe the permissible temperatures

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Faults	Causes	Measures
Signal span drops/too small	Mechanical overload caused by overpressure	Replace instrument; if it fails repeatedly, contact the manufacturer
	Diaphragm damage	Replace instrument; if it fails repeatedly, contact the manufacturer
Signal span drops	Moisture has entered at the cable end	Fit the cable correctly
	Cable damaged	Replace instrument; if it fails repeatedly, contact the manufacturer

7. Maintenance and cleaning

7.1 Maintenance

When used in strongly contaminated and adhesive media, the pressure port of the submersible pressure sensor has to be cleaned regularly. The cleaning interval is dependent upon the respective application. The checking and cleaning of the pressure port should thus be added to the maintenance plan.
Since the cleaning intervals are dependent on the operating conditions, no universal time periods can be specified.

Repairs must only be carried out by the manufacturer.

7.2 Cleaning

WARNING!
Physical injuries and damage to property and the environment through residual media
Residual media at the dismounted instrument can result in a risk to persons, the environment and equipment.

- ► With hazardous substances, observe the material safety data sheet for the corresponding medium.
- ► Wear the requisite protective equipment.

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CAUTION!

Unsuitable cleaning agents

Cleaning with unsuitable cleaning agents may damage the instrument and the product label.

- ► Do not use any aggressive cleaning agents.
- ► Do not use any hard or pointed objects.
- ► Do not use any abrasive cloths or sponges.

Suitable cleaning agents

- Water
- Conventional dishwashing detergent

Cleaning the instrument

1. Disconnect the submersible pressure sensor from the mains.
2. Wipe the instrument surface using a soft, damp cloth.

8. Dismounting, return and disposal

8.1 Dismounting

WARNING!

Physical injuries and damage to property and the environment caused by hazardous media

Upon contact with hazardous media (e.g. oxygen, acetylene, flammable or toxic substances), harmful media (e.g. corrosive, toxic, carcinogenic, radioactive), and also with refrigeration plants and compressors, there is a danger of physical injuries and damage to property and the environment.

- ► Should a failure occur, aggressive media with extremely high temperature and under high pressure or vacuum may be present at the instrument.
- ► Wear the requisite protective equipment.

Dismounting the instrument

1. Disconnect the submersible pressure sensor from the mains.
2. Disconnect the electrical connection.
3. Withdraw the submersible pressure sensor from the medium.

8. Dismounting, return and disposal

8.2 Return

EN

Strictly observe the following when shipping the instrument:
All instruments delivered to WIKA must be free from any kind of hazardous substances (acids, bases, solutions, etc.) and must therefore be cleaned before being returned.

WARNING!
Physical injuries and damage to property and the environment through residual media
Residual media in the dismounted instrument can result in a risk to persons, the environment and equipment.

- ► With hazardous substances, include the material safety data sheet for the corresponding medium.
- ► Clean the instrument, see chapter 7.2 “Cleaning”.

When returning the instrument, use the original packaging or a suitable transport packaging.

Information on returns can be found under the heading “Service” on our local website.

8.3 Disposal

Incorrect disposal can put the environment at risk.
Dispose of instrument components and packaging materials in an environmentally compatible way and in accordance with the country-specific waste disposal regulations.

Do not dispose of with household waste. Ensure a proper disposal in accordance with national regulations.

9. Specifications

EN

Specifications	
Measuring range	See product label
Overload safety	≥ 1.5 times
Temperature measurement (option)	See product label
Output signal	See product label
Load	
Current output	≤ (U_+ -(U_{+min} - 0.5 V)) / 0.023 A
Voltage output	≤ 1mA
Additional load of the cable	≤ cable length in m x 0.084 Ω
Supply voltage	See product label
Current consumption	
Current output	Max. 25 mA per output
Voltage output	Max. 5 mA
Accuracy (pressure sensor) (at reference conditions)	■ ≤ ±1 % of span ■ ≤ ±0.5 % of span (option)
Accuracy (temperature sensor)	
-10 ... +80 °C [14 ... 176 °F]:	±1.8 K
-30 ... -10 °C [-22 ... +14 °F]:	±3 K
-40 ... -30 °C [-40 ... -22 °F]:	±4.5 K
Accuracy after turndown 5:1 via HART®	■ ≤ ±1.25 % of scaled span ■ ≤ ±0.75 % of scaled span (option)
Non-linearity per IEC 61298-2	■ ≤ ±0.5 % of span BFSL ■ ≤ ±0.25 % of span BFSL (option)
Non-repeatability	■ ≤ 0.1 % of span ■ ≤ 0.2 % of span (with voltage output and cable length >100 m [325 ft])
Temperature error	See table “Temperature error”

9. Specifications

EN

Specifications		
Long-term stability per DIN 16086)		
Measuring range > 0 ... 0.1 bar	≤ ±0.1 % of span/year	
Measuring range ≤ 0 ... 0.1 bar	≤ ±0.2 % of span/year	
Reference conditions		
Ambient temperature	15 ... 25 °C [59 ... 77 °F]	
Atmospheric pressure	860 … 1,060 mbar [86 … 106 kPa /12.5 … 15.4 psig]	
Humidity	45 ... 75 % r. h.	
Supply voltage [1)]	With current output	DC 24 V
	With voltage output	DC 5 V
Mounting position	Calibrated in vertical mounting position with protection cap thread facing downwards.	
Ingress protection	IP68	
Insulation voltage	■ DC 850 V ■ Option of increased overvoltage protection for lightning strikes: DC 50 V	
Resistance to overvoltage	DC 40 V	
Reverse polarity protection	U+ vs. U-	
Short-circuit resistance	S+ vs. U-	
Immersion depth	Max. 100 m [325 ft]	
Max. tensile force of the cable	1,000 N	
Weight		
Submersible pressure sensor	Approx. 300 g	
Cable	Approx. 80 g/m	
Additional weight	300 g	
Permissible temperature ranges		
Medium	■ -10 ... + 50 °C [14 ... 122 °F] ■ Option: -40 ... +80 °C [-40 ... +176 °F]	
Ambient	-40 ... +80 °C [-40 ... +176°F]	

1) CSA approved submersible pressure sensors for general applications must be used with a certified CEC or NEC “Class 2” power supply or alternatively a certified limited power supply in accordance with CSA C22.2 60950-1/UL 60950-1.

9. Specifications

Specifications	
Storage	-30 ... +80 °C [-22 ... +176°F]
Switch-on time	
Output signals without HART®	≤ 150 ms
Output signals with HART®	≤ 250 ms
Settling time	
Output signals without HART®	≤ 100 ms
Output signals with HART®	≤ 250 ms
Materials (wetted)	
Case	316L (high-resistance option: 318LN)
Sensor	316L (high-resistance option: Hastelloy C276)
Cable	PUR (high-resistance option: FEP)
Sealing	FKM
Protection cap	PVDF
CE conformity	EMC directive, emission (group 1, class B) and interference immunity (industrial application)

For further specifications see WIKA data sheet LM 40.04 and the order documentation.

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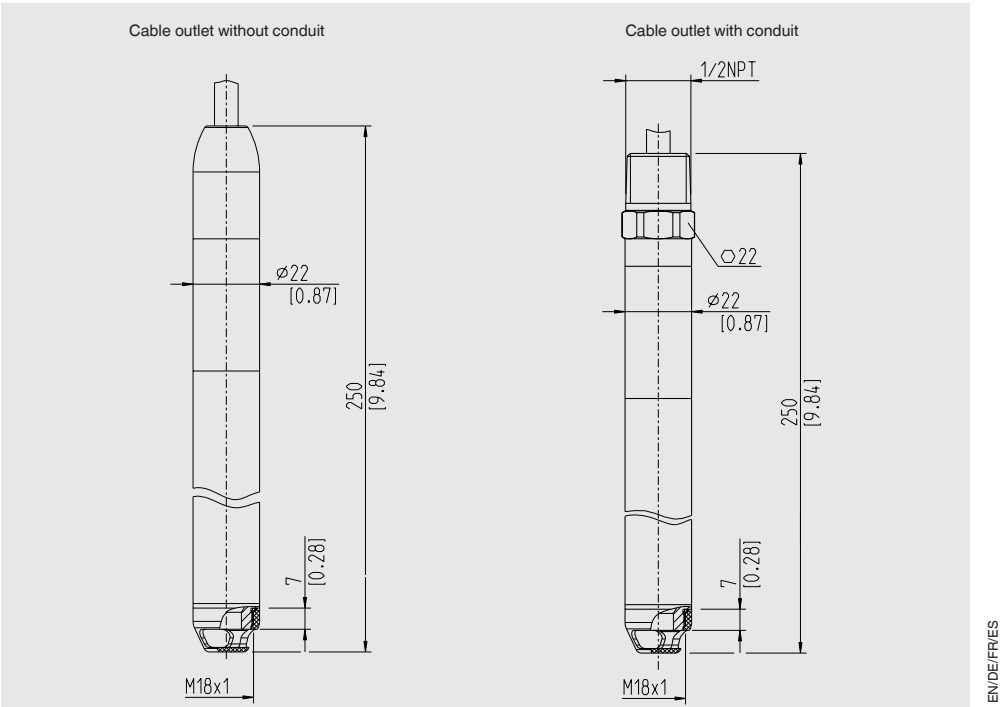
9. Specifications

Dimensions in mm [in]



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Qty (1): 5W4C50-C6ELHA0DUA1KGA
Qty (1): 5W4C80-C6ELHA0DUA1KGA

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

Table of contents

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

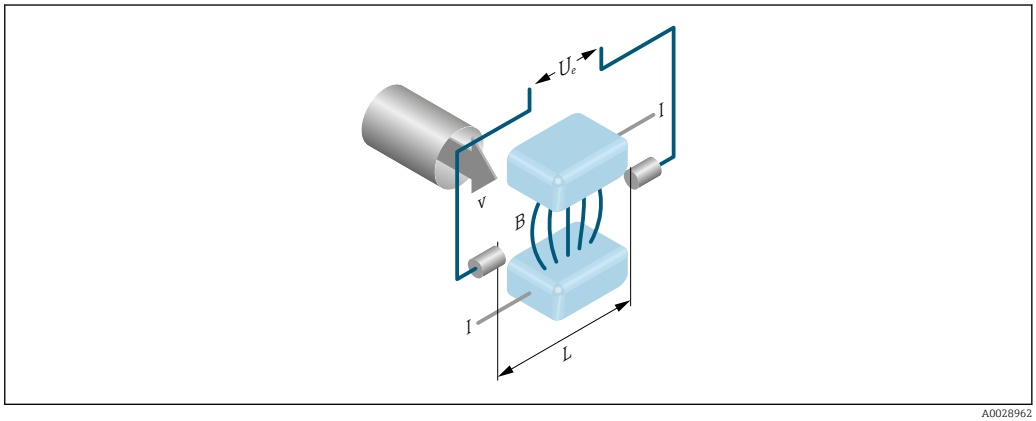
Symbols in graphics

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.



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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

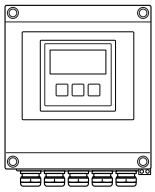
- Induced voltage $U_e = B \cdot L \cdot v$
- Volume flow $Q = A \cdot v$

Measuring system

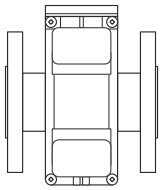
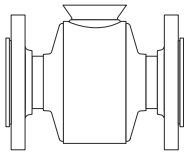
The device consists of a transmitter and a sensor.

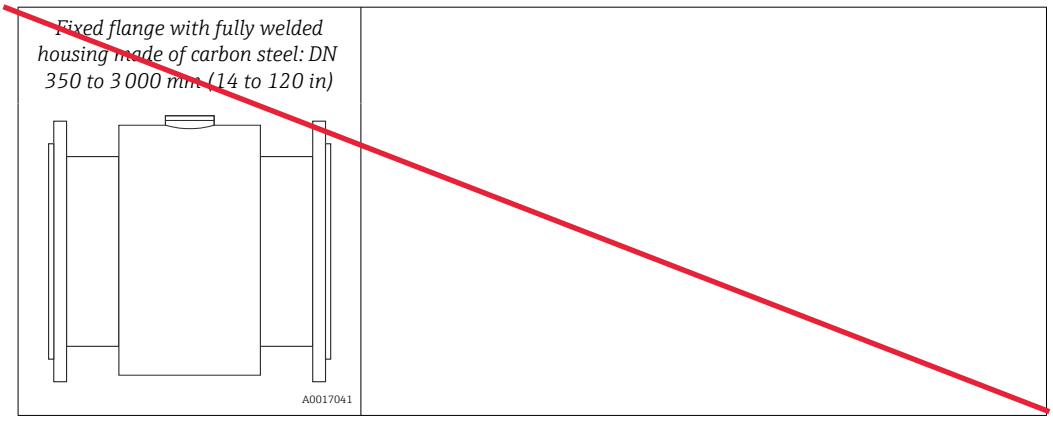
Two device versions are available:
- Compact version - transmitter and sensor form a mechanical unit.
- Remote version - transmitter and sensor are mounted in separate locations.

Transmitter

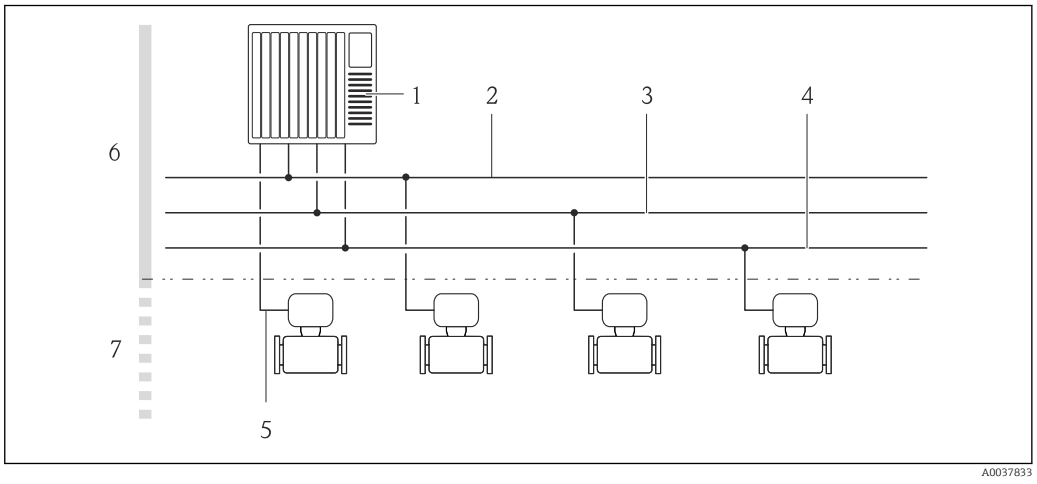
Proline 400
 
A0045222
	Device versions and materials:
	▪ Compact version: compact housing
	  ▪ Polycarbonate plastic
	  ▪ Aluminum, AlSi10Mg, coated
	▪ Remote version: wall-mount housing
	  ▪ Polycarbonate plastic
	  ▪ Aluminum, AlSi10Mg, coated
	
	Configuration:
	▪ External operation via four-line, 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

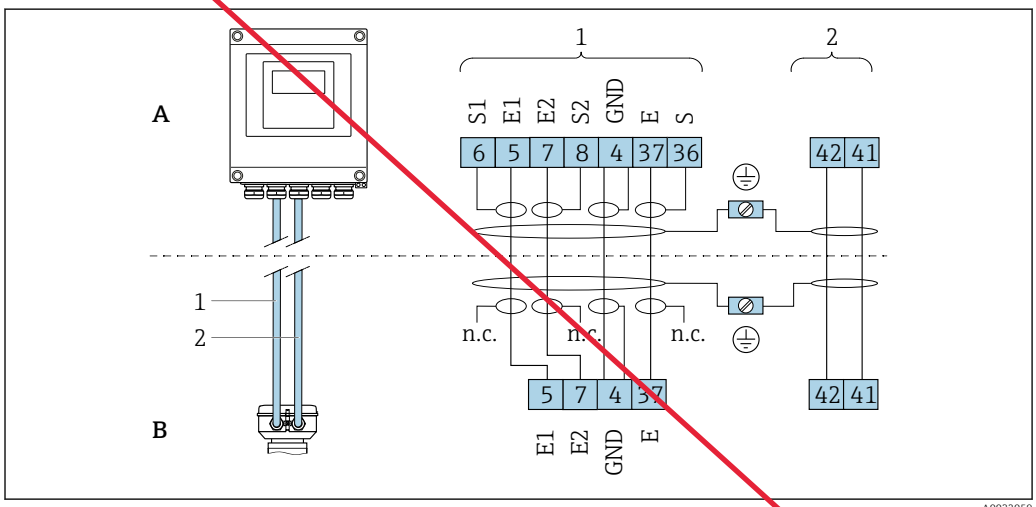
Supply voltage

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

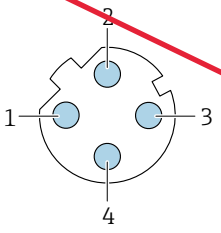
Terminal No. and cable colors: 6/5 = brown; 7/8 = white; 4 = green; 36/37 = yellow

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

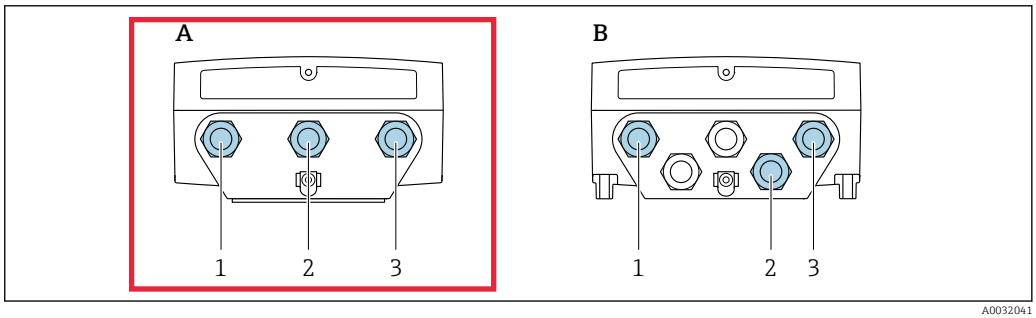
Order code for "Power supply"	Maximum Current consumption	Maximum switch-on current
Option **L**: AC 100 to 240 V	145 mA	25 A (< 5 ms)
Option **L**: AC/DC 24 V	350 mA	27 A (< 5 ms)

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

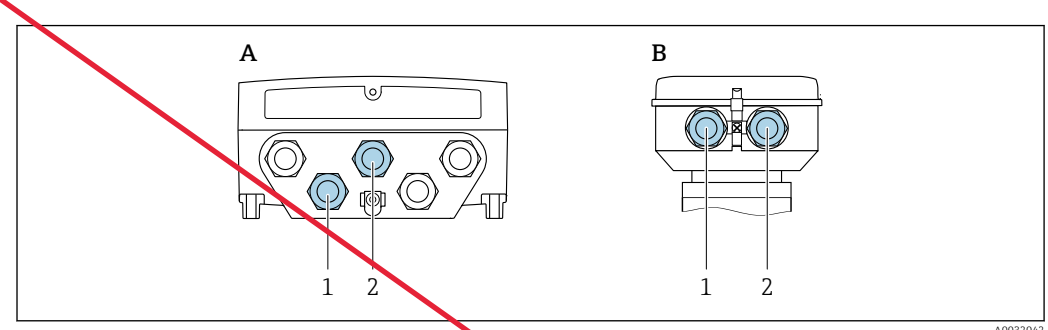


3 *Supply voltage and signal transmission connection*

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



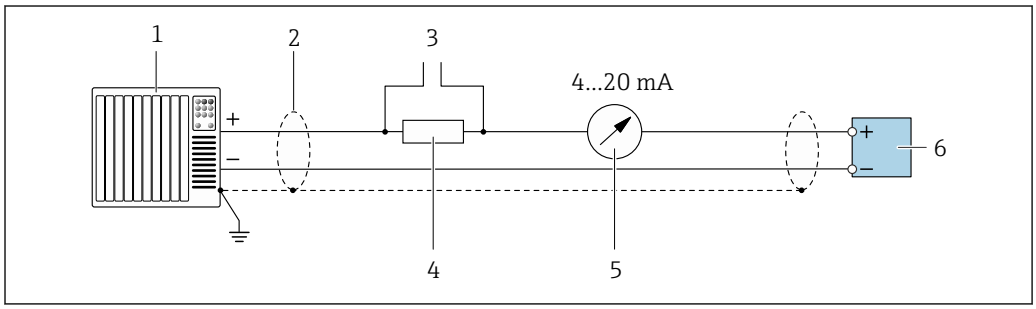
4 *Connecting cable connection: electrode and coil current cable*

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

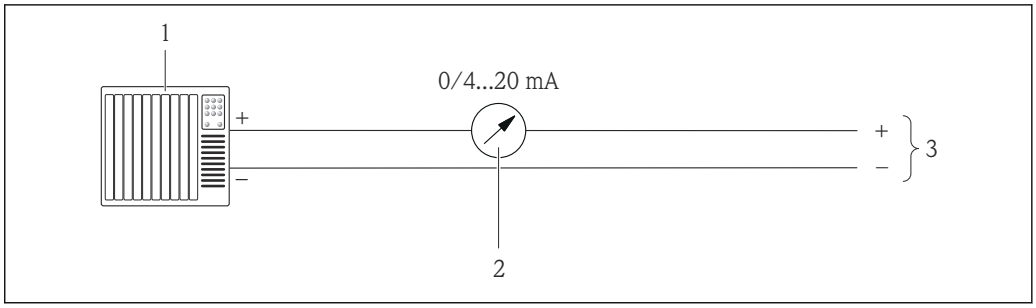
Current output 4 to 20 mA HART



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

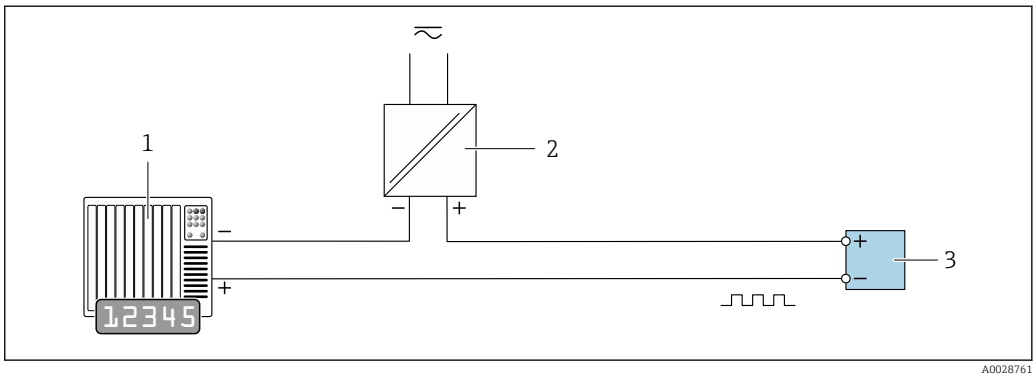
Current output 4 to 20 mA



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

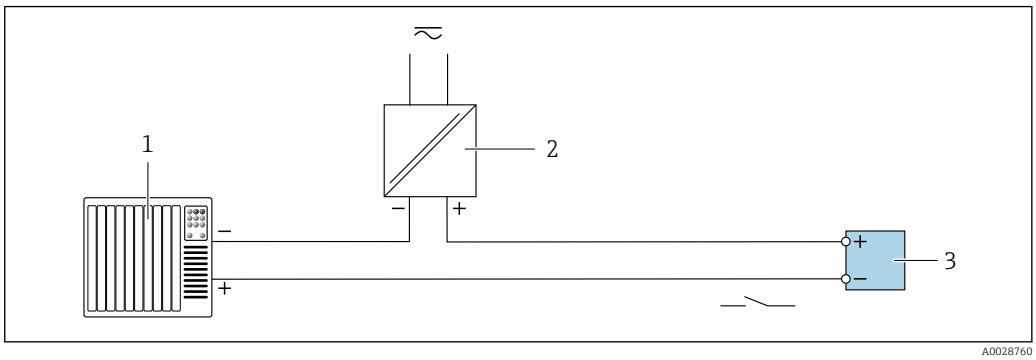
Pulse/frequency output



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

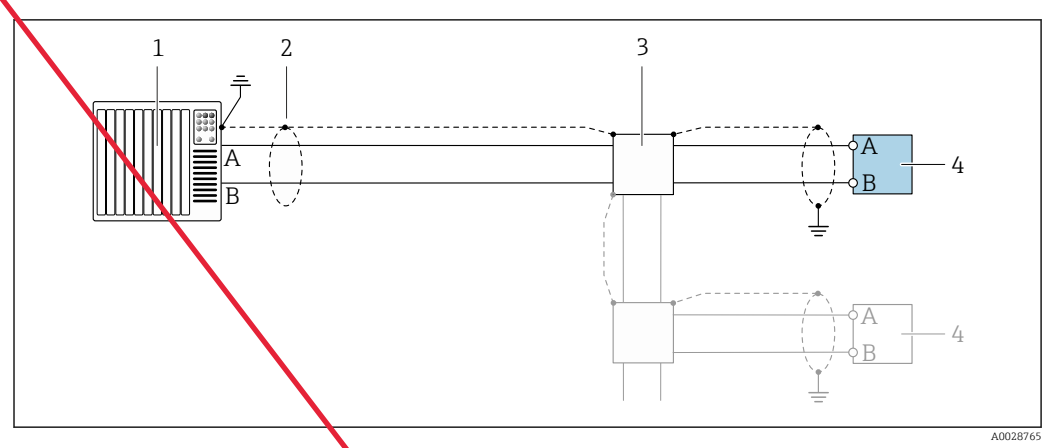
Switch output



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

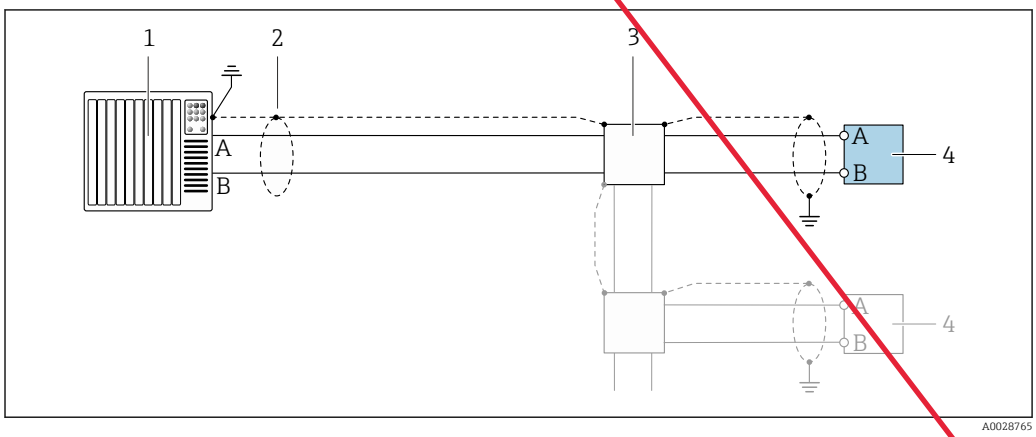


9 Connection example for PROFIBUS DP, non-hazardous area and Zone 2/Div. 2

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.

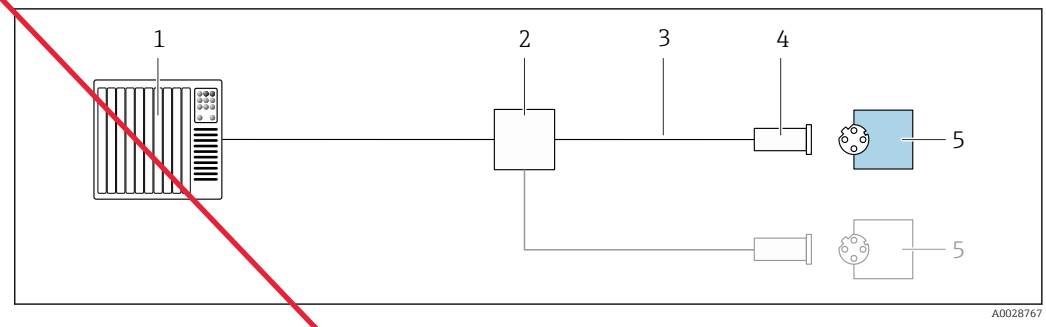
Modbus RS485



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

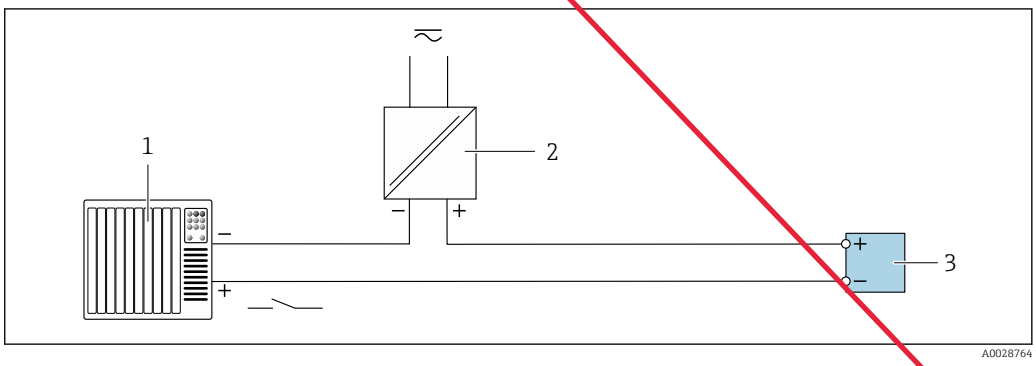
EtherNet/IP



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).

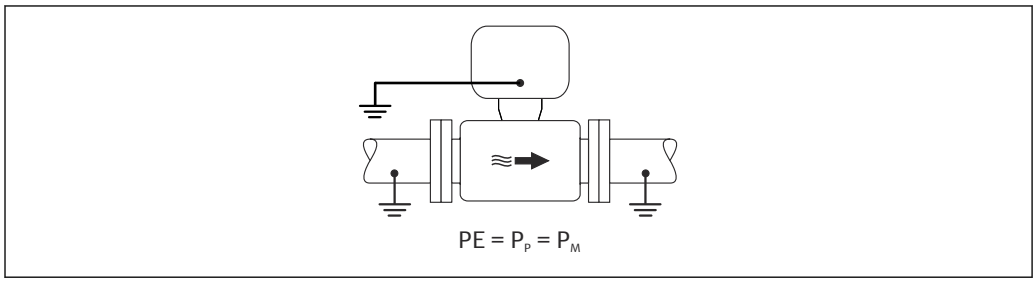
Abbreviations used
- PE (Protective Earth): potential at the protective earth terminals of the device
- P_P (Potential Pipe): potential of the pipe, measured at the flanges
- P_M (Potential Medium): potential of the medium

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



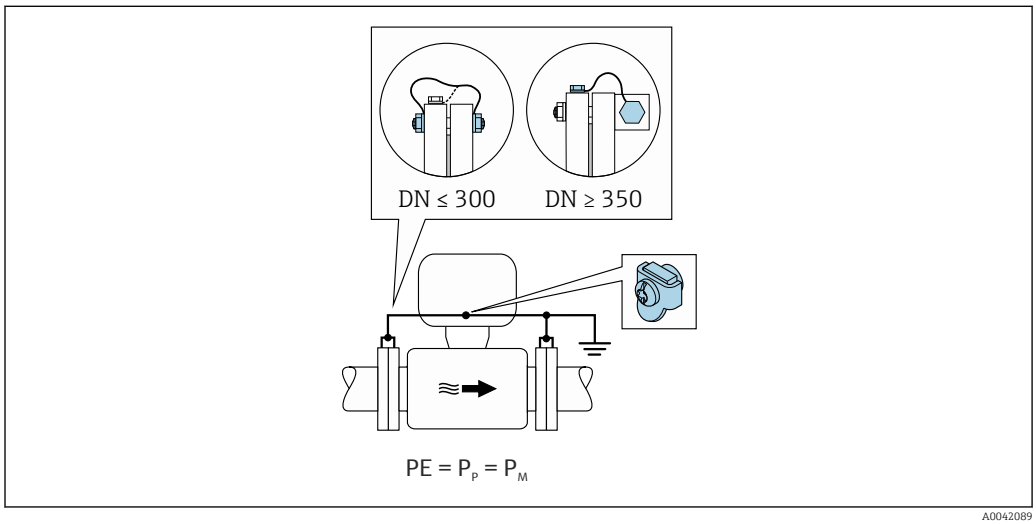
A0044854

▶ 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



A0042089

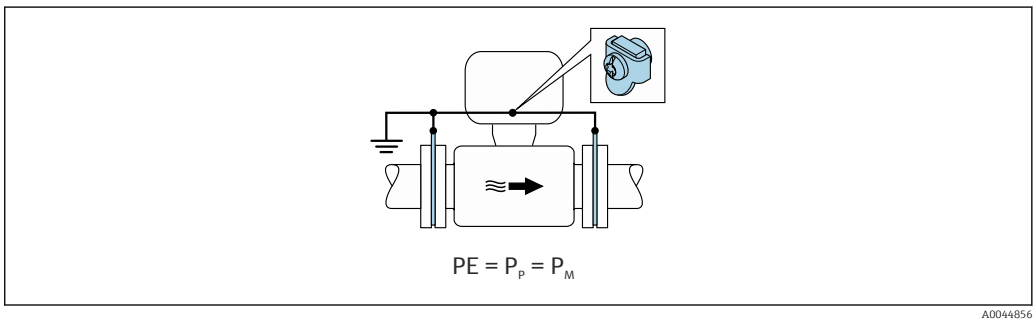
1. Connect both sensor flanges to the pipe flange via a ground cable and ground them.
2. Connect the connection housing of the transmitter or sensor to ground potential by means of the ground terminal provided for this purpose.

- 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.

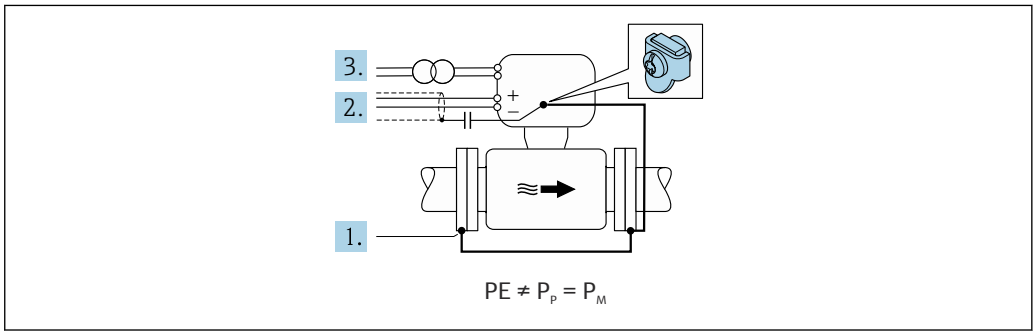
Connection example with the potential of the medium not equal to the protective ground

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

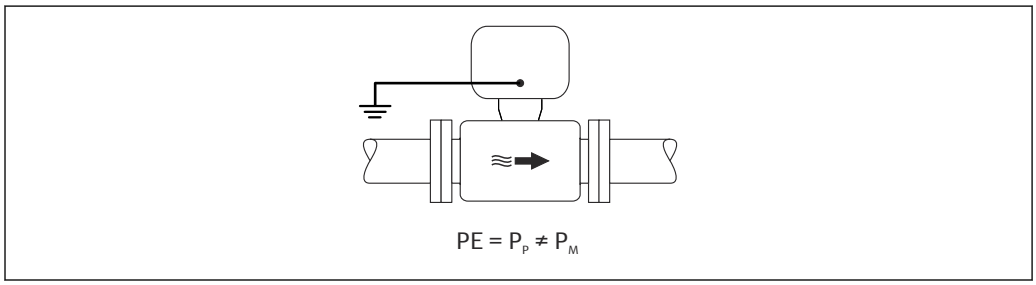
To achieve the specified conductivity measuring accuracy, a conductivity calibration is recommended when the device is installed.

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.



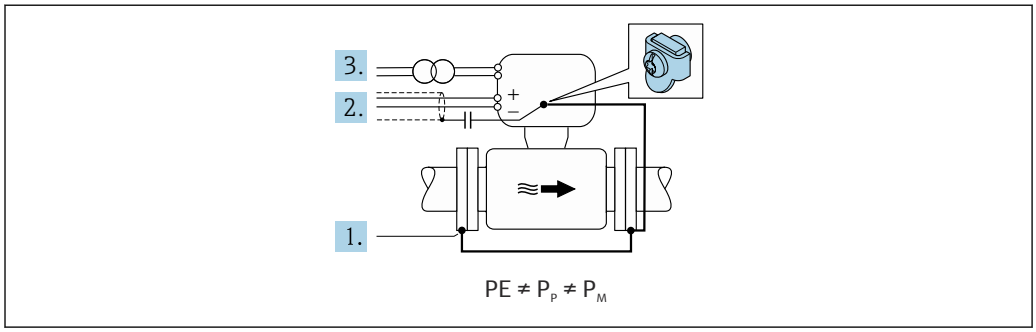
A0044855

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

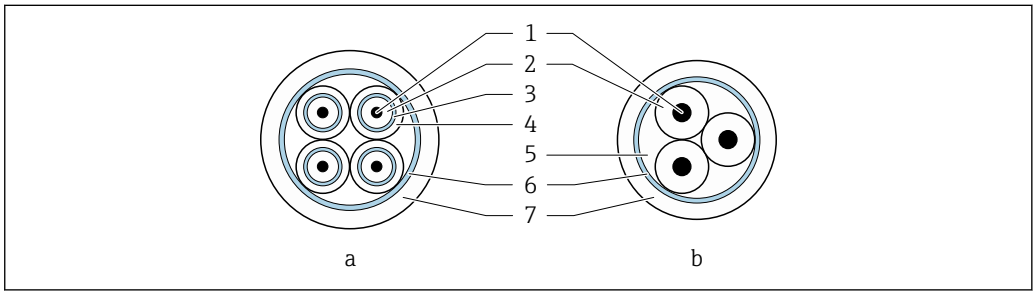
Electrode cable

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

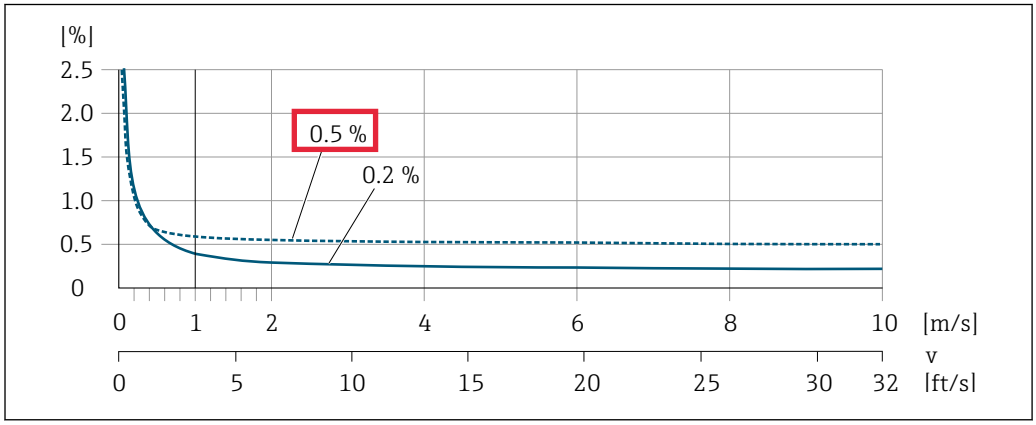
Maximum measured error

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)

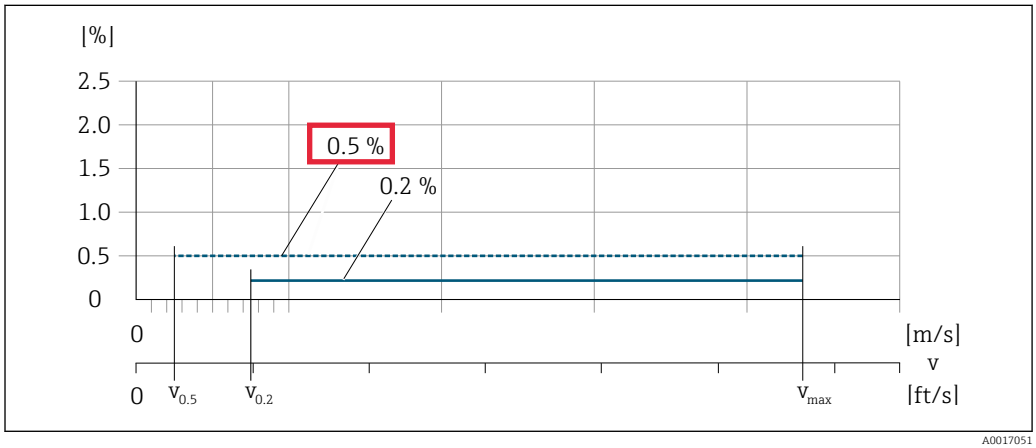
Fluctuations in the supply voltage do not have any effect within the specified range.



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 %

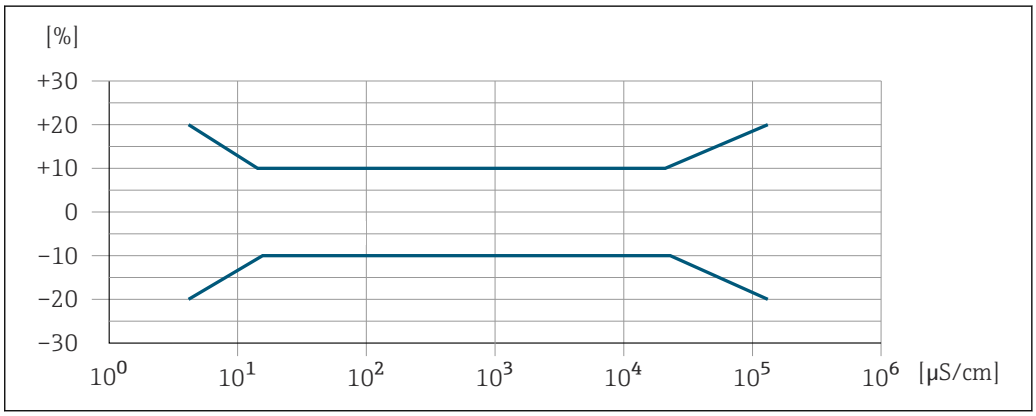
Nominal diameter		$v_{0.2}$		v_{max}	
[mm]	[in]	[m/s]	[ft/s]	[m/s]	[ft/s]
25 to 600	1 to 24	1.5	4.92	10	32
50 to 300 [1)]	2 to 12	0.6	1.97	4	13

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

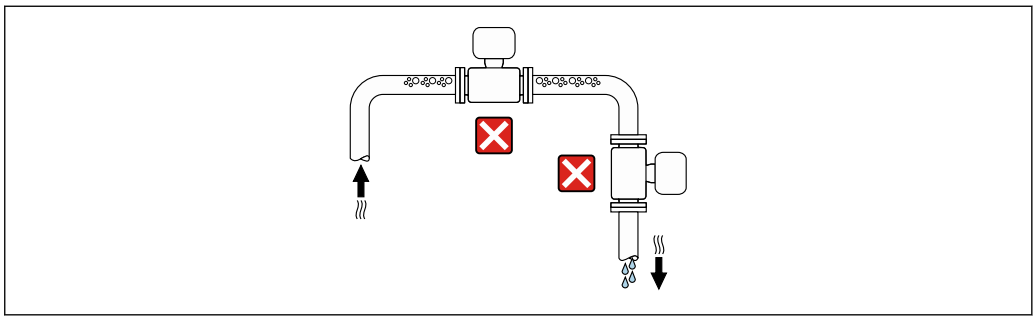
Pulse/frequency output

Temperature coefficient	No additional effect. Included in accuracy.

Installation

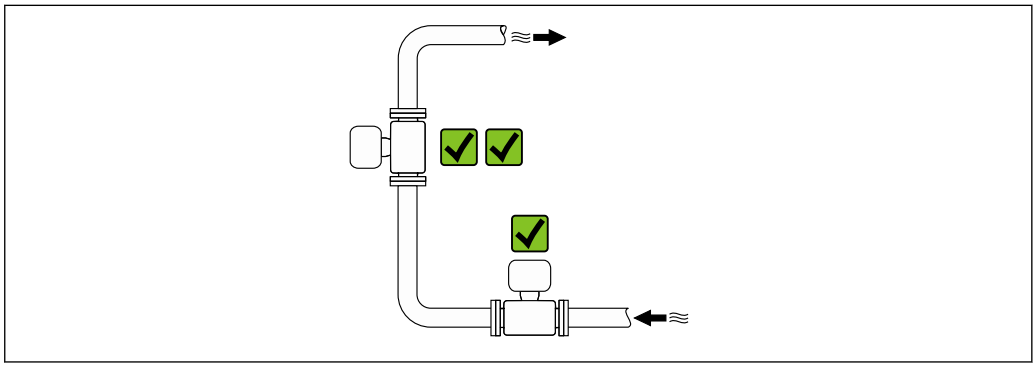
Mounting location

- 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

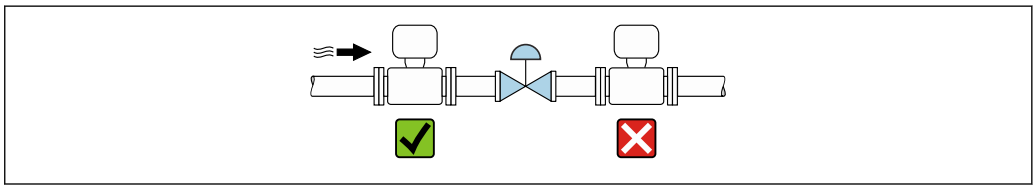
The device should ideally be installed in an ascending pipe.



A0042317

Installation near valves

Install the device in the direction of flow upstream from the valve.



A0041091

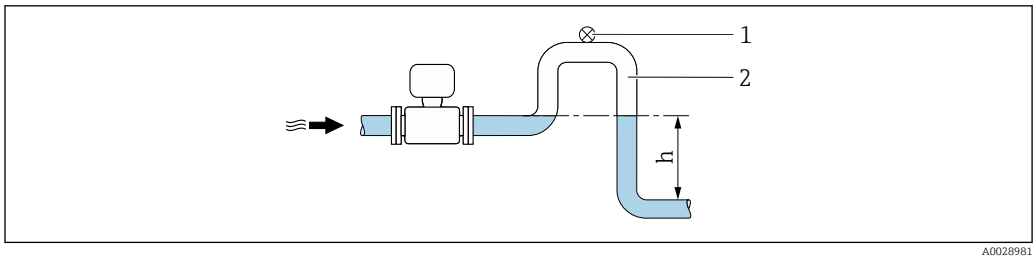
Installation upstream from a down pipe

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.

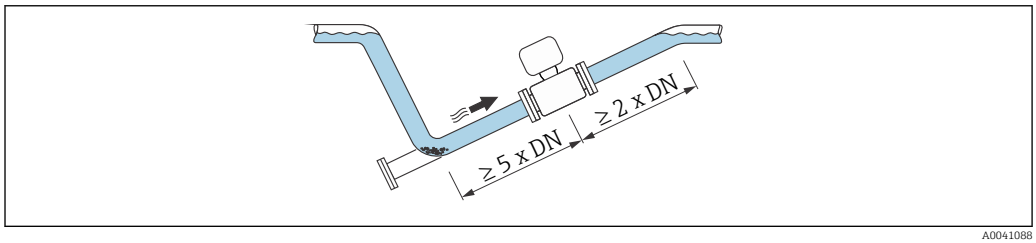


A0028981

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

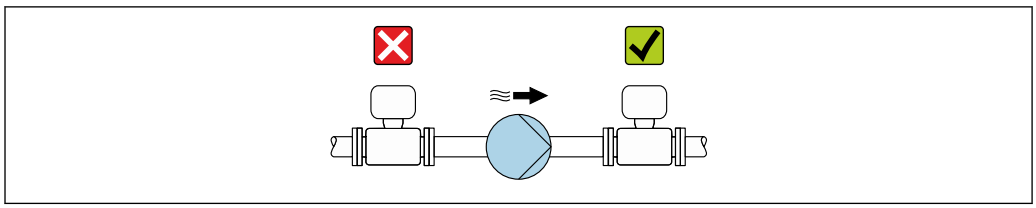
No inlet and outlet runs for devices with the order code for "Design": Option C, H, I, J or K.

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

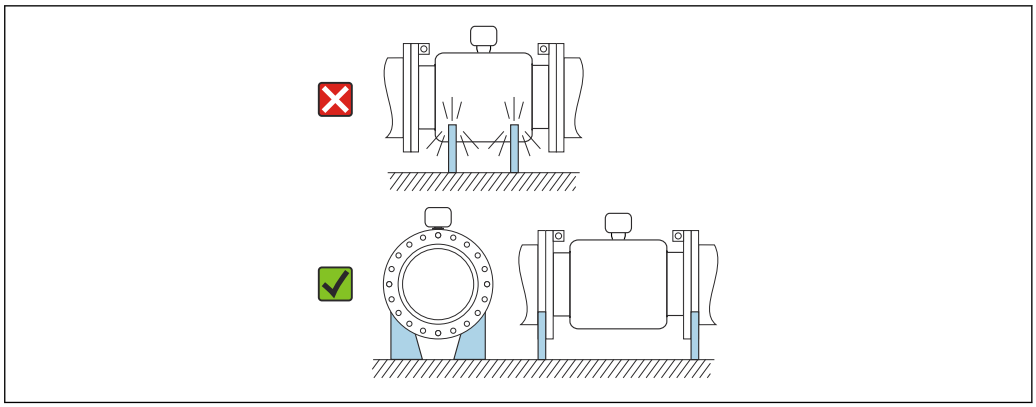
Support required for nominal diameters of DN ≥ 350 mm (14 in).

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

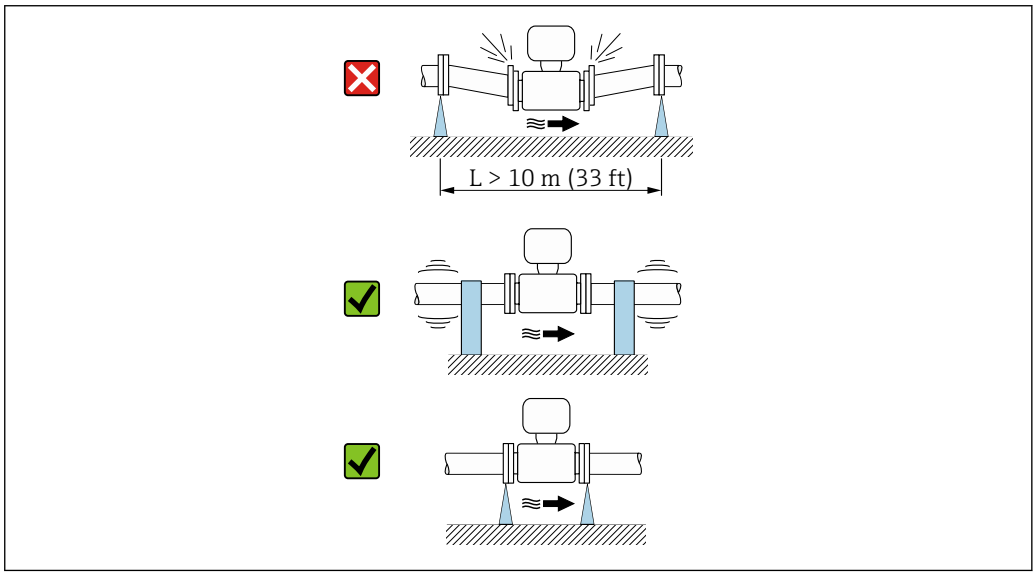
Installation in event of pipe vibrations

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.

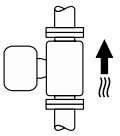
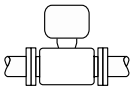
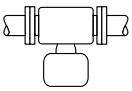
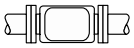


A0041092

Information on the measuring system's resistance to vibration and shock → 47

Orientation

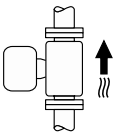
The direction of the arrow on the sensor nameplate helps you to install the sensor according to the flow direction (direction of medium flow through the piping).

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

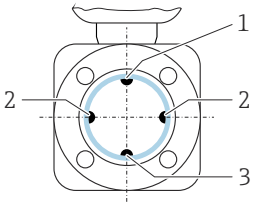
Optimum for self-emptying pipe systems and for use in conjunction with empty pipe detection.



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

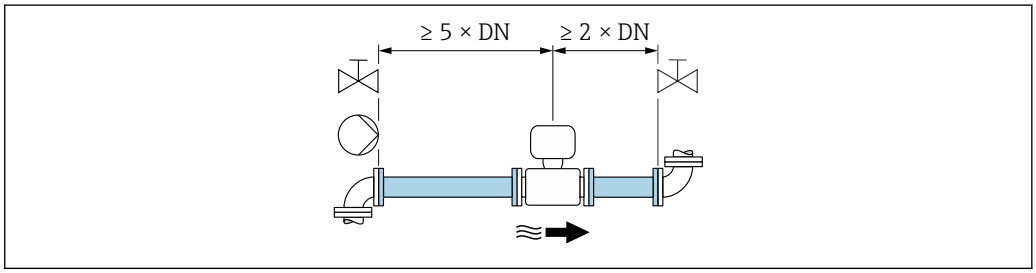
Installation with inlet and outlet runs

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.



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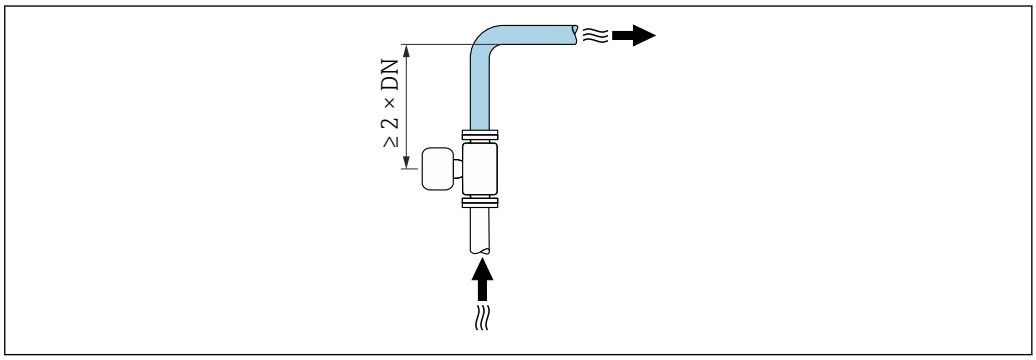

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Installation without inlet and outlet runs

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.

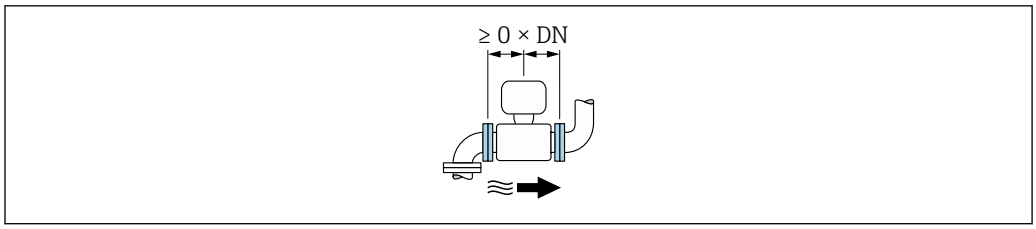
Devices and possible order options

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

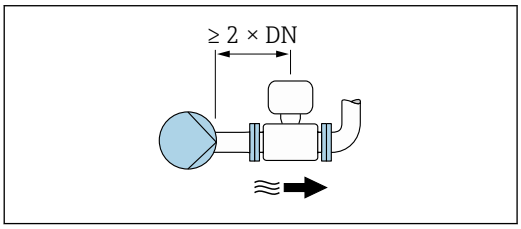
Installation without inlet and outlet runs is possible: devices with the order code for "Design", option C, H, I, J and K.



Installation downstream of pumps

Installation without inlet and outlet runs is possible: devices with the order code for "Design", option C, H and I.

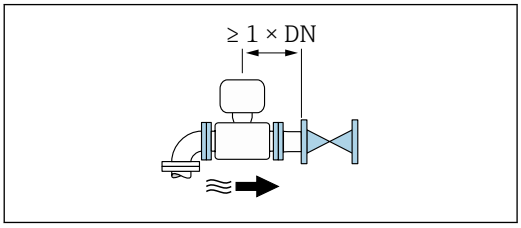
In the case of devices with the order code for "Design", option J and K, an inlet run of only ≥ 2 x DN must be taken into consideration.



Installation upstream of valves

Installation without inlet and outlet runs is possible: devices with the order code for "Design", option C, H and I.

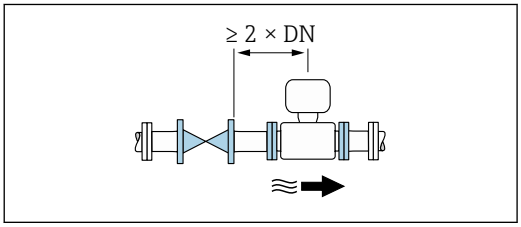
In the case of devices with the order code for "Design", option J and K, an outlet run of only ≥ 1 x DN must be taken into consideration.



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.



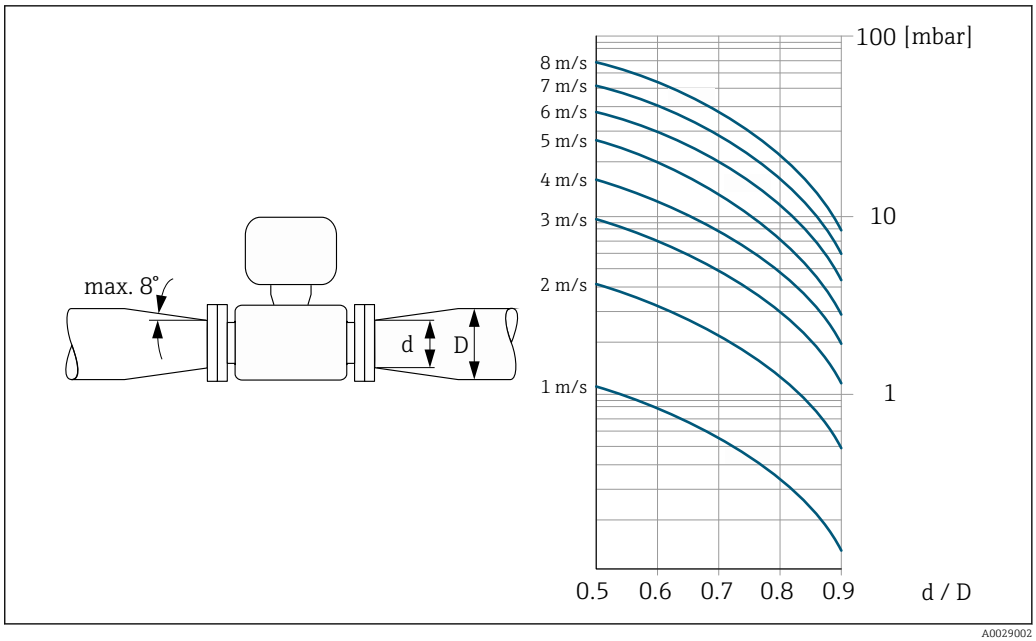
Adapters

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:

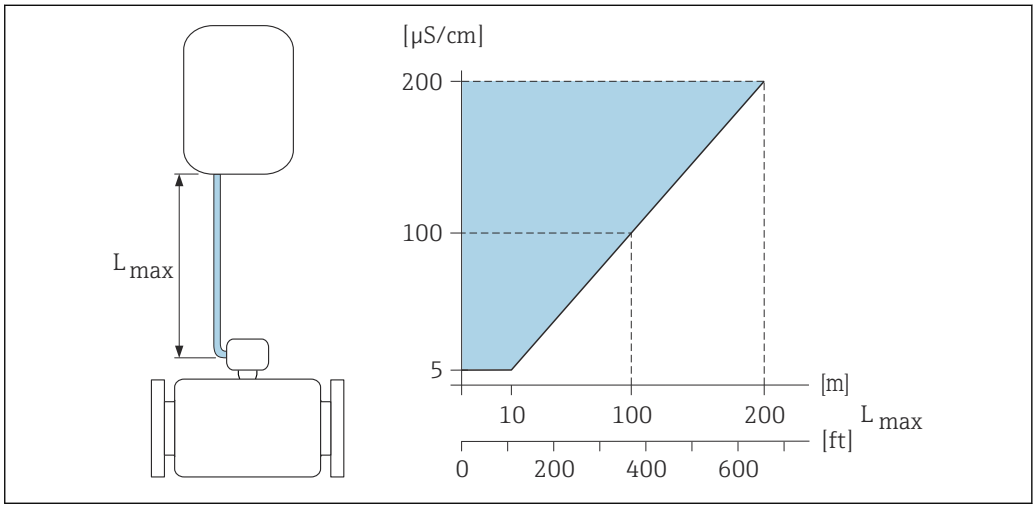
- Calculate the ratio of the diameters d/D.
- From the nomogram read off the pressure loss as a function of flow velocity (downstream from the reduction) and the d/D ratio.

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

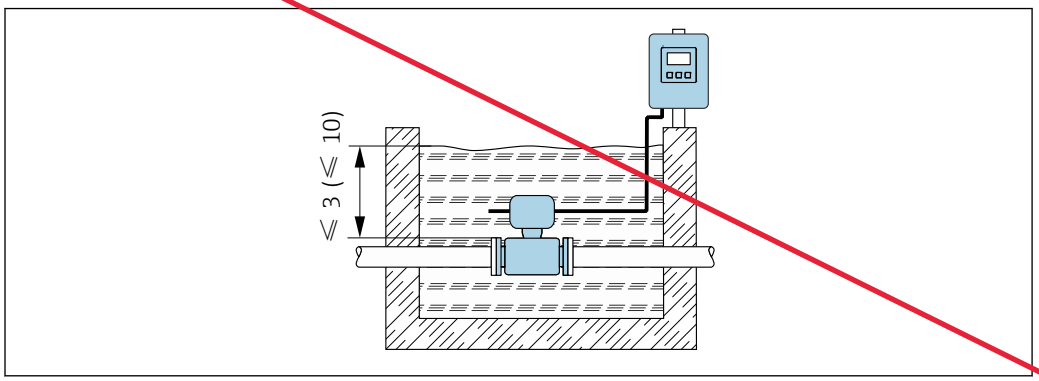
- For the operation of the device under water
- Operating duration at a maximum depth of:
  - 3 m (10 ft): permanent use
  - 10 m (30 ft): maximum 48 hours

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



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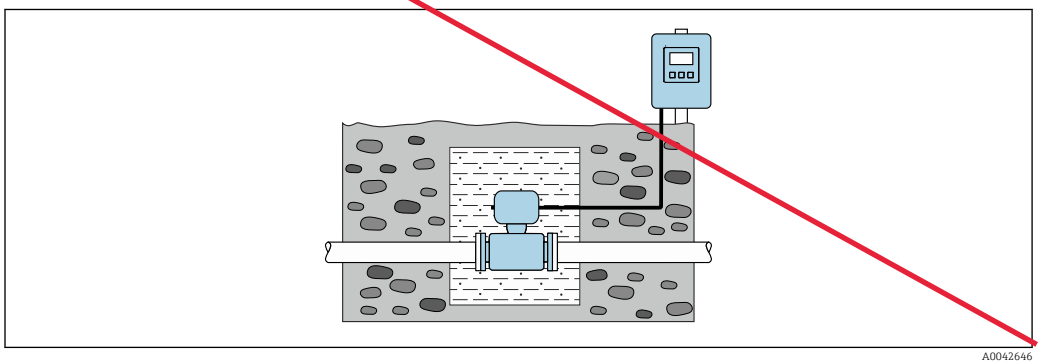
Use in buried applications

- 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.



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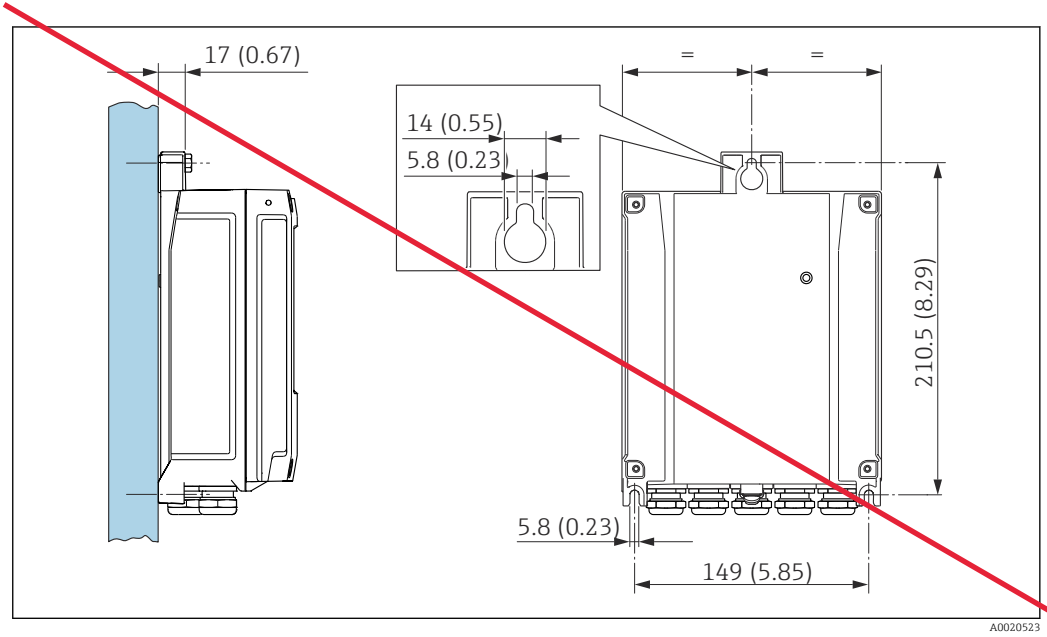
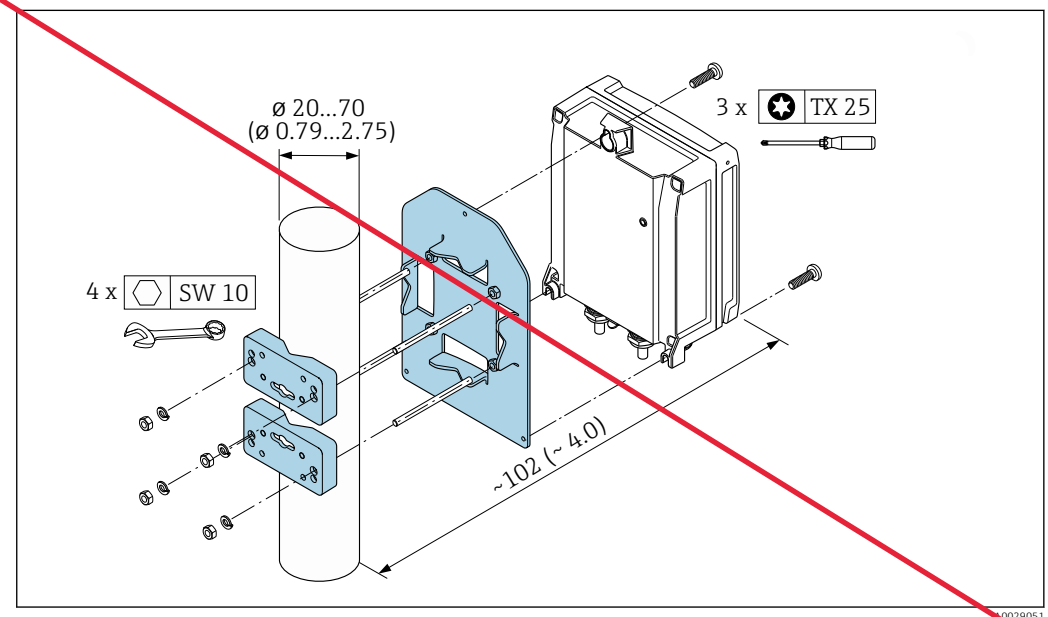
Mounting the transmitter housing

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

Option C6 Chosen:
Class I Div 2

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

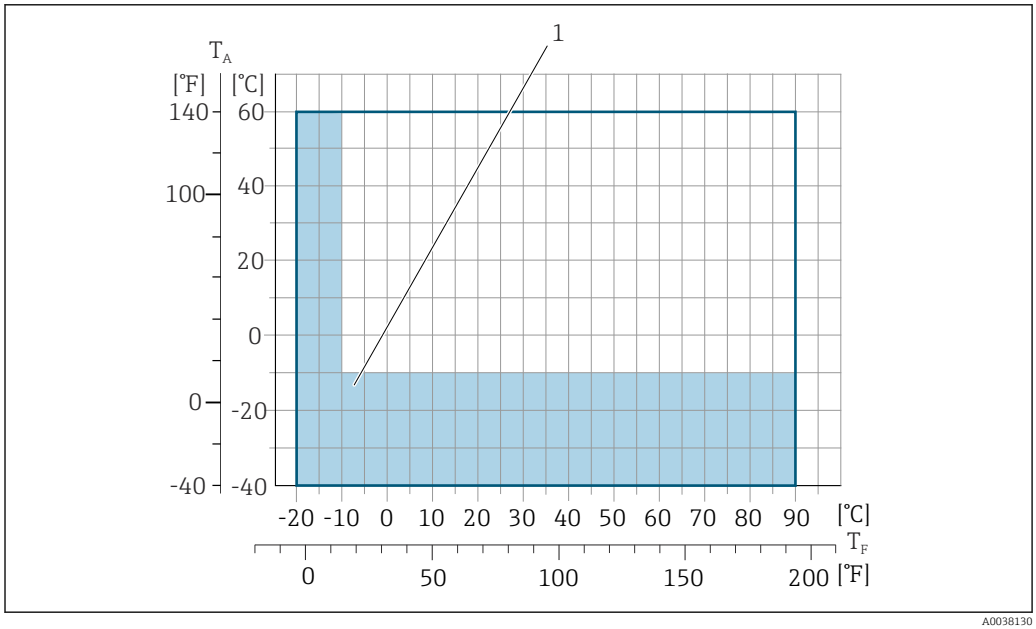
The following applies for PROFIBUS DP: If baud rates > 1.5 MBaud, an EMC cable entry must be used and the cable shield must continue as far as the terminal wherever possible.

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

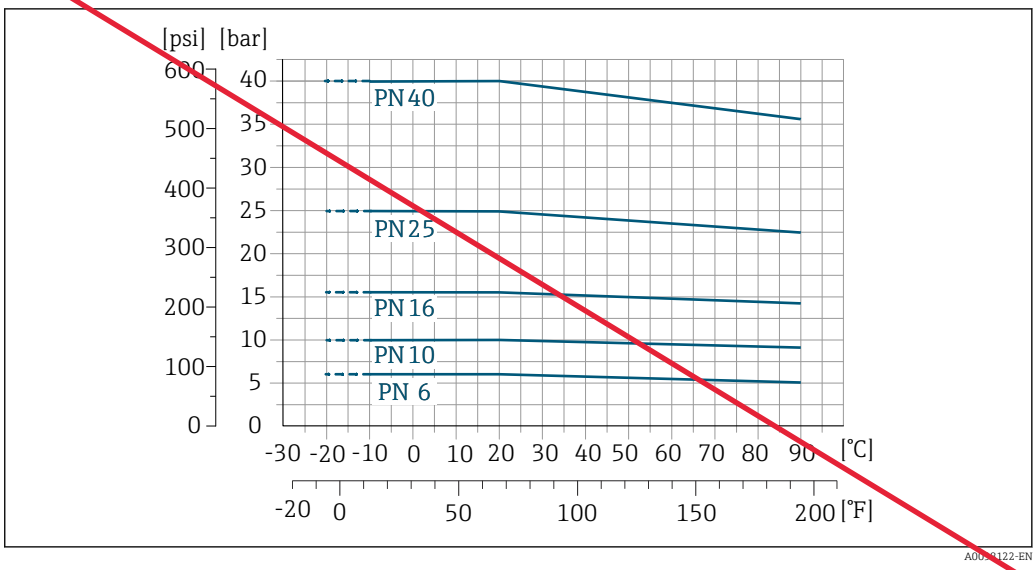
≥5 µS/cm for liquids in general.

- 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

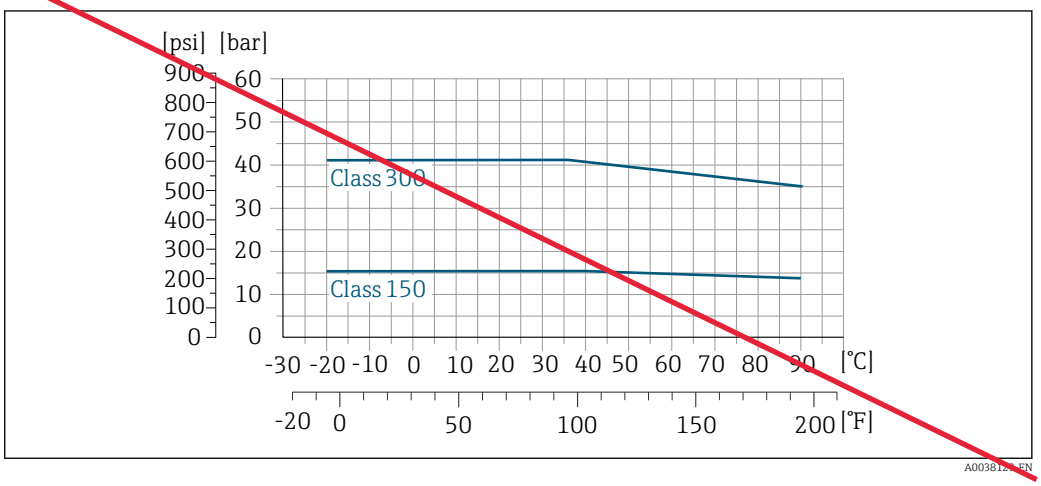
The following pressure/temperature diagrams apply to all pressure-bearing parts of the device and not just the process connection. The diagrams show the maximum permissible medium pressure depending on the specific medium temperature.

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))*

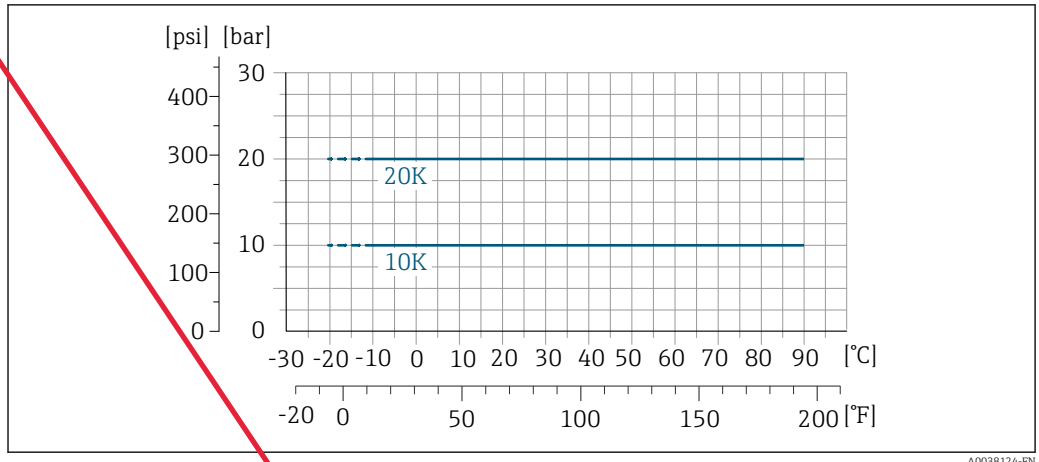
Process connection: fixed flange according to ASME B16.5



21 *Process connection material: stainless steel*

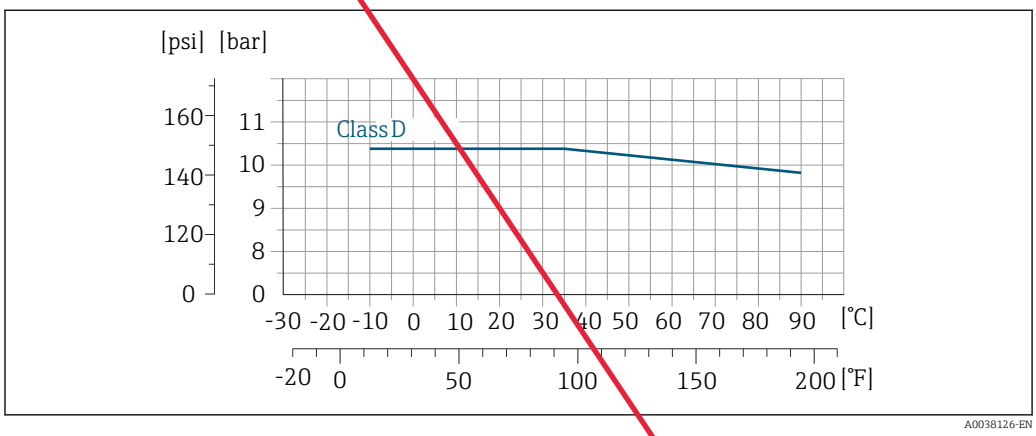
22 *Process connection material: carbon steel*

Process connection: fixed flange according to JIS B2220



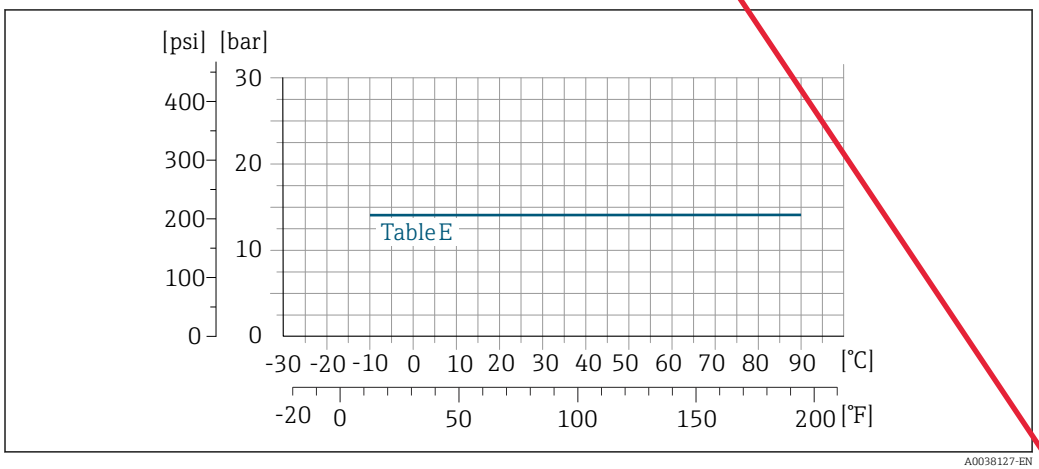
23 Process connection material: stainless steel (−20 °C (−4 °F)); carbon steel (−10 °C (14 °F))

Process connection: fixed flange according to AWWA C207



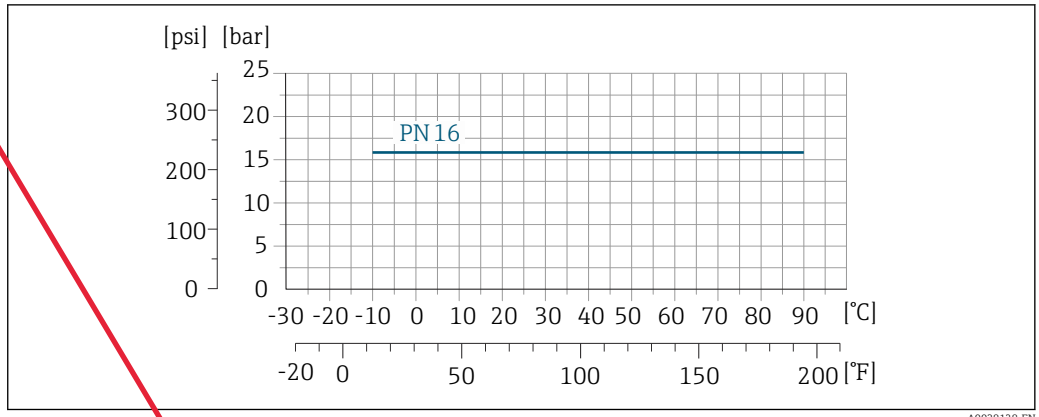
24 Process connection material: carbon steel

Process connection: fixed flange according to AS 2129



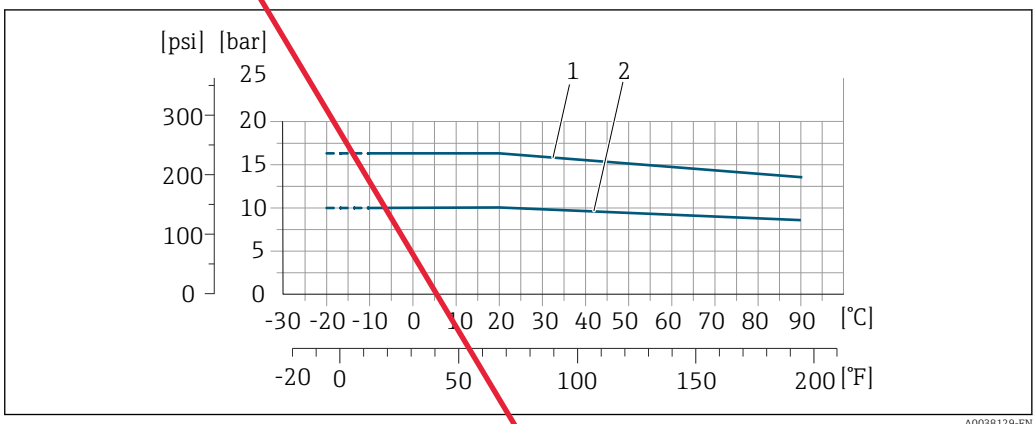
25 Process connection material: carbon steel

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)

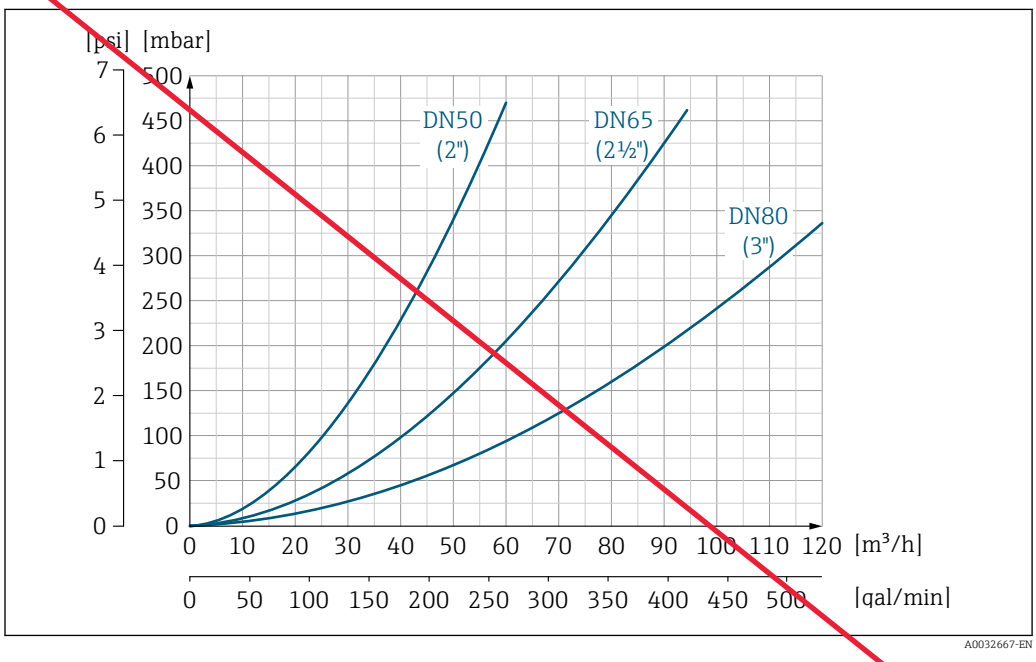
A necessary increase in the flow velocity can be achieved by reducing the sensor nominal diameter.

For an overview of the full scale values for the measuring range, see the "Measuring range" section → 8

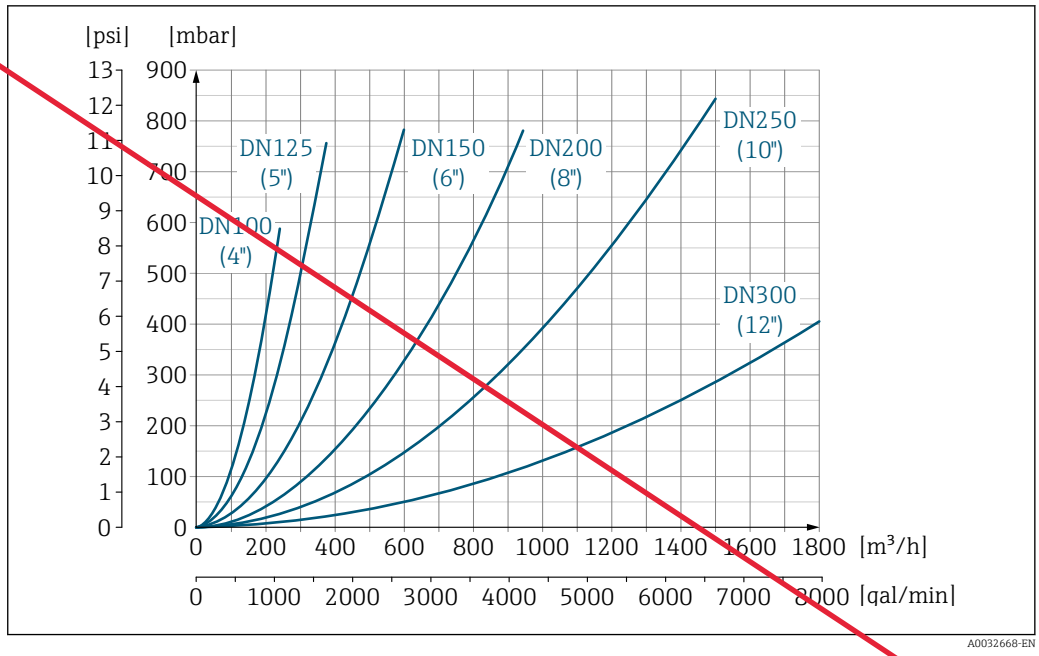
For custody transfer, the applicable approval determines the permitted measuring range.

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.

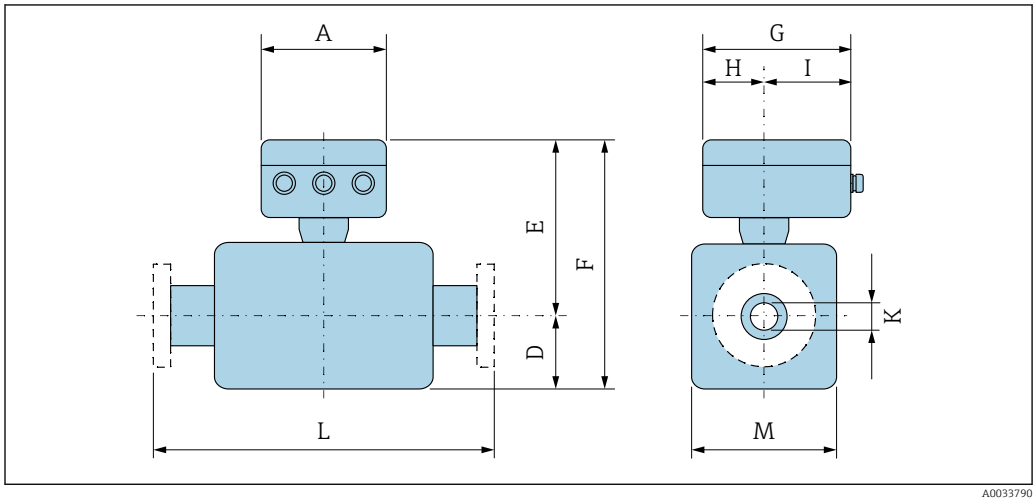
Detailed ordering information is available from your local Endress+Hauser sales center for national approvals (outside Europe) as cold water meters based on OIML R49.

Mechanical construction

Dimensions in SI units

Compact version

Order code for "Housing", option A "Compact, aluminum, coated" or option M "Compact, polycarbonate"



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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"									
		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	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"										
		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) 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

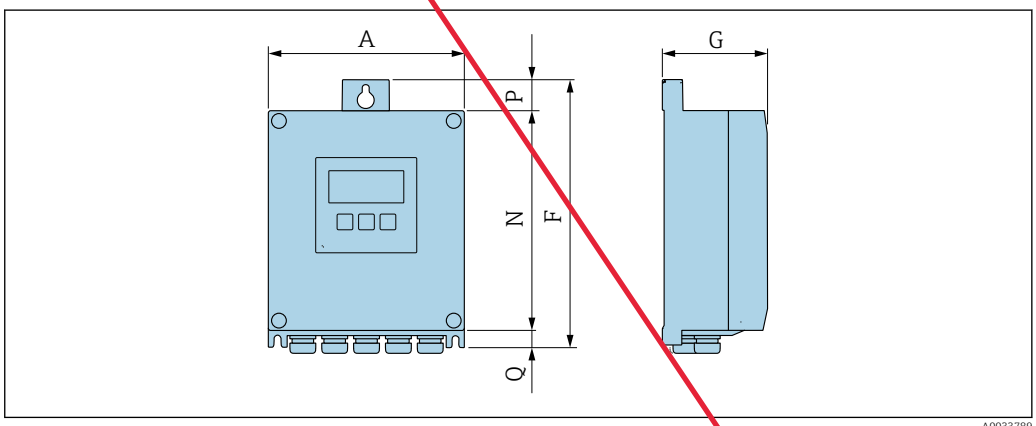
DN		Order code for "Design" Option F, J					
		D [1]	E [1]	F [1]	M [1]	K	L
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
–	102	1516	1631	3147	3032	[2]	2600
2600	–	1442	1557	2999	2883	[2]	2600
–	108	1602	1718	3320	3204	[2]	2750
2800	–	1547	1662	3209	3093	[2]	2800
–	114	1688	1803	3491	3375	[2]	2900
3000	–	1647	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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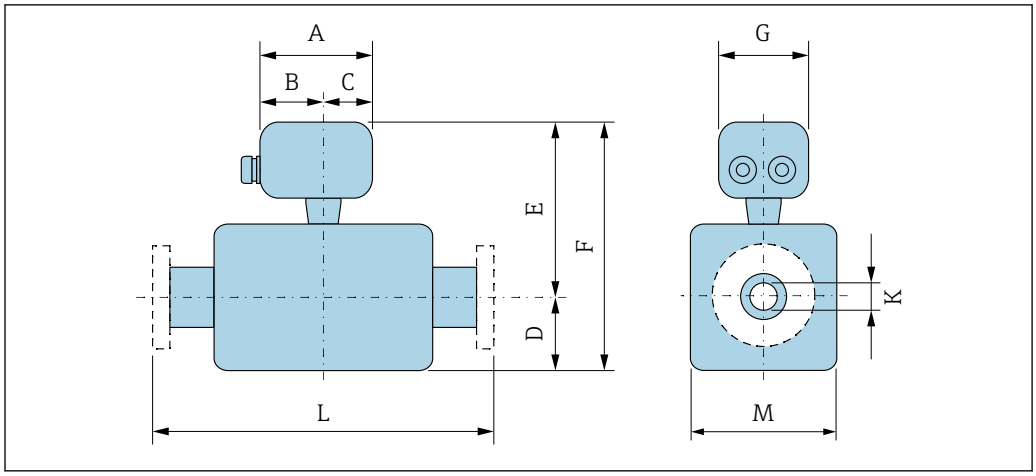
Order code for "Transmitter housing", option P "Remote, aluminum, coated"

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)

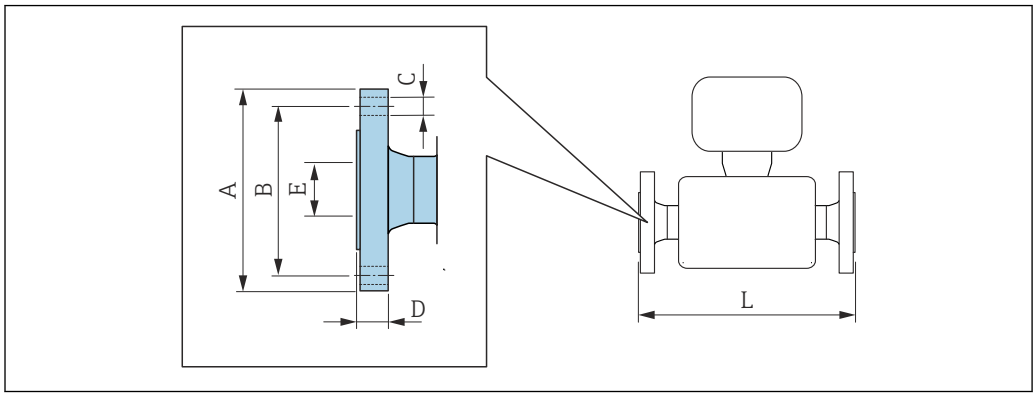
DN		Order code for "Design" Option F, J				K	L
		D [1]	E [1]	F [1]	M [1]		
[mm]	[in]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
–	84	1227	1342	2569	2454	[2]	2200
2200	–	1227	1342	2569	2454	[2]	2200
–	90	1332	1447	2779	2664	[2]	2400
2400	–	1332	1447	2783	2664	[2]	2400
–	96	1431	1546	2977	2861	[2]	2450

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



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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)

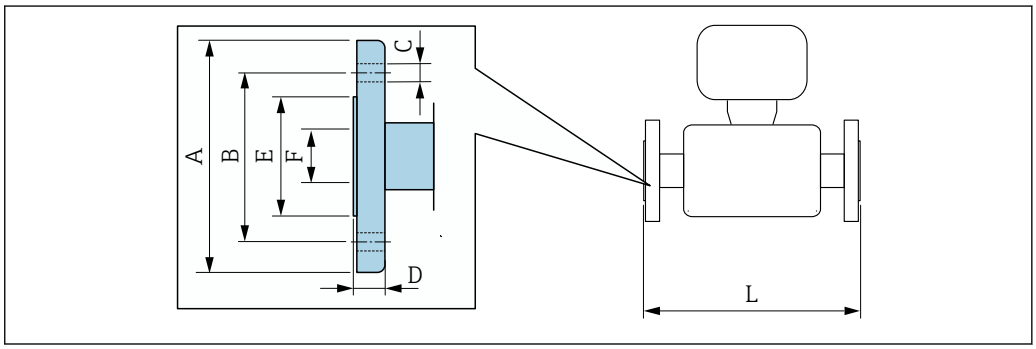
Flange according to AS 4087, PN 16 *Order code for "Process connection", option* **M3K**						
DN [mm]	**A [mm]**	**B [mm]**	**C [mm]**	**D [mm]**	**E [mm]**	**L [mm]**
80	185	146	4 × Ø18	12	1)	2)
100	215	178	4 × Ø18	13		
150	280	235	8 × Ø18	13		
200	335	292	8 × Ø18	19		
250	405	356	8 × Ø22	19		
300	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



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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 [mm]	DN [in]	A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	F [mm]	L [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 [mm]	DN [in]	A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	F [mm]	L [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 [mm]	DN [in]	A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	F [mm]	L [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								

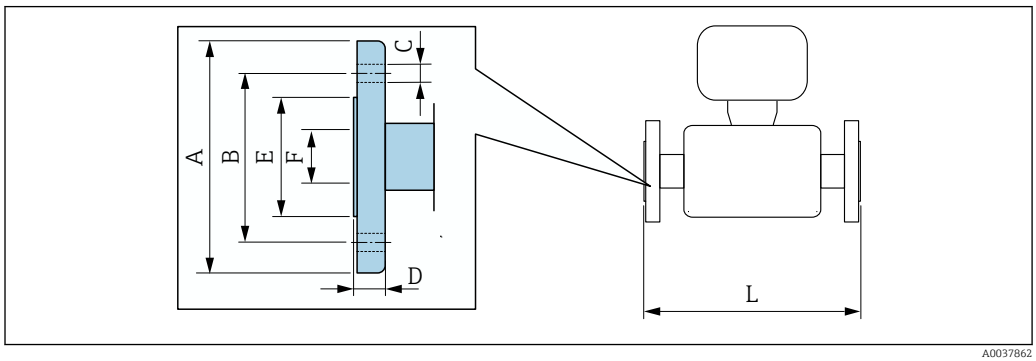
1) Depends on the liner→ 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 54 (compact version) → 🖹 58 (remote version)

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 [mm]	DN [in]	A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	F [mm]	L [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



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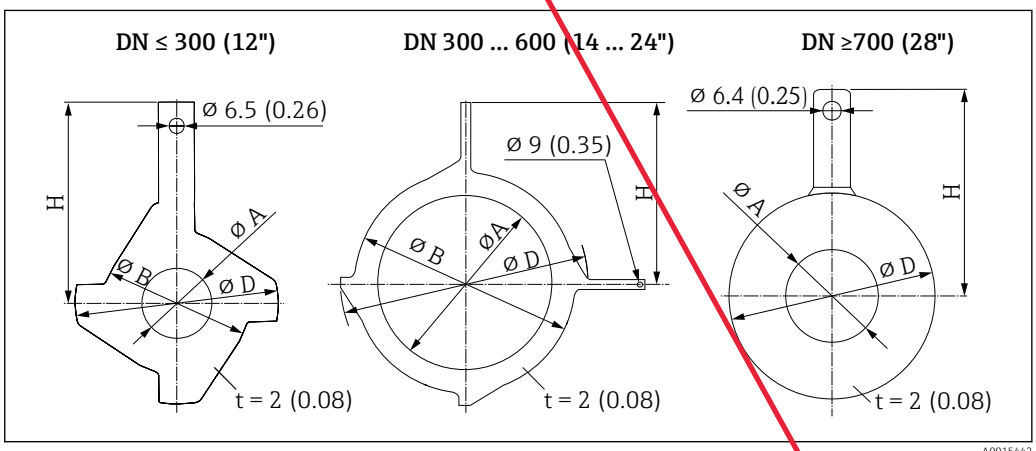
Lap joint flange, stamped plate in accordance with EN 1092-1 (DIN 2501 / DIN 2512N): PN 10 **Carbon steel:** *order code for "Process connection", option* **D21** **Stainless steel:** *order code for "Process connection", option* **D23**							
DN [mm]	**A [mm]**	**B [mm]**	**C [mm]**	**D [mm]**	**E [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



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

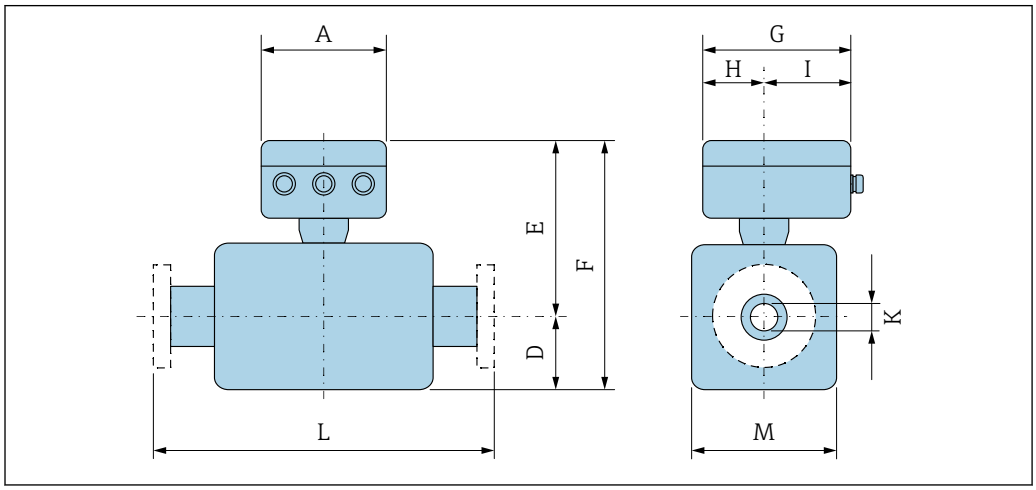
DN		Pressure rating	A		B		D		H	
[mm]	[inch]		[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]
		Cl, D	995	39.2	–	–	1163	45.79	675	26.57
–	42"	PN 6	1044	41.1	–	–	1220	48.03	704	27.72
1200	48"	PN 6	1203	47.4	–	–	1310	51.57	733	28.86
		PN 10	1196	47.1	–	–	1344	52.91	760	29.92
		PN 16	1196	47.1	–	–	1385	54.53	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					
		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				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						
		D [1]	E [1]	F [1]	M [1]	K	L	
[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)

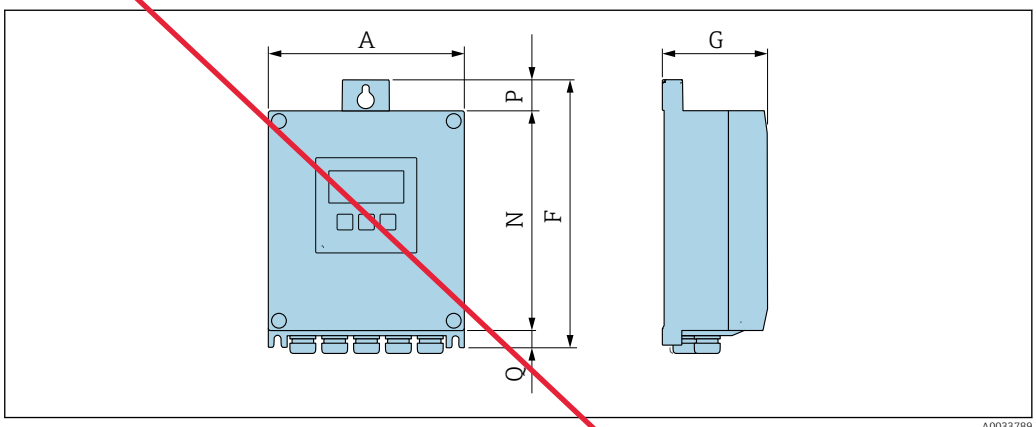
DN		Order code for "Design" Option F, J				K	L
		D [1]	E [1]	F [1]	M [1]		
[mm]	[in]	[in]	[in]	[in]	[in]	[in]	[in]
–	84	48.31	52.83	101.14	96.61	[2]	86.61
2200	–	48.31	52.83	101.14	96.61	[2]	86.61
–	90	52.44	56.97	109.41	104.88	[2]	94.49
2400	–	52.44	56.97	109.57	104.88	[2]	94.49
–	96	56.34	60.87	117.20	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"



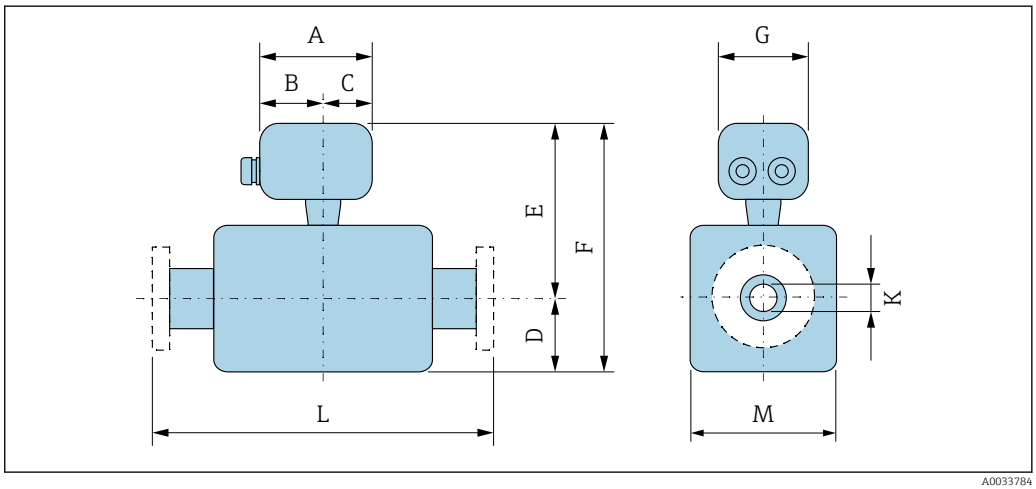
Order code for "Transmitter housing", option P "Remote, aluminum, coated"

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



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					
		L [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"

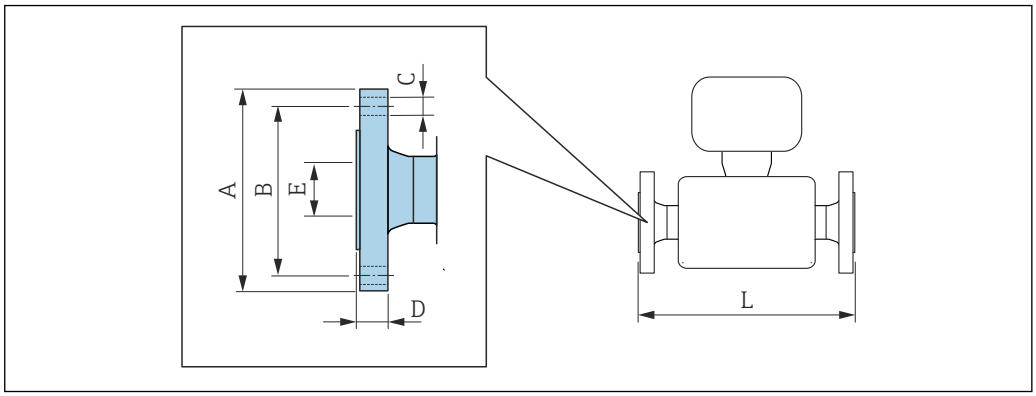
DN 84 to 120 in (2200 to 3000 mm)

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



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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							

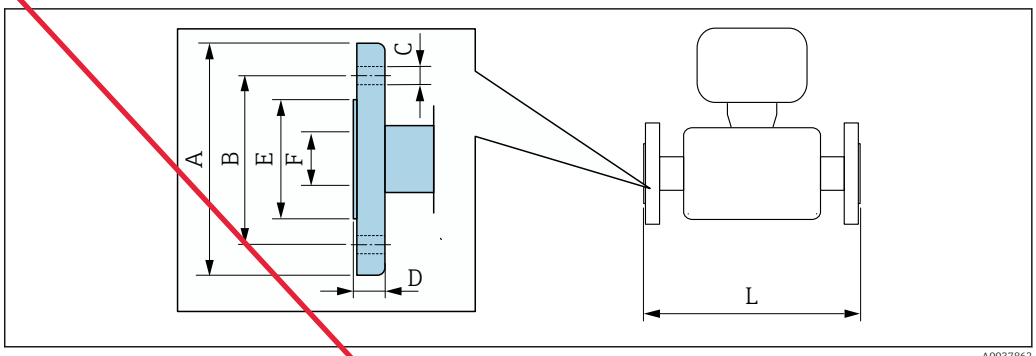
1) Depends on the liner → 🖹 90
2) Total length is independent of the process connections. Length according to DVGW (German Technical and Scientific Association for Gas and Water) → 🖹 74 (compact version) → 🖹 77 (remote version)

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



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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**

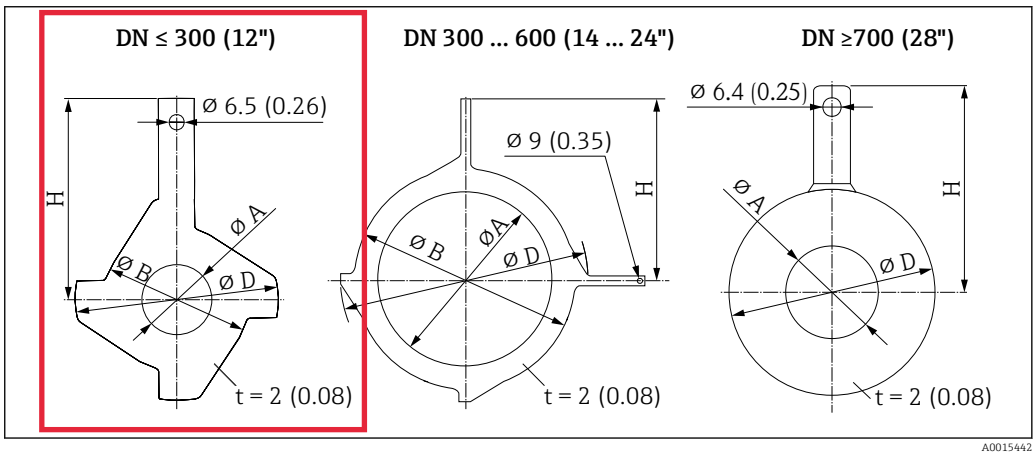
DN		A	B	C	D	E	F	L
[mm]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]
25	1	4.33	3.15	4 × Ø0.63	0.55	1.93	1)	2)
40	1 ½	4.92	3.86	4 × Ø0.63	0.69	2.8		
50	2	5.91	4.76	4 × Ø0.75	0.75	3.46		
80	3	7.48	5.98	4 × Ø0.75	0.94	4.72		
100	4	9.06	7.48	8 × Ø0.75	0.94	5.83		
150	6	11.02	9.49	8 × Ø0.91	0.98	8.23		
200	8	13.58	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



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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	1 229
–	54	–	–
1400	–	1 204	–
–	60	–	–
1600	–	1 845	–
–	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	10143
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

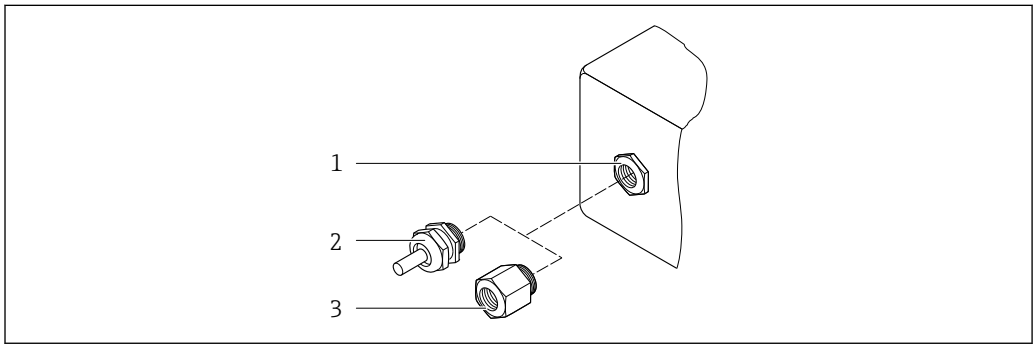
Remote version (wall-mount housing)

- 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

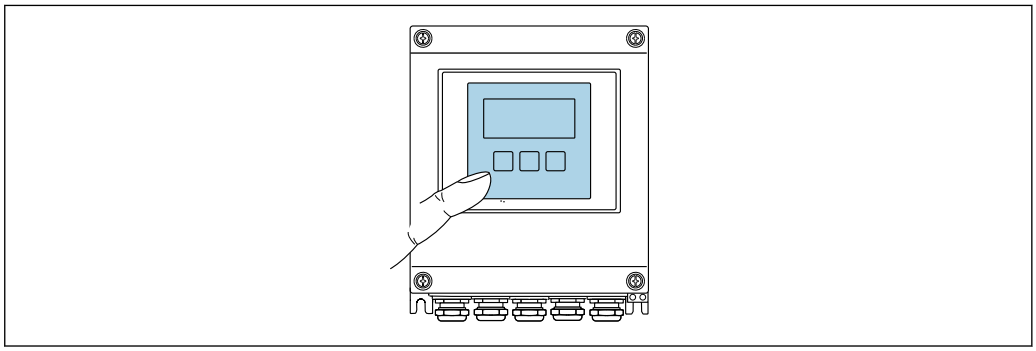
Can be operated in the following languages:
- Via local operation:
  English, German, French, Spanish, Italian, Dutch, Portuguese, Polish, Russian, Turkish, Chinese, Japanese, Bahasa (Indonesian), Vietnamese, Czech, Swedish
- Via "FieldCare", "DeviceCare" operating tool:
  English, German, French, Spanish, 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



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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.

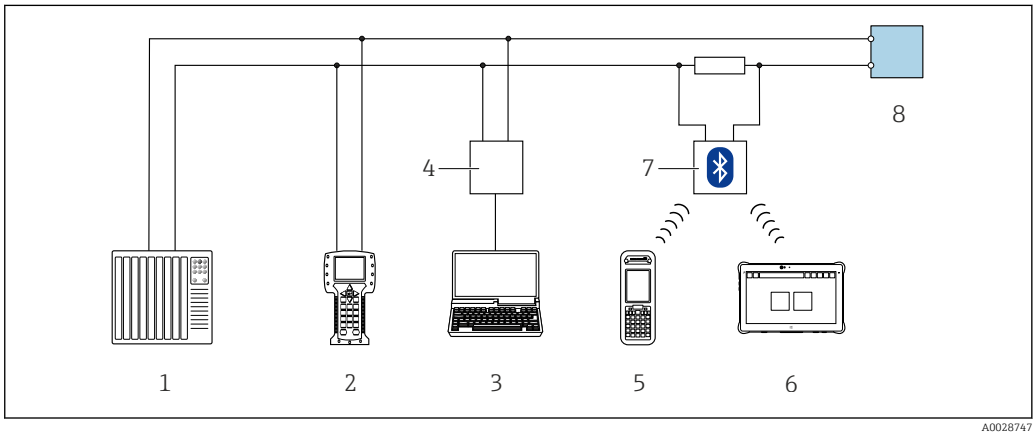
Operating elements

- 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.



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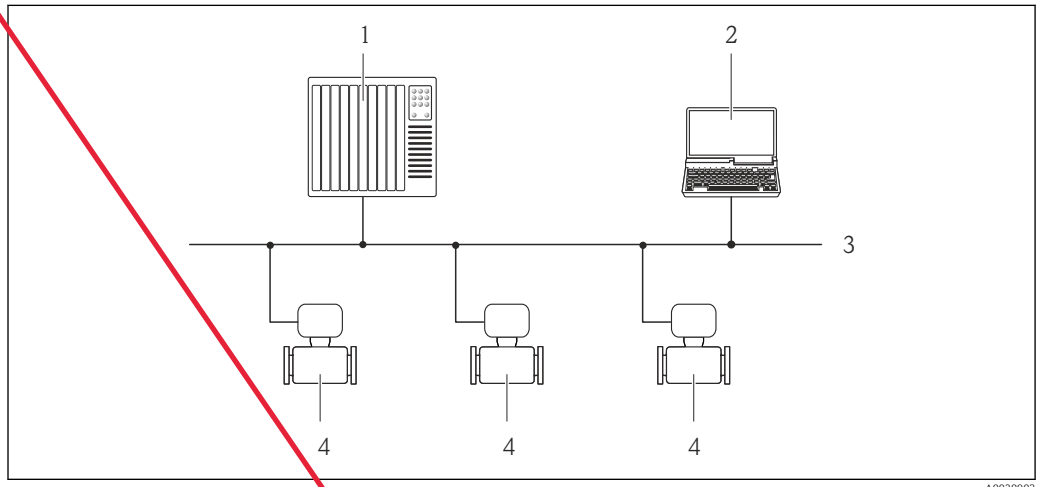
32 *Options for remote operation via HART protocol*

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.

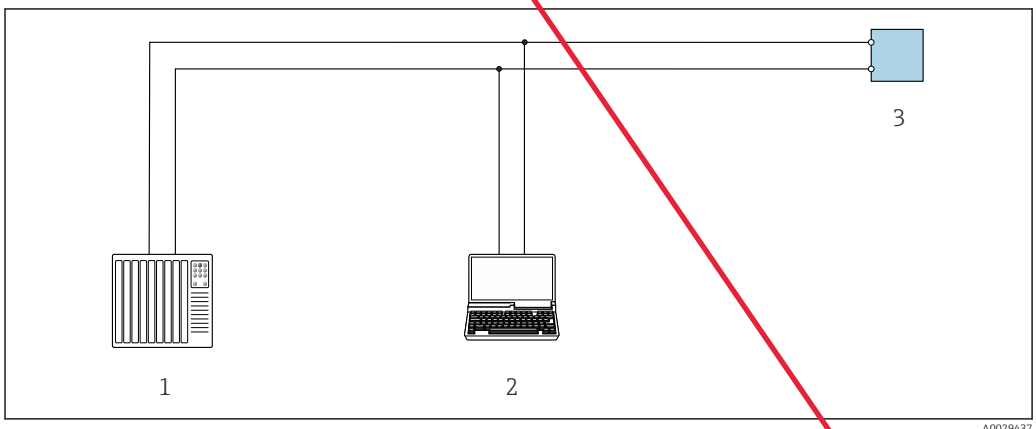


33 *Options for remote operation via PROFIBUS DP network*

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.



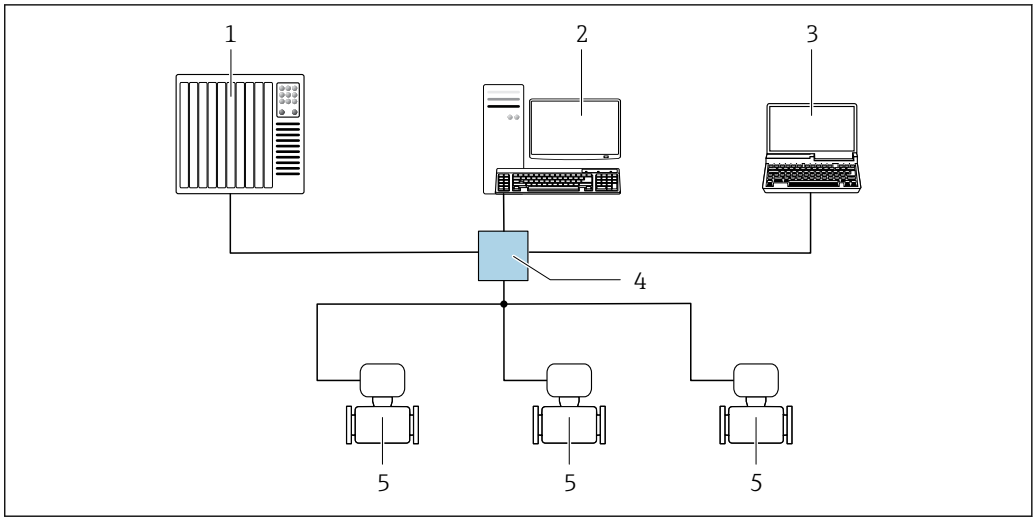
34 *Options for remote operation via Modbus-RS485 protocol (active)*

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*

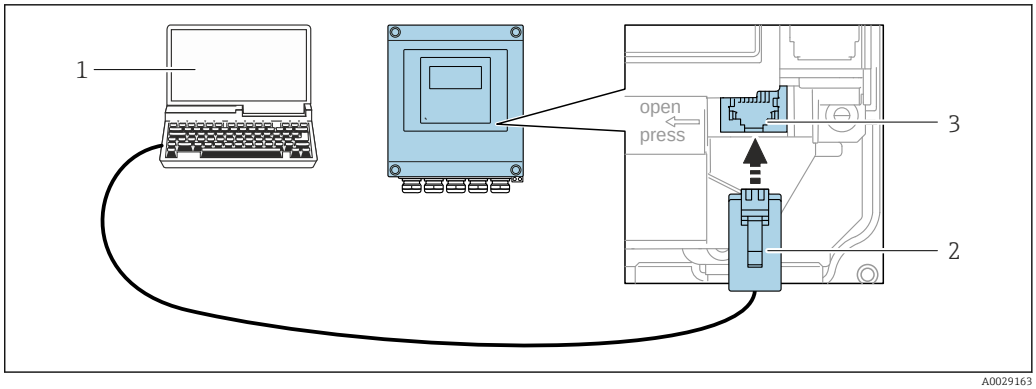
1 *Automation system, e.g. "RSLogix" (Rockwell Automation)*
2 *Workstation for measuring device operation: with Custom Add-On Profile for "RSLogix 5000" (Rockwell Automation) or with Electronic Data Sheet (EDS)*
3 *Computer with Web browser (e.g. Internet Explorer) for accessing the integrated device 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

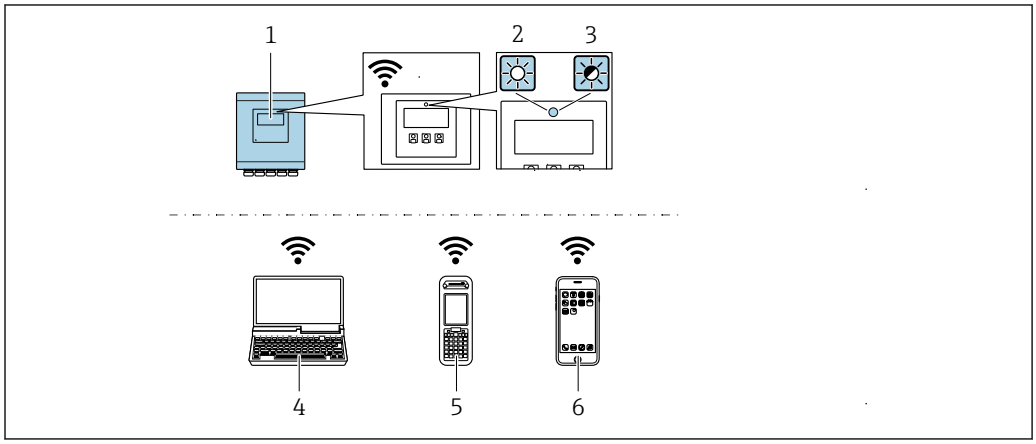


36 *Connection via service interface (CDI-RJ45)*

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

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Instruction Manual

Series E7
Metering Pumps

For file reference, please record the following data:

Model No: _____

Serial No: _____

Installation Date: _____

Installation Location: _____

When ordering replacement parts for your LMI Pump, please include the complete Model Number and Serial Number of your unit.

LMI
MILTON ROY

201 Ivyland Road
Ivyland, PA 18974 USA
TEL: (215) 293-0401
FAX: (215) 293-0445
http://www.lmipumps.com

Replaces same of Rev. C 10/97
1718.D 3/06

Contents

1.0 INSTALLATION

1.1 UNPACKING

Remove tubing, injection check and foot valve (if included) from the pump carton. Notify delivery carrier immediately if there are any signs of damage to the metering pump or parts.

1.2 LOCATION AND MOUNTING

a) When pumping solutions, make certain that all tubing is securely attached to the fittings. It is recommended that tubing or pipe lines be shielded to prevent possible injury in case of rupture or accidental damage. Always wear protective face shield and clothing when working on or near a chemical metering pump.

b) LMI accessories used with the Series E pumps must be placed in an explosion proof enclosure or located in an area where they will not be subjected to explosion hazard.

c) Be sure installation does not constitute a cross connection. Check local plumbing code.

A. Locate the pump in an area that is convenient to both solution injection point and electrical supply. LMI Series E7 metering pumps have corrosion resistant housings, but should not be subjected to continuous high temperature (over 122° F or 50° C).

B. Mount pump as shown below. Secure pump to shelf with 5/16” bolts through the four (4) holes in the pump base. Shelf must be able to support 50 lbs minimum (23 kg).

C. Figures 1 and 2 (below) show typical metering pump installation methods. Note location of injection check valve which is most important. Refer to separate Liquid Handling Assembly Instructions Section A regarding installation of injection check valve.

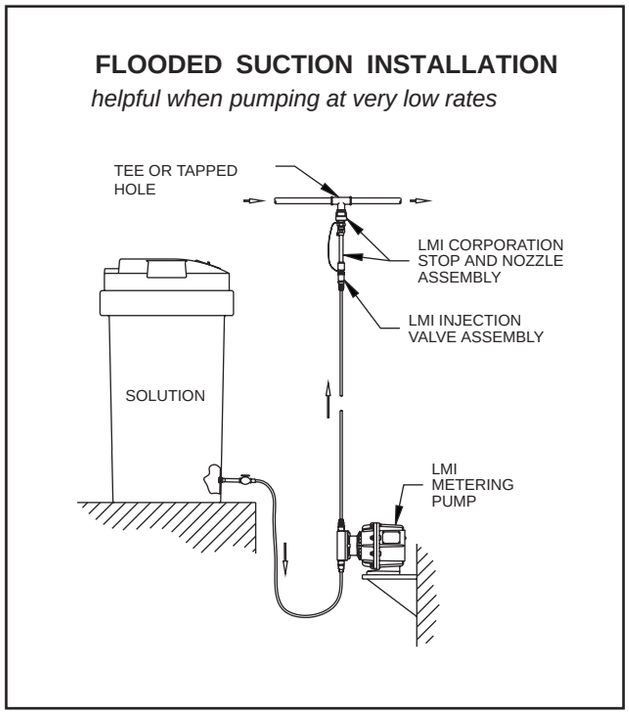


Figure 1

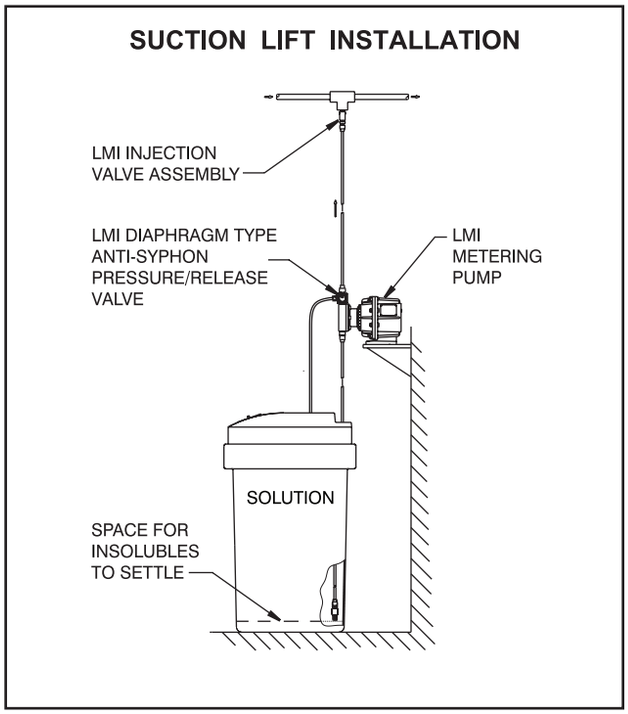


Figure 2

D. BACK PRESSURE REQUIREMENTS

All electronically controlled magnetically driven pumps maintain maximum velocity on the discharge portion of their stroke regardless of the stroke frequency setting. If there is little or no resistance (back pressure), the velocity of the pumped fluid will be so great as to cause over-pumping. Be cause of this characteristic, back pressure equal to approximately 25 psi (1.7 Bar)* must be supplied by an anti-syphon/back pressure valve if the system pressure at the injection point is not high enough to provide the needed back pressure.

* 10 psi (0.7 Bar) for Series E74.

PREVENT SYPHONING

When pumping "downhill" or into pump suction, always use (a) a 4FV at pump discharge and (b) an injection check valve at injection point (see Figure 2 below).

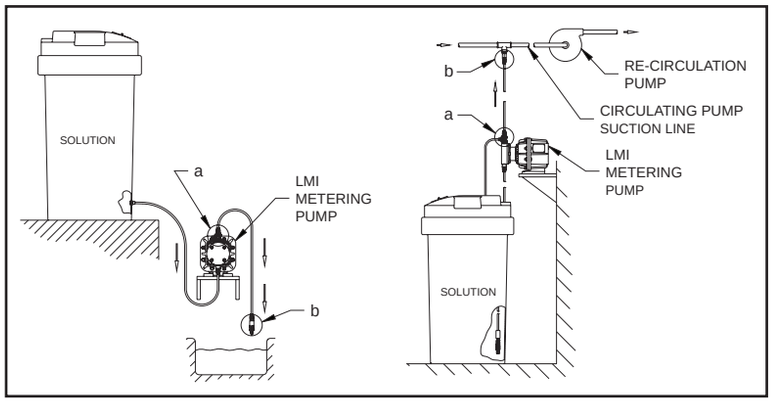


Figure 2

1.3 ELECTRICAL

Installation wiring must conform to U.L. listings and local electrical codes.

Conduit seals must be installed and need to adhere to NEC Article 501-5(a)(b). Installation of drain, breather, or combination fittings is required to guard against water accumulation, which can cause pump failure and compromise the integrity of the explosion-proof enclosure which in turn voids the Series E7 pump warranty.

The external trigger circuit is isolated and has the same characteristics as the other LMI Control Code 7 Series metering pumps. Minimum time in low impedance state (on) is 50 milliseconds. Minimum time in high impedance state (off) is 100 milliseconds.

METHOD OF TRIGGERING A SERIES E PUMP

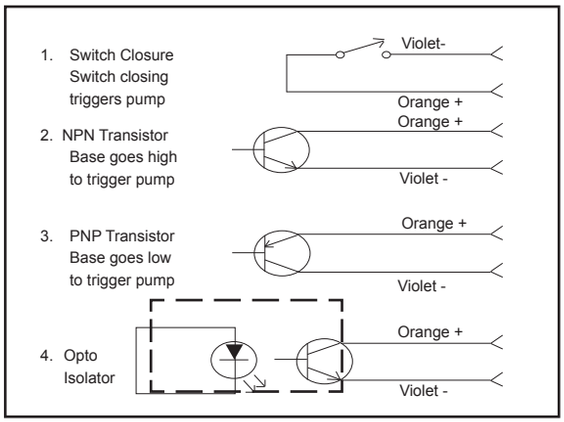


Figure 3

WIRING DIAGRAM

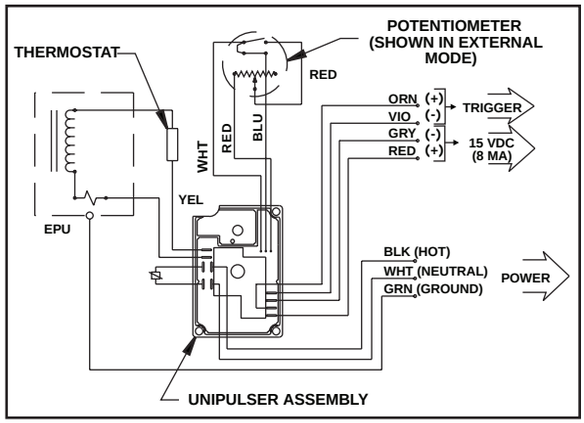


Figure 4

E7 WIRING FOR ACCESSORIES

LMI accessories used with the Series E pumps must be placed in an explosion proof enclosure or located in an area where they will not be subjected to explosion hazard.

WARNING: These accessories are not explosion proof and must be installed remotely in a non-hazardous area or mounted in an explosion proof enclosure. Wiring must adhere to local electrical codes for hazardous locations.

E7 Series metering pumps come equipped with four external control wires for operating the complete line of LMI accessories. Since hardwiring is essential for operating devices in hazardous locations, removal of the four pin connector from the accessory is necessary. The chart below indicates proper wiring for each accessory.

ACCESSORY	ACCESSORY WIRES E7 WIRES
RFP Flowmeters 26034 Extension Cables	(Pin #) 1 White . . . . . Orange 2 Black . . . . . Violet 3 Green . . . . . Gray 4 Red . . . . . Red
DP5000 pH Controllers DR5000 ORP Controllers DX6000 Controllers	1 White . . . . . .Orange 2 Black . . . . . Violet . . . . . .Gray (No Connection-wire cap) . . . . . .Red (No Connection-wire cap)
MP-100 Micropace MP-400D Micropace MP-500M Micropace	. . . . . .Orange (No Connection-wire cap) 2 Black . . . . . Violet 3 Green . . . . . Gray 4 White . . . . . Red
FC Flowmeters 26006 Pulse Transmitter (A7, B7, C7, P7) 41319 Pulse Transmitter (AA7)	1 White . . . . . .Orange 2 Brown . . . . . .Violet . . . . . .Gray (No Connection-wire cap) . . . . . .Red (No Connection-wire cap)

OUTPUT ADJUSTMENT - INITIAL APPROXIMATION

A. Speed control dial is graduated in approximate percent of maximum strokes per minute (spm). Turning this knob clockwise ↻ increases pumping frequency.

OUTPUT ESTIMATE - Total output of pump may be estimated by multiplying stroke frequency (percent of maximum) by stroke length setting (percent of maximum). For example, if the stroke length knob is set at 100% of maximum and the stroke frequency is 20% of maximum, total pump output will be approximately 20%; if the stroke length knob is set at 30% of maximum and stroke frequency is 20% of maximum, total output will be approximately 6% of the pump's maximum rating. This is .2 x.3 = .06 or 6%.

B. To determine exact frequency in strokes per minute at any speed knob setting, count number of strokes for one minute.

C. Stroke length adjustment knob is the lower of the control panel knobs. Adjust by rotating to desired setting,while pump is stroking.

D. SETTING—Maximum output of the pump is obtained with stroke frequency knob set at maximum and stroke length knob set at maximum.
If pump is to be used at less than maximum output, best volumetric efficiency will be achieved if stroke length knob is left at maximum, and stroke frequency knob rotated counter-clockwise ↺ to reduce pump output. If more output reduction is required than can be achieved by reducing stroke frequency, reduce output by turning the stroke length knob counter-clockwise ↺.

E. After installation is complete and an initial approximation setting has been made, the pump should be calibrated and the stroke frequency and/or stroke length settings adjusted.

F. Nominal output and pressure ratings are at 100% settings of stroke frequency and stroke length.

Series	Max. Pressure Rating		Max. Output	
	psi	Bar	GPH	l/h
E70	300	20.7	1.3	4.9
E71	150	10.3	2.5	9.5
E72	100	6.9	4.0	15.1
E73	60	4.1	8.0	30
E74	25	1.7	20.0	76

PROCEDURE FOR ON-SITE VOLUMETRIC CALIBRATION E7 IN INTERNAL MODE

A. Make certain speed control knob is turned fully clockwise. Turn off power to pump.
B. With pump primed and discharge tubing connected to the injection point as it would be in normal service, place foot valve and strainer assembly in a graduated container with a volume of 500 ml or more (so that the volume displaced by tubing and foot valve assembly is minimal in relation to volume of the solution in the container).
C. Turn pump on, and pump until air is exhausted from the suction line and pump head.
D. Turn pump off, note the solution level in the graduate. Refill graduate if necessary.
F. Turn off pump at the end of the calibration period, note volume pumped during the calibration period, and calculate volume of solution pumped in the time unit you choose (minute, hour, day, etc.).
G. Adjust stroke frequency and/or stroke length knobs to your best estimate of required correction, and repeat calibration measurements as a check.

PROCEDURE FOR ON-SITE VOLUMETRIC CALIBRATION OF E7 IN EXTERNAL MODE

A. Since pump output is governed by an external device, only the output per stroke may be calibrated.
B. With pump primed and discharge tubing connected to the injection point as it would be in normal service, turn off pump and place foot valve and strainer assembly in a graduated container with a volume of 500 ml or more.
C. Turn pump to internal mode with speed knob set at 100 and operate until air is exhausted from suction line and pump head.
D. Turn pump off and note solution level in graduated container. Refill graduate if necessary.
E. Turn pump on and count the number of strokes for exactly one minute. Then switch pump off.
F. Note volume pumped during the calibration period of one minute. Divide into this, the number of strokes to determine the volume of solution pumped per stroke.

Example: 50 ml/100 spm = 0.5 ml per stroke.
Multiply this by your expected stroke rate per minute, per hour or per day and compare with desired output requirements.

G. Adjust stroke length knob (lower knob) to your best estimate of required correction and repeat calibration procedure.

You may elect, for safety and convenience, to do the first calibration or operating test with water or other non-hazardous solution. If so, make certain the water or test fluid is removed from the Liquid End before pumping solutions that may react with the test fluid or be exothermic, such as sulfuric acid.

The final calibration adjustment should be made with pumping conditions identical to conditions of normal pumping service. This means that factors such as injection pressure, fluid viscosity, suction lift and others will automatically be accounted for in making the final adjustment of the pump.

2.0 TROUBLESHOOTING LIQUID END

2.1 LOW PUMP OUTPUT

Low pump output can be caused by many things. Some of the more common ones are:

- Very low stroke setting, i.e. red zone setting of knob
- Trapped air in pump head (trapped air in discharge tubing has no effect)
- Air leak through valve seal rings
- Ruptured pumping Liquifram™ (diaphragm)
- Clogged Liquid End, or injection point connection
- Injection into pressure within 25 psi (1.7 Bar)* of pump's maximum pressure rating with anti-syphon spring in place (if so supplied)
- Injection into pressure in excess of pump rating-see chart on page 6.

* 10 psi (0.7 Bar) for Series E74.

A. **Very low stroke setting** - Check position of stroke length knob (lower knob) by rotating it counter-clockwise ↺ until Liquifram™ (diaphragm) stops moving with the pump operating. The Liquifram™ should not stop reciprocating (moving or clicking) until the knob points to zero. If it stops before zero, reset knob by grasping the knob and pulling it towards you. Pry the yellow cap off of the knob. Place the knob on a flat surface. Using needle nose pliers, squeeze the inner section together while lifting the outer section up (see Figure 5, below).

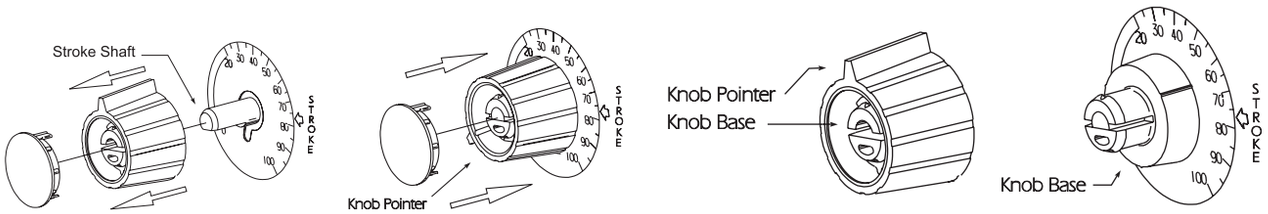


Figure 5

Push the inner section back onto the "D" shaped stroke shaft. With the pump running, zero the pump by turning the inner section of the knob counter clockwise. Position the outer section of the knob so that the pointer aligns with zero on the nameplate. Push down on the outer section of the knob (a snap sound will indicate that parts are locked together). Replace the yellow cap over the outer section of the knob, aligning the tabs on the cap with the slots on the knob.

B. **Trapped air in pump head -** May be caused by leaks in the suction line, where the suction line joins the suction fitting, or at the seal ring between suction fitting and pump head. It may also be caused by air or gases coming out of solution. Trapped air or bubbles in the discharge line have no effect on the pump's operation. They may be ignored.

- To remove trapped air from the pump head, operate the pump with stroke frequency knob and stroke length knob set at 100.
- It may be neccessary to pull on both knobs of the 4FV, or rotate pressure relief knob ¼ turn, if so equipped. Follow "Priming" instructions in the Liquid Handling Assembly Sheet inserted in this instruction book and operate the pump for a few minutes to purge the head and valves of air or gas.

C. **Air leak through valve seal rings-** usually caused by worn or damaged seal rings or loose fittings. Tighten fittings by hand until they are very snug. If there is no improvement, replace both seal rings in pump head. See enclosed Liquid Handling Assembly Sheet.

D. **Ruptured pumping diaphragm—**If rupture is severe and pump is injecting into pressure, solution leak will be obvious through the 3/16” (5 mm) diameter hole at the bottom of the spacer directly behind the pump head. Replace pumping Liquifram™ (diaphragm). If rupture is a small pin hole, there may be oozing of solution through the 3/16” (5 mm) diameter hole described above. Replace ment of pumping Liquifram™ (diaphragm) will be necessary.

E. **Clogged Liquid End—**will cause low pump output. Purge Liquid End. Disassemble Liquid End. Clean individual parts with water and detergent or appropriate cleaning solution.

F. **Injection into excessive pressure—**If discharge pressure is within 25 psi (1.7 Bar)* of maximum pump rating, remove spring in injection check valve, if so supplied.
* 10 psi (0.7 Bar) for Series E74.

2.2 EXCESSIVE PUMP OUTPUT

A. **Syphoning**—If your Series E pump has a Liquid End other than a high viscosity LE, its injection check valve assembly has a chemically resistant anti-syphon spring. Disassemble the injection check valve and check to be sure this spring is in place and undamaged. Replace if necessary.

Note that the anti-syphon spring must be removed if injection is into a pressure within 25 psi (1.7 Bar)* of pump’s maximum pressure rating. Liquid Ends with a suffix “S” have, in addition, a diaphragm type anti-syphon valve, which prevents syphoning and over pumping.
* 10 psi (0.7 Bar) for Series E74.

B. **Incorrect knob settings**—Check stroke length knob (lower knob) by rotating it counter-clockwise ↺ to zero position. The Liquifram™ (pumping diaphragm) should stop reciprocating. If it does not, reset knob and continue counter-clockwise rotation until motion stops. Reset knob by grasping the knob and pulling it towards you. Pry the yellow cap off of the knob. Place the knob on a flat surface. Using needle nose pliers, squeeze the inner section together while lifting the outer section up (see Figure 5). Push the inner section back onto the “D” shaped stroke shaft. With the pump running, zero the pump by turning the inner section of the knob counter-clockwise ↺. Position the outer section of the knob so that the pointer aligns with zero (0) on the nameplate. Push down on the outer section of the knob (a snap sound will indicate that parts are locked together). Replace the yellow cap over the outer section of the knob, aligning the tabs on the cap with the slots on the knob.

2.3 CHANGING PUMPING LIQUIFRAM™ (DIAPHRAGM)

A. Make sure size code marking (0.9 S.I., 1.8 S.I. or 3.0 S.I.) on spacer and Liquifram™ (diaphragm) are the same. Liquifram™ and spacer size code must match in order for the pump to function. The E74 Liquifram™size code is 6.0 S.I., (spacer is 3.0 S.I., but there is a large black spacer adapter).

Always wear protective clothing, gloves and face shield when working on or near chemical metering pumps.

B. Depressurize discharge line following steps outlined on the supplement “Liquid Handling Assembly Instructions”. Lift foot valve from solution and let pump run pumping air for a few minutes. Then remove pump head.

C. Set stroke length knob (lower knob) to zero, rotate it counter-clockwise ↺ with the pump running, then stop the pump by turning stroke frequency knob (upper knob) to “off”.

D. Lift edge of Liquifram™ and rotate it counter-clockwise ↺ to unscrew the Liquifram™.

E. Before installing new pumping Liquifram™, turn pump on and rotate stroke length control knob (lower knob) to the proper setting per the following table:

Model	Stroke Setting Length
E70, E71, E72	90%
E73, E74	70%

- With pump stroking, screw on new Liquifram™ until the center part begins to buckle inwards during the latter half of the stroke. Turn pump off and check Liquifram™ position with a straight edge according to Figure 6 (below).

- If Liquifram™ setting is not correct, restart pump then screw the Liquifram™ in or out. Always stop pump electrically when checking Liquifram™ setting. Repeat procedure if necessary.

- After Liquifram™ is set properly, restart pump and turn stroke knob to 100%.

F. Re-install pump head and tighten head mounting screws in criss-cross pattern.

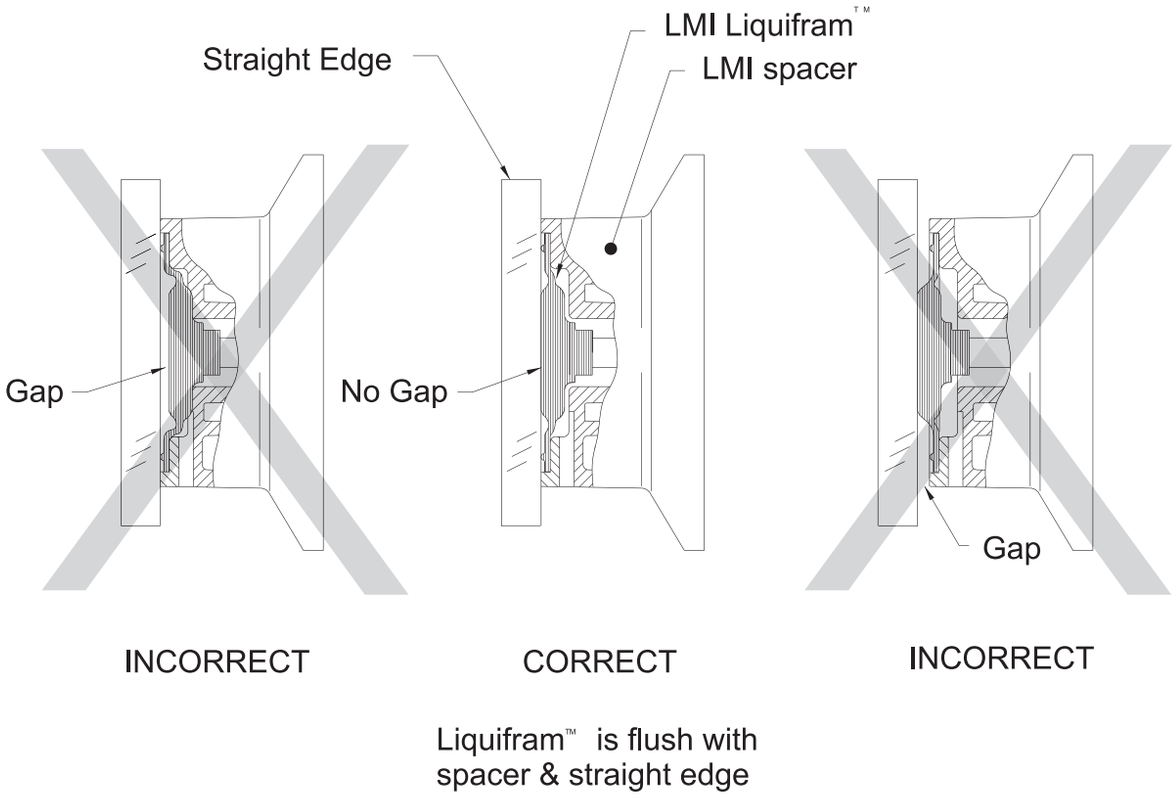
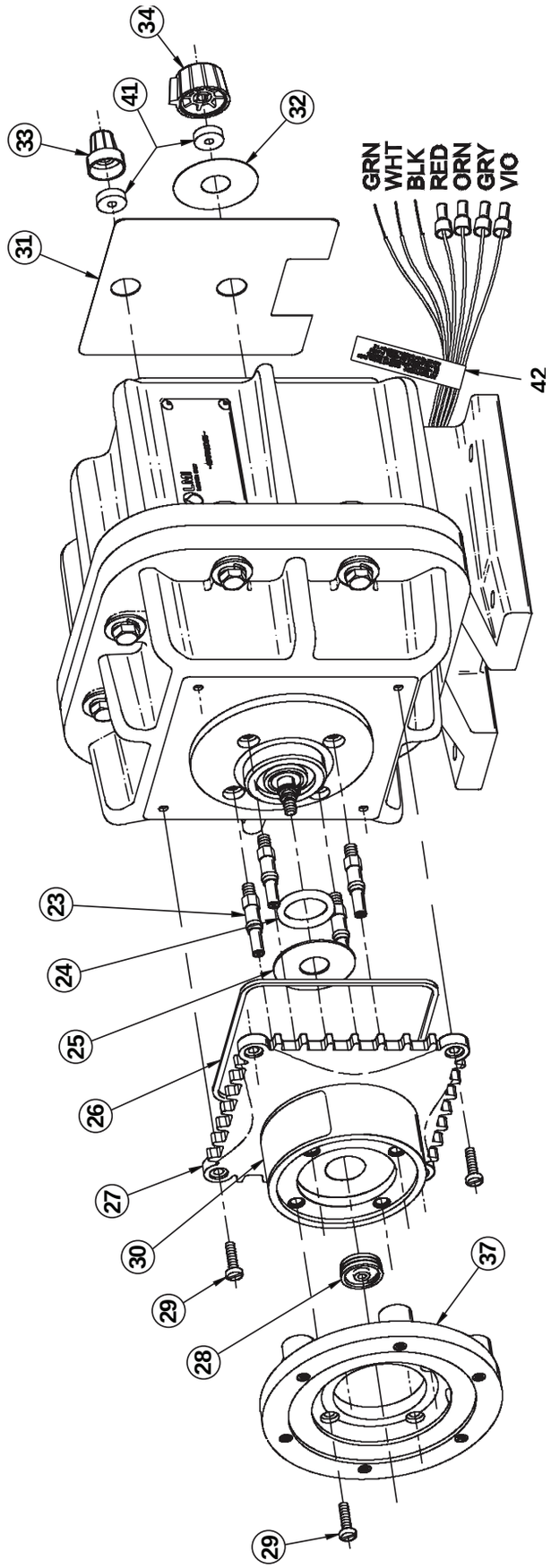


Figure 6

3.0 EXPLODED VIEW



4.0 PARTS LIST

Key No.	For Model No.	Part No.	Description	Quantity
23	E70, E71, E72	27641	Stud	4
	E73, E74	29605	Stud	4
24	E7	26983	O-Ring	1
25	E7	27586	Shim	1
26	E7	35269	Seal	1
27	E70	35837	Spacer, 0.9	1
	E71, E72	35838	Spacer, 1.8	1
	E73, E74	35839	Spacer, 3.0	1
28	E7	10973	Shaft Seal	1
29	E70, E71, E72, E73	10598	Screw, 10-24 S.S.	4
	E74	10598	Screw, 10-24 S.S.	8
30	E7	25452	Label	1
31	E7	31542	Nameplate	1
32	E70, E71	32465	Stroke Dial	1
	E72	32466	Stroke Dial	1
	E73	32467	Stroke Dial	1
	E74	32468	Stroke Dial	1
33	E7	25889	Knob Asm., Speed	1
34	E7	31891	Knob Asm., Stroke	1
37	E74	25887	Adapter, 6.0 SI	1
41	E7	30803	Gasket	1
42	E7	48340	Wire Tab Label	1





LMI
MILTON ROY

201 Ivyland Road
Ivyland, PA 18974 USA
TEL: (215) 293-0401
FAX: (215) 293-0445
http://www.lmipumps.com

Replaces same of Rev. C 10/97
1718.D 3/06

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Neptune™

INSTALLATION OPERATION & MAINTENANCE

NEPTUNE

SERIES JG Gear Drive
SERIES JD Direct Drive
Clamp Mount Mixer

PLUS:

JGR and JDR Angle Riser Mount

JGF and JDF Flange Mount

NEP-ZL106636

PSG
22069 Van Buren Street
Grand Terrace, CA 92313 USA
P: +1 (215) 699-8700 F: +1 (215) 699-0370
neptune1.com

NEP-ZL106636
03.2018_REV 2

PSG a DOVER company
psgdover.com

WARNING

LOCKOUTS ARE REQUIRED BEFORE SERVICING THIS EQUIPMENT.

SAFETY INSTRUCTIONS:

Shut off/Lockout Mixer Power before Servicing.

DO NOT OPERATE MIXER UNLESS PROPERLY INSTALLED, AVOID ROTATING SHAFT AND BLADES, TURN OFF POWER AND LOCKOUT EQUIPMENT BEFORE ADJUSTING OR SERVICING, ETC.

TABLE OF CONTENTS

LIMITED WARRANTY

All Neptune Mixers are tested at the factory prior to shipment. Each part used in their construction has been carefully checked for workmanship.

If the Mixer is installed properly, Neptune Chemical Pump Company warrants to the purchaser of this product for a period of one year from the date of shipment, whichever occurs first, this product shall be free of defects in material and/or workmanship, as follows:

1. Neptune Chemical Pump Company will replace, at no charge, any part that fails due to a defect in material and/or workmanship during the warranty period, FOB our factory, North Wales, Pennsylvania. To obtain warranty service, you must get an RMA number to return the defective parts to the factory for examination, freight pre-paid.

2. This warranty period does not cover any product or product part, which has been subject to accident, misuse, abuse or negligence. Neptune Chemical Pump Company shall only be liable under this warranty if the product is used in the manner intended by the manufacturer as specified in the written instructions furnished with this product.

Any express warranty not provided in this warranty document, and any remedy for breach of contract that, but for this provision, might arise by implication or operation of law, is hereby excluded and disclaimed. Under no circumstances shall Neptune Chemical Pump Company be liable to purchaser or any other person for any charge for labor, repairs, or parts, performed or furnished by others, nor for any incidental consequential damages, whether arising out of breach of warranty, express or implied, a breach of contract or otherwise. Except to the extent prohibited by applicable law, any implied warranty of merchantability and fitness for a particular purpose are expressly limited in duration to the duration of this limited warranty.

Some states do not allow the exclusion or limitation of incidental or consequential damages, or allow limitations on how long any implied warranty lasts, so the above limitations may not apply to you. This warranty gives you specific legal rights, and you may have other rights, which may vary from state to state.

IMPORTANT

SHOULD IT BE NECESSARY TO SEND THE PUMP TO THE FACTORY FOR REPAIR OR MAINTENANCE REBUILDING; DRAIN ALL OIL AND CHEMICAL FROM PUMP BEFORE SHIPPING. FAILURE TO DO SO CAN CAUSE EXTENSIVE DAMAGE TO THE MOTOR.

[1] SEE IMPORTANT NOTICE - RETURN GOODS AUTHORIZATION

IMPORTANT NOTICE
RETURN GOODS AUTHORIZATION

(1) All equipment returned to Neptune Chemical Pump Company requires proper Returned Goods Authorization Number (RGA) and tags.

(2) All equipment returned to the factory for repair or service must first be thoroughly flushed and have all chemical contact areas neutralized.

(3) All equipment which has been in contact with chemicals must be accompanied by a copy of the Chemical Product Material Safety Data Sheet (MSDS).

(4) Failure to comply with the above instructions will result in equipment being returned to sender, freight collect, without service.

PARTS ORDERING INSTRUCTIONS

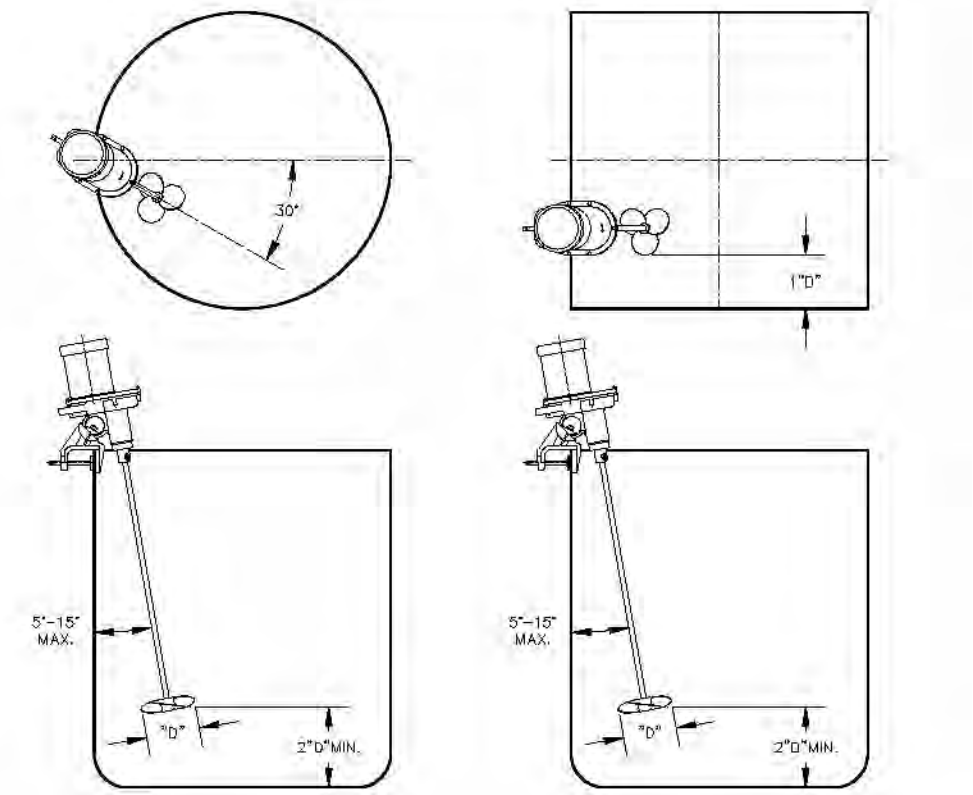
The complete model number and serial number of the pump must be furnished to insure prompt and accurate parts service. These numbers are found on the name plate (sample below) located on the side of the mixer. Refer to Pages 6, 7, 9, 11 and 13 for complete parts lists.

Send all orders or inquiries for parts to:

Parts Department
Neptune Chemical Pump Company
22069 Van Buren, Grand Terrance, CA 92313
Tel.: 215-699-8700
1 -888-3NEPTUNE (888-363-7886)
FAX: 215-699-0370
Web: www.neptune1.com
Email: pump@neptune1.com

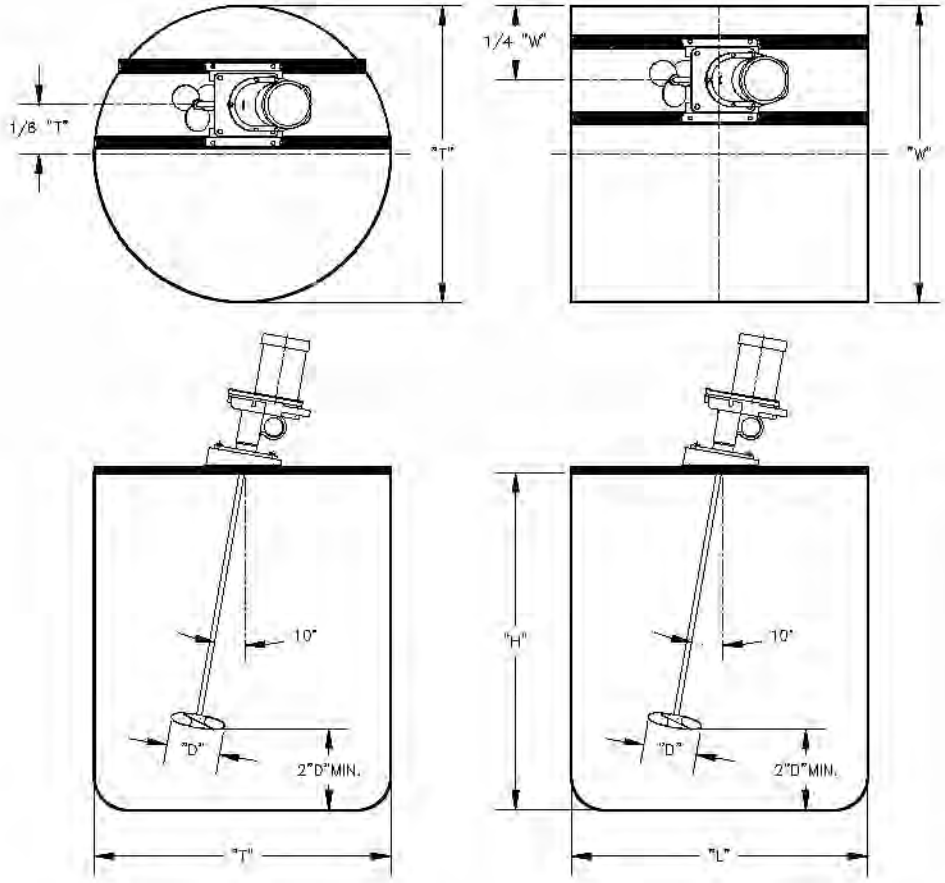
NOTE: PLEASE SUPPLY BOTH MODEL AND SERIAL NUMBERS.

MIXER POSITIONING



VERTICAL
CYLINDRICAL

CUBICAL
(L=W)



"T" = TANK DIAMETER
"D" = IMPELLER DIAMETER

INTRODUCTION

The Neptune Mixer is a carefully designed piece of precision equipment which will give you years of satisfactory service under normal operating conditions.

A. INSPECTION

All Neptune Mixers are shipped in a specially designed carton to insure against damage in shipment. Each shaft is shipped in an individual box. Upon receipt, examine the mixer for damage; report any damage to Neptune and the delivering carrier at once.

B. LUBRICATION/MAINTENANCE

The outboard ball bearing [30] and upper ball bearing [27] are sealed and pre-greased for bearing life. The gear box is lubricated at the factory. Neptune recommends changing grease annually. To change grease or to change the motor: Remove motor midplate (fig. 21) by taking out the six bolts & washers (fig. 14/15). Remove motor and midplate (they will be attached) from gearbox. Remove four motor bolts (fig. 12/13) underneath midplate. Clean gear box and gears with solvent. Coat gears with about 4.8 oz of the following grease.

Mixers use Bel-Ray® 72560 Grease. Order P/N 104750

C. MOUNTING THE MIXER

Remove the mixer from the carton and attach clamp. Rotate the clamp to an initial position such that the motor will be upright when the unit is clamped to the tank. Place the clamp on the desired location on the tank, being certain that both the horizontal and vertical surfaces of the clamp are in contact with the top and side of the tank. Rotate the nut clockwise to tighten; counter clockwise to loosen.

D. MOUNTING MIXER SHAFT

Neptune supplies standard square pitch propellers which may be put on the mixer shaft either face up or face down. Place the propellers on the end of the shaft WITHOUT THE NOTCHES. If two propellers are used, they should be spaced at least two propeller diameters apart. Be certain to securely tighten the propeller set screws. Place the end of shaft with the notches into the shaft collar until it bottoms. Screw in the setscrews [32]. Rotate the shaft to line up the shaft notches with setscrews [32] and tighten the setscrews.
(See Shaft Installation Diagram on pg. 5.)

E. ELECTRICAL CONNECTIONS

Your Neptune mixer is designed to rotate clockwise when looking down from the top of the motor. This is so indicated by arrows cast on the motor midplate.

Follow the wiring directions as indicated on the motor to obtain proper rotation. Jog motor to check propeller rotation.

F. MIXER POSITIONING

To utilize energy supplied by the mixer, a top to bottom turnover of the liquid should be created. The mixer shaft should be angled 5° to 15° off vertical wall of tank pointed 20° to 30° right of the center line.
Refer to diagrams on page 3.

Moving the shaft to the left of the position described will increase swirl of vortex. This helps to submerge light powders and to aerate the mix but decreases mixing efficiency. Adjust vortexing by changing shaft position and angle (Stay within maximum limits).

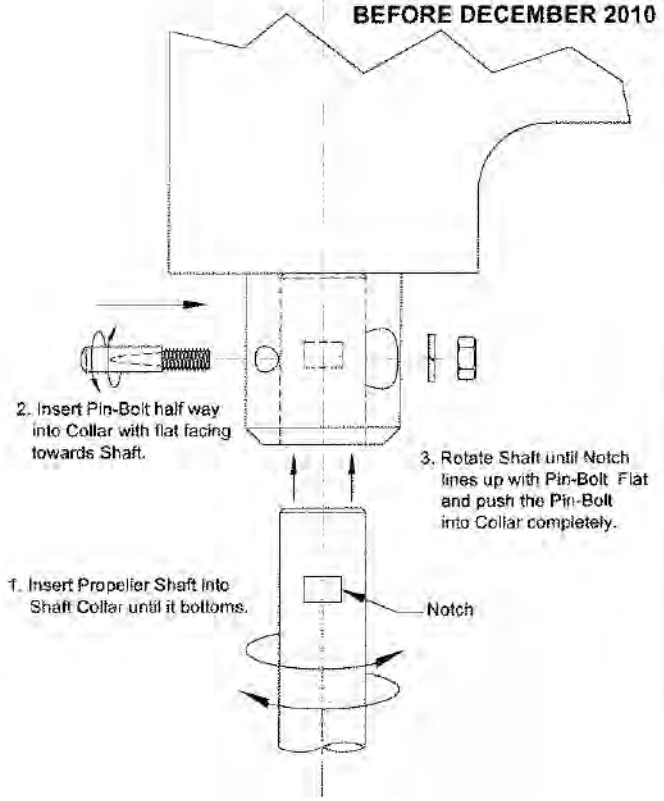
G. MIXER OPERATION

Neptune mixers are designed for continuous operation under normal conditions. It is not a good practice to operate continuously when extreme vortexing occurs. Mixer Propellers must be submerged in the Liquid during mixing operation or damage could occur.

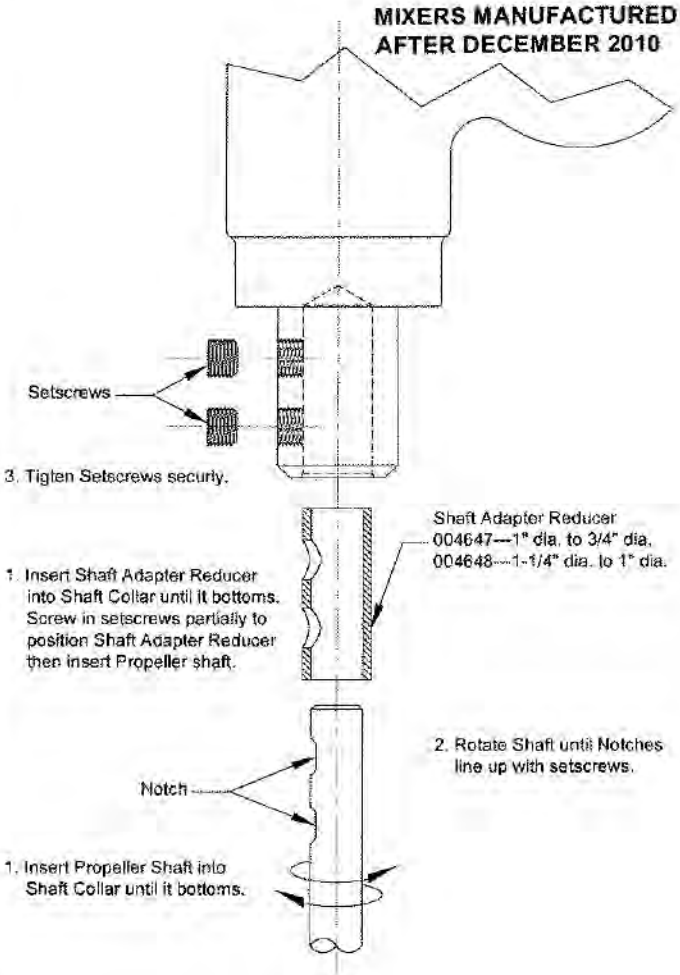
After mixer has been turned on and the mixing pattern developed, adjust mixer position if necessary.
DO NOT ADUST WHILE RUNNING

After ten days of operation, check the Motor Midplate screws, and shaft collar Hex Nut for tightness. At the end of a mixing period, it is a good practice to turn off the mixer before the tank is drained. Turn mixer off when liquid level is one propeller diameter above lower propeller.

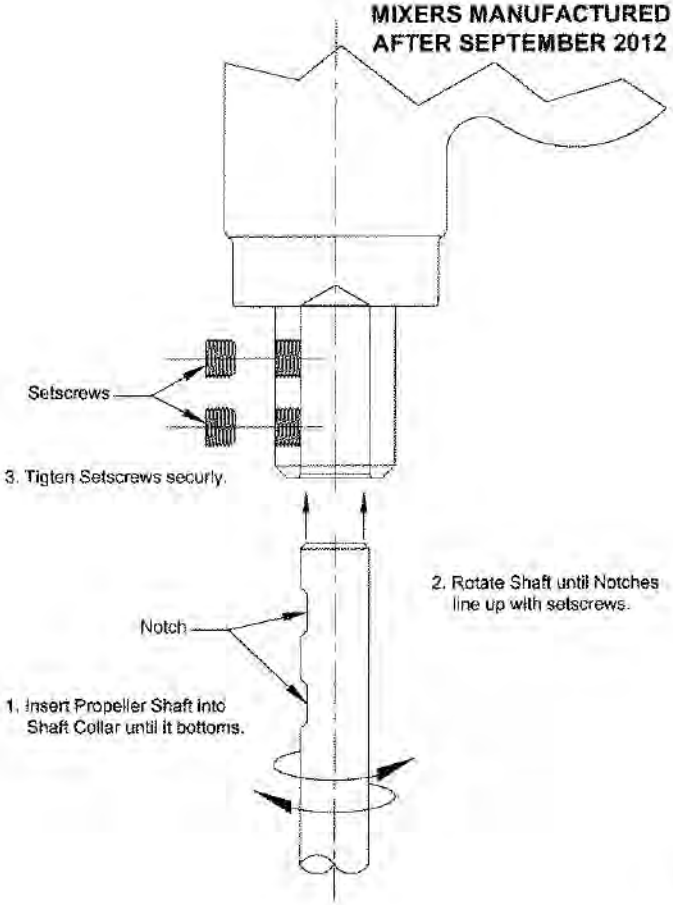
MIXERS MANUFACTURED BEFORE DECEMBER 2010



MIXERS MANUFACTURED AFTER DECEMBER 2010



MIXERS MANUFACTURED AFTER SEPTEMBER 2012



SHAFT INSTALLATION DIAGRAM
(Refer to Section D.)

SHAFT AND PROPELLER PARTS LIST
For Series JG, JD Clamp Mount Model Mixers
And Series JGR and JDR Angle Riser Mount Model Mixers

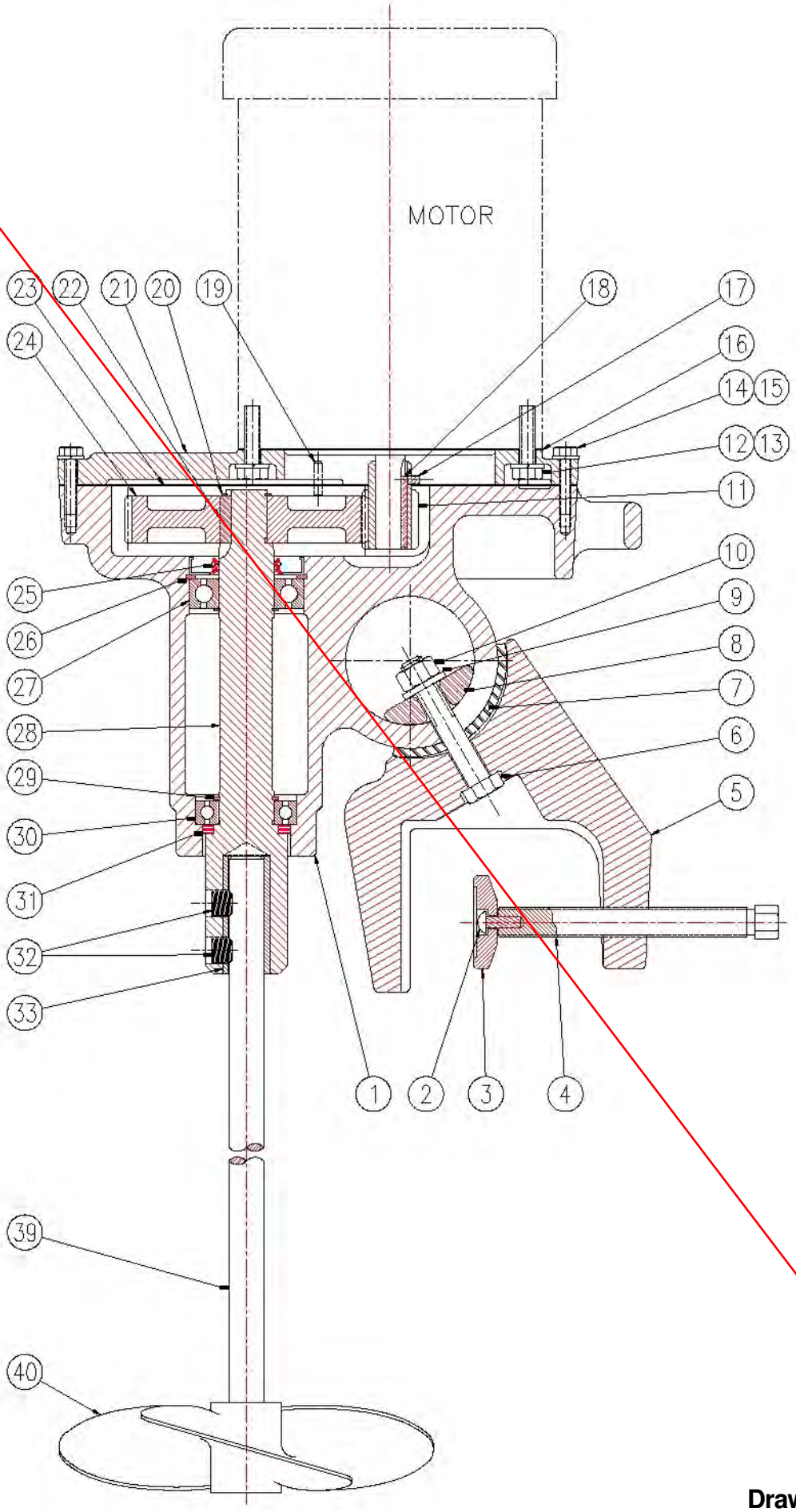
(Refer to Drawing on Page 8)

ITEM NUMBER	ITEM DESCRIPTION	OTY.	MODEL JG2.0- JG6.1	MODEL JG7.1 - JG8.1	MODEL JG9.1
39	Shaft 3/4" dia. x 30" lg.	1	004396		
	Shaft 3/4" dia. x 40" lg.	1	004397		
	Shaft 3/4" dia. x 36" lg.	1	003084		
	Shaft 3/4" dia. x 48" lg.	1	003075		
	Shaft 3/4" dia. x 60" lg.	1	003076		
	Shaft 1" dia. x 48" lg.	1	004398		
	Shaft 1" dia. x 60" lg.	1	003071		
	Shaft 1" dia. x 72" lg.	1	003072		
	Shaft 1-1/4" dia. x 60" lg.	1		003073	003073
	Shaft 1-114" dia. x 72" lg.	1		003074	003074
40	Prop 5 x 5, 3/4" Bore, P/N 100383	A/R	As Required Per Application	As Required Per Application	As Required Per Application
	Prop 4 x 4, 3/4" Bore, P/N 100384				
	Prop 14 x 14, 1-1/4" Bore, P/N 100385				
	Prop 12 x 12, 1" Bore, P/N 100389				
	Prop 11 x 11, 1" Bore, P/N 100390				
	Prop 6 x 6, 1" Bore, P/N 100392				
	Prop 5 x 5, 1" Bore, P/N 100393				
	Prop 7 x 7, 3/4" Bore, P/N 100394				
	Prop 6 x 6, 3/4" Bore, P/N 100395				
	Prop 5 x 5, 3/4" Bore, P/N 106046				
	Prop 6 x 6, 3/4" Bore, P/N 106043				
	Prop 8 x 8, 3/4" Bore, P/N 106218				
	Prop 10 x 10, 3/4" Bore, P/N 106219				
	Prop 12 x 12, 3/4" Bore, P/N 106220				
	Prop 13 x 13, 3/4" Bore, P/N 106221				
	Prop 13 x 13, 1" Bore, P/N 1 06222				
	Prop 16 x 16, 1-1/4" Bore, P/N 106225				
	Prop 11 x 11, 3/4" Bore, P/N 106229				
	Prop 7 x 7, 1" Bore, P/N 106232				
	Prop 15 x 15, 1-1/4" Bore, P/N 106344				

PARTS LIST
For Series JG Clamp Mount Model Mixers
(Refer to Drawing on Page 8)

ITEM NUMBER	ITEM DESCRIPTION	QTY.	MODEL JG2.0 - JG6.1	MODEL JG7.1 - JG8.4	MODEL JG9.1
1	Mixer Gearbox - Body	1	003161	003053	003053
2	Drive Screw	1	100370	N/A	N/A
3	Clamp Button	1	000476	N/A	N/A
4	Stud	1	002683	N/A	N/A
5	Mounting Clamp	1	003146	NIA	N/A
6	Hex Head Cap Screw or Stud	1	100397	N/A	N/A
7*	Flat Washer	1	100369	N/A	N/A
8	Pivot Washer	1	100509	N/A	N/A
9	Flat Washer	1	106833	NIA	N/A
10	Hex Nut	1	WA170583	NIA	N/A
11	Helical Pinion	1	003143	003141	003054
12	Hex Head Cap Screw	4	100216	100216	100216
13	Lock Washer	4	100217	100217	100217
14	Hex Head Cap Screw	6	106748	106748	106748
15	Lock Washer	6	100075	100075	100075
16	Motor Gasket	1	106097	106097	106097
17	Set Screw	1	105159	105159	105159
18	Key	1	003060	106589	003060
19	Dowel Pin	2	100351	100579	100579
20	Retaining Ring	1	106594	106496	106496
21	Motor Midplate	1	003148	003147	003057
22	Key	1	100110	100110	100110
23	Midplate Gasket	1	106507	106494	106494
24	Helical Gear	1	003144	003142	003055
25	Seal	1	106586	106542	106542
26	Retaining Ring	1	106592	106562	106562
27*	Ball Bearing	1	106180	106495	106495
28	Shaft Adapter, 3/4" dia.	1	003406	N/A	N/A
	Shaft Adapter, 1" dia.	1	003407	003059	N/A
	Shaft Adapter, 1-1/4" dia.	1	N/A	003058	003058
29	Retaining Ring	2	106593	106497	106497
30*	Ball Bearing	1	106588	106564	106564
31	Felt Wiper Seal	1	106502	106488	106488
32	Setscrew	2	104618	104618	104618
33	Shaft Adapter Reducer, 1" to 3/4"	1	004647	N/A	N/A
	Shaft Adapter Reducer, 1-1/4" to 1"	1	N/A	004648	N/A

*Recommended Spare Parts

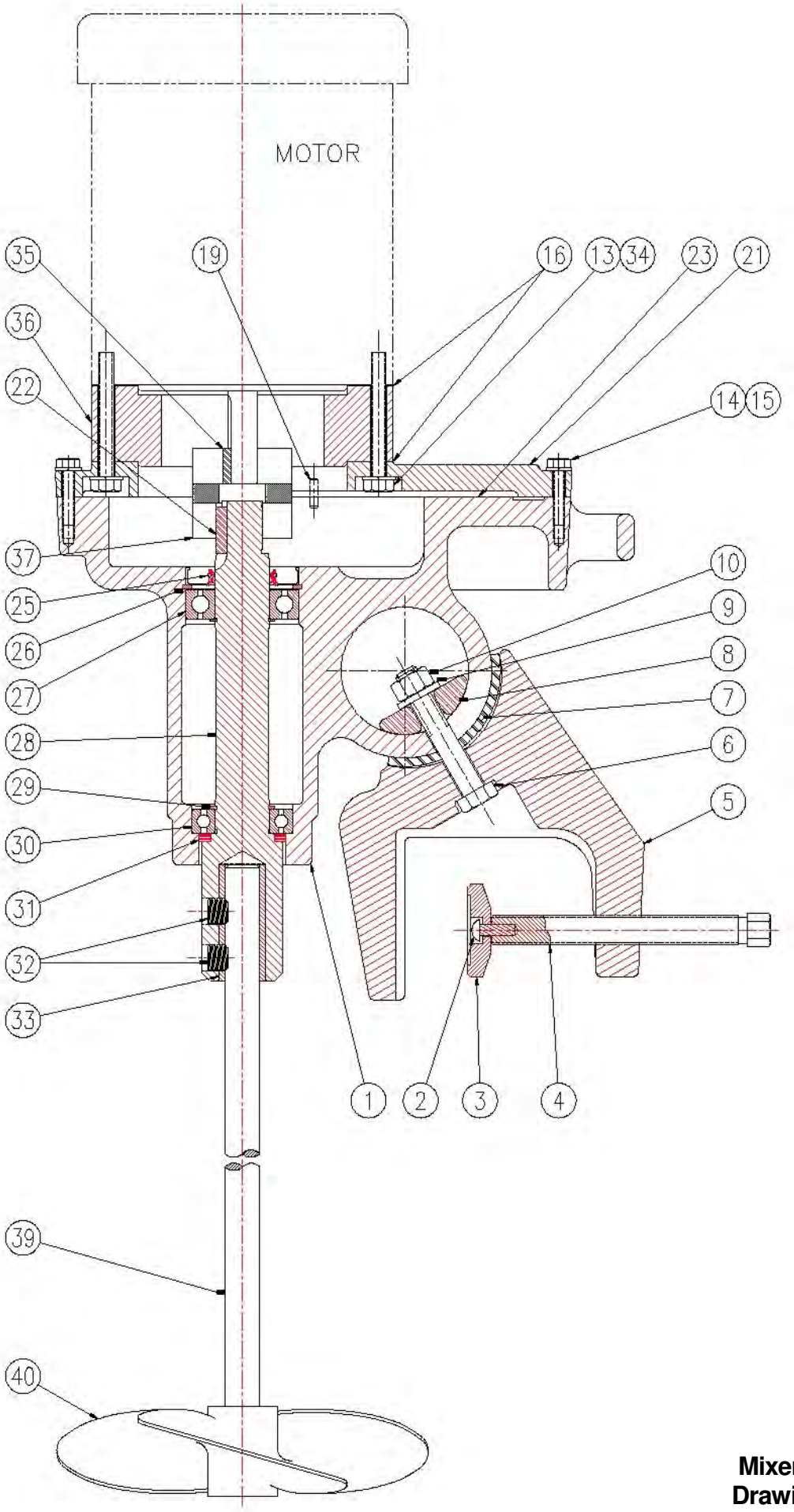


Mixer Model JG
Drawing No. S00070

PARTS LIST
For Series JD Clamp Mount Model Mixers
(Refer to Drawing on Page 10)

ITEM NUMBER	ITEM DESCRIPTION	QTY.	MODEL JD2.0 - JG6.1	MODEL JD7.1 - JD7.4
1	Mixer Gearbox - Body	1	003161	003053
2	Drive Screw	1	100370	100370
3	Clamp Button	1	000476	000476
4	Stud	1	002683	002683
5	Mounting Clamp	1	003146	002682
6	Hex Head Cap Screw or Stud	1	100397	106387
7*	Flat Washer	1	100369	100369
8	Pivot Washer	1	100509	106074
9	Flat Washer	1	106833	100051
10	Hex Nut	1	WA170583	108518
13	Lock Washer	4	100217	100217
14	Hex Head Cap Screw	6	106748	106748
15	Lock Washer	6	100075	100075
16	Motor Gasket	1	106097	106097
19	Dowel Pin	2	100351	100579
21	Motor Midplate	1	003148	003057
22	Key	1	100110	100110
23	Midplate Gasket	1	106507	106494
25	Seal	1	106586	106542
26	Retaining Ring	1	106592	106562
27*	Ball Bearing	1	106180	106495
28	Shaft Adapter, 3/4" dia.	1	003406	N/A
	Shaft Adapter, 1" dia.	1	003407	003058
	Shaft Adapter, 1-1/4" dia.	1	N/A	N/A
29	Retaining Ring	2	106593	106497
30*	Ball Bearing	1	106588	106564
31	Felt Wiper Seal	1	106502	106488
32	Setscrew	2	104618	104618
33	Shaft Adapter Reducer, 1” to 3/4"	1	004647	N/A
	Shaft Adapter Reducer, 1-1/4” to 1”	1	N/A	004648
34	Hex Head Cap Screw	4	108338	108338
35	Key	1	100218	100218
36	Motor Extension	1	003197	003197
37	Coupling	1	106664	106640

*Recommended Spare Parts



Mixer Model JD
Drawing No. S00072

PARTS LIST
For Series JGR and JDR Angle Riser Mount Model Mixers

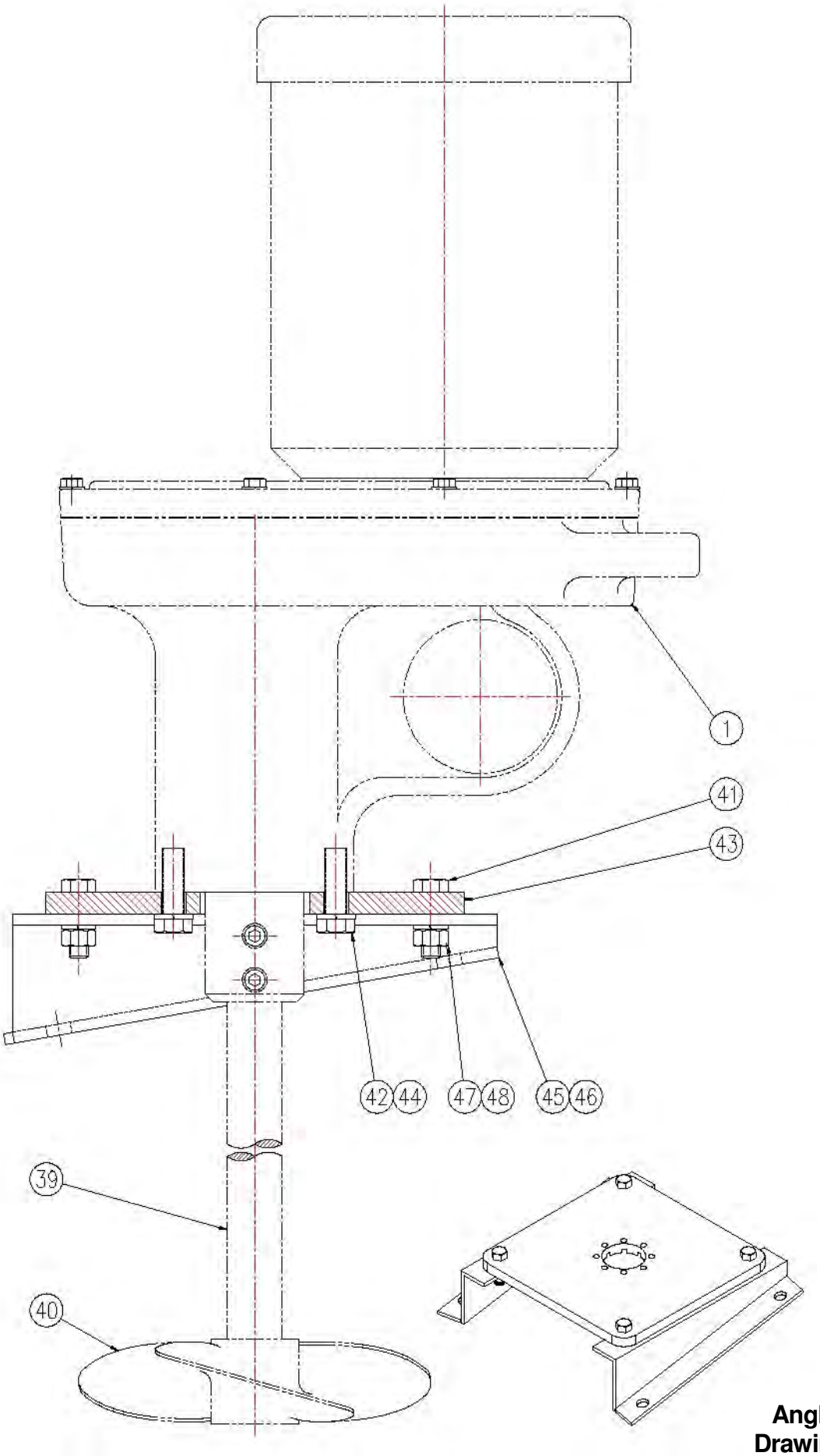
NOTE: All parts in JGR and JDR Mixers are the same as JG or JD Mixers except mounting clamps. JGR and JDR Mixers do not use items 2 to 10 including items on parts list (Refer to pages 7 and 9). JGR and JDR do use parts listed below for Angle Riser Mount.

ITEM NUMBER	PART NUMBER	ITEM DESCRIPTION	QTY. PER ASSEMBLY	
			JGR QTY.	JDR QTY.
1 **	003161	Mixer Gearbox - Body	1	1
41	106268	Hex Head Cap Screw	4	4
42	106704	Hex Head Cap Screw	4	4
**	106996	Socket Head Cap Screw	8	8
43	106281	Angle Riser Midplate	1	1
**	106809	Angle Riser Midplate	1	1
44	100457	Lock Washer	4	4
**	108592	Internal Tooth Lock Washer	8	8
45	002794	Angle Riser (Right Side)	1	1
46	002795	Angle Riser (Left Side)	1	1
47	100105	Lock Washer	4	4
48	106267	Hex Nut	4	4

**These Parts are for JGR/JDR-2.0-JGR/JDR 6.1 Only.

INSTALLATION:

1. Remove the Mixer and Angle Riser Unit (A.R.U.) from their shipping cartons.
2. Install assembled A.R.U. onto tank, see page 3, for mounting instruction, and secure in place.
3. Place Mixer onto A.R.U. and secure with hardware provided (42, 44).
4. Insert Shaft into Mixer Shaft Collar and secure as described on page 5 in Section "0" of the Operating and Instruction Manual of Series JG and JD Mixers.



Angle Riser Mount
Drawing No. S00051

FLANGE MOUNTING MIXER
ADDENDUM TO OPERATING AND INSTRUCTION MANUAL FOR SERIES JG AND JD MIXERS

PARTS LIST
For Series JGF and JDF Stuffing-Box Model Mixers

NOTE: All parts in JGF and JDF Mixers are the same as JG or JD Mixers except mounting clamps. JGF and JDF Mixers do not use items 2 to 10 including items on parts list (Refer to pages 7 and 9). JGF and JDF do use Parts listed below for Flange Mount.

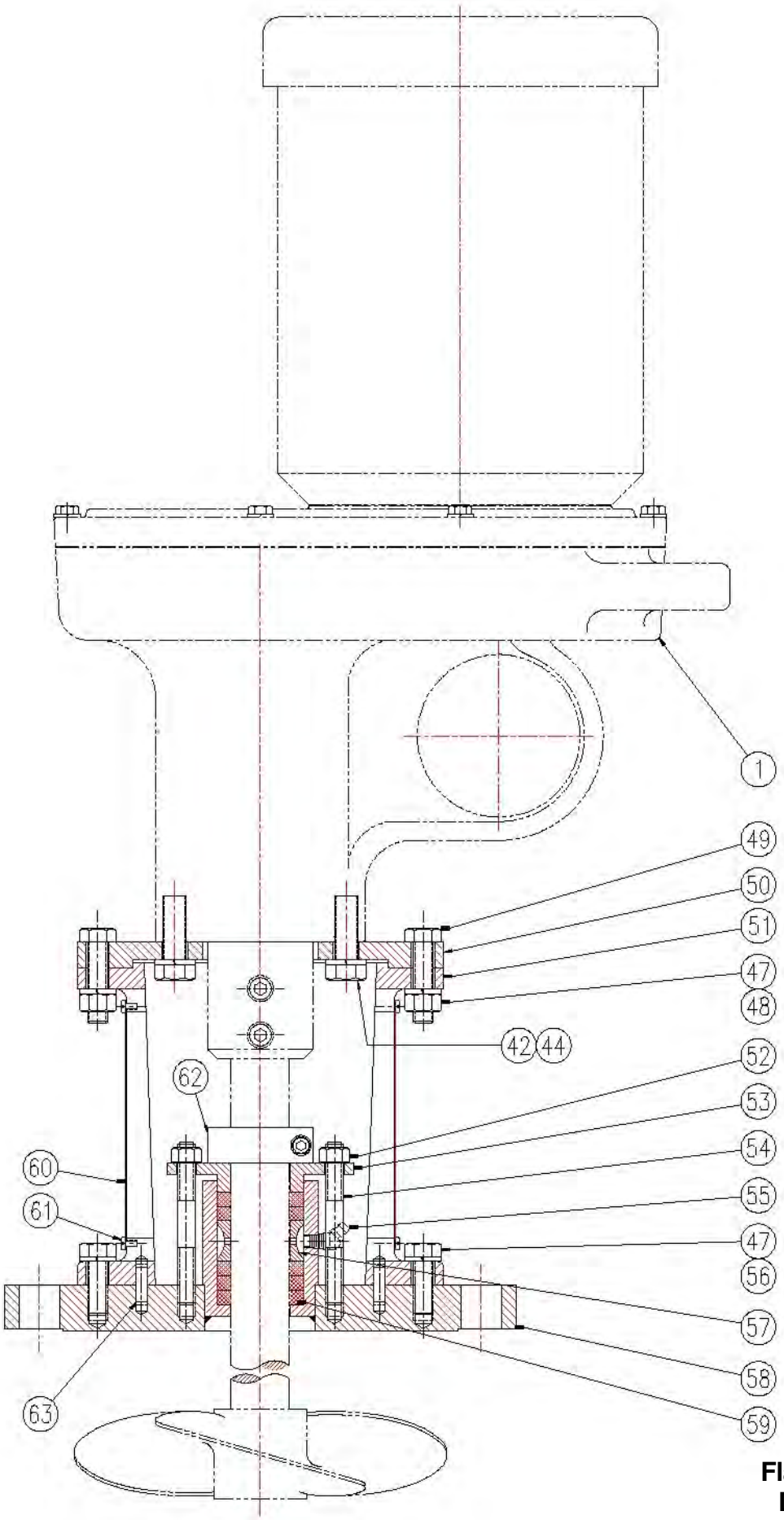
ITEM NO.	PART NO.	ITEM DESCRIPTION	QTY.
1 **	003161	Mixer Gearbox - Body	1
42	106704	Hex Head Cap Screw 1/2-20 x 1-1/2" lg.	4
**	106996	Socket Head Cap Screw 1/4-20 x 3/4" lg.	8
44	100457	1/2" Lock Washer	4
**	108592	1/4" Internal Tooth Lock Washer	8
47	100105	7/16" Lock Washer	16
48	106267	7/16-14 Hex Nut	8
49	106619	Hex Head Cap Screw 7/16-14 x 1-3/4" lg.	8
50 **	003270	Mixer Spacer Adapter	1
	003271	Mixer Spacer Adapter	1
51	003260	Stuffing-Box Spacer	1
52	108180	3/8-16 Hex Nut with Nylock	4
53 **	003265	1" dia. Shaft, Sealing Bushing	1
	003266	1-1 /4" dia. Shaft, Sealing Bushing	1
**	003274	3/4" dia. Shaft, Sealing Bushing	1
54	106620	3/8-16 x 3-1/2" lg. Stud	4
55	100036	Grease Filling	1
56	100104	Hex Head Cap Screw 7/16-14 x 1-1/4" lg.	8
*57 **	003261	1" dia. Shaft, Lantern Ring	1
	003262	1-1/4" dia. Shaft, Lantern Ring	1
**	003273	3/4" dia. Shaft, Lantern Ring	1

ITEM NO.	PART NO.	ITEM DESCRIPTION	QTY.
58 **		1" dia. Shaft, 6" Flange Assembly	1
**		1" dia. Shaft, 8" Flange Assembly	1
**		1" dia. Shaft, 10" Flange Assembly	1
**		1" dia. Shall, 12" Flange Assembly	1
**		1" dia. Shaft, 14" Flange Assembly	1
		1-1/4" dia. Shaft, 6" Flange Assembly	1
		1-1/4" dia. Shaft, 8" Flange Assembly	1
		1-1/4" dia. Shaft, 10" Flange Assembly	1
		1-1/4" dia. Shaft, 12" Flange Assembly	1
		1-1/4" dia. Shaft, 14" Flange Assembly	1
**		3/4" dia. Shaft, 6" Flange Assembly	1
**		3/4" dia. Shaft, 8" Flange Assembly	1
**		3/4" dia Shaft, 10" Flange Assembly	1
**		3/4" dia. Shaft, 12" Flange Assembly	1
**		3/4" dia. Shaft, 14" Flange Assembly	1
59 **	003267	1" dia. Shaft, Packing	5
	003268	1-1/4" dia. Shaft, Packing	5
**	003269	3/4"dia. Shaft, Packing	5
60	003272	Mixer Window Screen	2
61	106621	#8-32 x 3/8 lg. Pan Head Screw	8
62 **	106614	1 " dia. Shaft Collar	1
	106615	1-1/4" dia. Shaft Collar	1
**	106811	3/4" dia. Shaft Collar	1
63	101208	1/4" x 3/4" lg. Dowel Pin	2

*Recommended Spare Parts.
**These Parts are for Models JGF JDF-2.0 through JGF/JDF-6.1 Only.
Item 58 available in 316SS & Carbon Steel.

INSTALLATION:

1. Remove the Mixer and Flange Mounting Unit (F.M.U.) from their shipping cartons.
2. Remove the (2) Window Screens [60] by unscrewing (8) Screws [61].
3. Remove Mixer Spacer Adapter [50] from the F.M.U.
4. Place the Propellers on the end of the shaft WITHOUT THE NOTCH and then insert into the empty tank.
5. Lubricate the end of the Shaft WITH THE NOTCH and insert through the Orifice of the F.M.U. to protrude approximately 2-1/2", taking care as not to mar the surface of the propeller shaft.
6. To prevent the Shaft from falling into the tank, place the Shaft Collar [62] on the Shaft and secure with a Socket Head Screw and Hex Wrench provided.
7. Install assembled F.M.U. onto Tank and secure in place, make sure that there is free access to the Stuffing Chamber through the windows.
8. Fasten Mixer Spacer [50] with Screws [42] and Lock Washers [44] onto Mixer.
9. Place Mixer assembled with Mixer Spacer Adapter [50] onto F.M.U. and secure with Hardware provided [47, 48, 49].
10. Insert Shaft into Mixer Shaft Collar and secure as described on pg. 5 in Section D, of the Operating and Instruction Manual of Series JG & JD Mixers.
11. Pack Stuffing Chamber with Grease through Grease Fitting [55].
12. Adjust the Packing Pressure with Sealing Bushing [53] by applying approximately 10 in. lbs. to the (4) 3/8-16 Hex Nuts (tightened uniformly).
13. Replace Window Screens [60] before operating Mixer.



Flange Mounting Unit
Drawing No. S00073

MATERIAL SAFETY DATA SHEET

1. Product and Company Identification

Material name	**Termalene Heavy Duty Construction Grease**
Product Code	72560
Version #	1.1
Revision date	05-23-2012
Synonym(s)	Termalene EP 2C Ex Tacky
Manufacturer information	Bel-Ray Company, Inc. P.O. Box 526 Farmingdale, NJ 07727 United States of America +1 732 938 2421 CHEMTREC: +1 703-527-3887 (outside USA) CHEMTREC: 800-424-9300 (USA)

2. Hazards Identification

Emergency overview	CAUTION Harmful in contact with eyes. Prolonged exposure may cause chronic effects.
OSHA regulatory status	This product is considered hazardous under 29 CFR 1910.1200 (Hazard Communication).
Potential health effects	
Routes of exposure	Inhalation. Ingestion. Skin contact. Eye contact.
Eyes	Eye contact may result in corneal injury. Contact may irritate or burn eyes. Do not get this material in contact with eyes.
Skin	Frequent or prolonged contact may defat and dry the skin, leading to discomfort and dermatitis. Avoid contact with the skin.
Inhalation	Avoid breathing dust/fume/gas/mist/vapors/spray.
Ingestion	Components of the product may be absorbed into the body by ingestion. Do not ingest.
Target organs	Eyes. RESPIRATORY SYSTEM. Skin.
Chronic effects	Conjunctiva. Frequent or prolonged contact may defat and dry the skin, leading to discomfort and dermatitis.
Signs and symptoms	Corneal damage. Conjunctivitis. Defatting of the skin. Skin irritation. Rash.
Potential environmental effects	Components of this product are hazardous to aquatic life. May cause long-term adverse effects in the environment.

3. Composition / Information on Ingredients

Components	CAS #	Percent
Distillates (petroleum), Hydrotreated Heavy Naphthenic	64742-52-5	0 - 90
Distillates (petroleum), Hydrotreated Heavy Paraffinic	64742-54-7	0 - 90
Distillates (petroleum), Solvent-refined Heavy Paraffinic	64741-88-4	0 - 90
Lubricating Oils (petroleum), Hydrotreated Spent	64742-58-1	0 - 90
White Mineral Oil (petroleum)	8042-47-5	0 - 90
Aluminum, (benzoato-o,o)hydroxy(octadecanoato-o,o)-	54326-11-3	2.5 - 10
Antimony Tris[o,o-dipropyl] Tris(dithiophosphate)	15874-48-3	1 - 2.5
Other components below reportable levels		2.5 - 10

Composition comments IP 346: < 3.0% DMSO extract for all base oil substances.

4. First Aid Measures

First aid procedures

Eye contact	Immediately flush eyes with plenty of water for at least 15 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Get medical attention immediately.
Skin contact	Wash off with warm water and soap. Get medical attention if irritation develops and persists.
Inhalation	If breathing is difficult, remove to fresh air and keep at rest in a position comfortable for breathing. Call a physician if symptoms develop or persist.
Ingestion	Rinse mouth thoroughly. Do not induce vomiting. If ingestion of a large amount does occur, call a poison control center immediately. Never give liquid to an unconscious person.
Notes to physician	Symptoms may be delayed.
General advice	Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves.

5. Fire Fighting Measures

Flammable properties	Not flammable by OSHA criteria. Not combustible by OSHA criteria.
Extinguishing media	
Suitable extinguishing media	Water fog. Foam. Dry powder. Carbon dioxide (CO2).
Unsuitable extinguishing media	Water. Do not use water jet as an extinguisher, as this will spread the fire.
Protection of firefighters	
Protective equipment and precautions for firefighters	Wear suitable protective equipment.
Fire fighting equipment/instructions	Move containers from fire area if you can do so without risk.
Hazardous combustion products	Carbon monoxide and carbon dioxide.

6. Accidental Release Measures

Personal precautions	Keep unnecessary personnel away. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Keep people away from and upwind of spill/leak. Keep upwind. Keep out of low areas. Ventilate closed spaces before entering them.
Environmental precautions	Prevent further leakage or spillage if safe to do so. Do not contaminate water.
Methods for containment	ELIMINATE all ignition sources (no smoking, flares, sparks or flames in immediate area). Stop the flow of material, if this is without risk. Dike the spilled material, where this is possible. Use water spray to reduce vapors or divert vapor cloud drift. Prevent entry into waterways, sewer, basements or confined areas.
Methods for cleaning up	Should not be released into the environment. This product is miscible in water. Large Spills: Stop the flow of material, if this is without risk. Dike the spilled material, where this is possible. Cover with plastic sheet to prevent spreading. Absorb in vermiculite, dry sand or earth and place into containers. Following product recovery, flush area with water. Small Spills: Wipe up with absorbent material (e.g. cloth, fleece). Clean surface thoroughly to remove residual contamination. Never return spills in original containers for re-use. For waste disposal, see section 13 of the MSDS.

7. Handling and Storage

Handling	DO NOT handle, store or open near an open flame, sources of heat or sources of ignition. Protect material from direct sunlight. Do not get this material in contact with eyes. Avoid contact with skin. Avoid prolonged exposure. Avoid release to the environment. Hydrogen sulfide (H2S) may be given off when this material is heated. Do not depend on sense of smell for warning.

Storage	Class IIIB Combustible Liquid. Keep away from heat, sparks and open flame. Store in a well-ventilated place. Keep container tightly closed. Keep away from food, drink and animal feedingstuffs. Keep out of the reach of children. Use care in handling/storage.

8. Exposure Controls / Personal Protection

Occupational exposure limits

ACGIH

Components	Type	Value	Form
Distillates (petroleum), Hydrotreated Heavy Naphthenic (64742-52-5)	TWA	5 mg/m3	Inhalable Fraction.

US. ACGIH Threshold Limit Values

Components	Type	Value	Form
Aluminum, (benzoato-o,o)hydroxy(octadecanoato-o,o)- (54326-11-3)	TWA	1 mg/m3	Respirable fraction.
Antimony Tris[o,o-dipropyl] Tris(dithiophosphate) (15874-48-3)	TWA	0.5 mg/m3	
White Mineral Oil (petroleum) (8042-47-5)	TWA	5 mg/m3	Inhalable fraction.

US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000)

Components	Type	Value	Form
Antimony Tris[o,o-dipropyl] Tris(dithiophosphate) (15874-48-3)	PEL	0.5 mg/m3	
Distillates (petroleum), Hydrotreated Heavy Naphthenic (64742-52-5)	PEL	5 mg/m3	Mist.
		2000 mg/m3 500 ppm	
Distillates (petroleum), Hydrotreated Heavy Paraffinic (64742-54-7)	PEL	5 mg/m3	Mist.
Distillates (petroleum), Solvent-refined Heavy Paraffinic (64741-88-4)	PEL	5 mg/m3	Mist.
		2000 mg/m3 500 ppm	
Lubricating Oils (petroleum), Hydrotreated Spent (64742-58-1)	PEL	5 mg/m3	Mist.
White Mineral Oil (petroleum) (8042-47-5)	PEL	5 mg/m3	Mist.

Exposure guidelines	Occupational Exposure Limits are not relevant to the current physical form of the product.
Personal protective equipment	
Eye / face protection	Do not get in eyes. Chemical goggles are recommended. Eye wash fountain is recommended.
Skin protection	Wear appropriate chemical resistant clothing. Chemical resistant gloves.
Respiratory protection	Wear positive pressure self-contained breathing apparatus (SCBA).
General hygiene considerations	Do not get in eyes. Avoid contact with skin. Keep away from food and drink. Handle in accordance with good industrial hygiene and safety practice.

9. Physical & Chemical Properties

Appearance	Gel.
Form	Grease
Color	Red.
Odor	Petroleum

Odor threshold	Not available. **pH**
	Not available.
Vapor pressure	0 hPa estimated
Density	875 kg/m³
Vapor density	Not available.
Boiling point	680 °F (360 °C) estimated
Melting point/Freezing point	156.74 °F (69.3 °C) estimated
Solubility (water)	Negligible
Solubility (other)	Oil
Specific gravity	0.88
Relative density	Not available.
Flash point	437 °F (225 °C) Cleveland Open Cup
Flammability limits in air, upper, % by volume	Not available.
Flammability limits in air, lower, % by volume	Not available.
Auto-ignition temperature	500 °F (260 °C) estimated
VOC	0.14 % estimated
Viscosity	269 cSt (Base Oil)
Percent volatile	0.14 % estimated
Other data	
Drop point	> 500 °F (> 260 °C)
Flammability class	Combustible IIIB estimated
Flash point class	Combustible IIIB
Viscosity temperature	104 °F (40 °C)

10. Chemical Stability & Reactivity Information

Chemical stability	Material is stable under normal conditions.
Conditions to avoid	Heat, flames and sparks. Avoid temperatures exceeding the flash point.
Incompatible materials	Not available.
Hazardous decomposition products	Toxic gas. At thermal decomposition temperatures, carbon monoxide and carbon dioxide. Hydrogen sulfide. Mercaptans.

11. Toxicological Information

Toxicological data

Product	Test Results
Termalene Heavy Duty Construction Grease (Mixture)	Acute Oral LD50 Rat: 343.94 g/kg estimated
	Acute Other LD50 Mouse: 1725.62 mg/kg estimated
	Acute Other LD50 Rat: 1432.53 mg/kg estimated

Local effects	Components of the product may be absorbed into the body through the skin. Contact may irritate or burn eyes.
Chronic effects	Hazardous by OSHA criteria. Prolonged exposure may cause chronic effects.
Carcinogenicity	This product is not considered to be a carcinogen by IARC, ACGIH, NTP, or OSHA.

ACGIH Carcinogens

Aluminum, (benzoato-o,o)hydroxy(octadecanoato-o,o)- ALUMINUM METAL AND INSOLUBLE COMPOUNDS, RESPIRABLE FRACTION (CAS 54326-11-3)	A4 Not classifiable as a human carcinogen.
Distillates (petroleum), Hydrotreated Heavy Naphthenic MINERAL OIL, EXCLUDING METAL WORKING FLUIDS, PURE, HIGHLY AND SEVERELY REFINED, INHALABLE FRACTION (CAS 64742-52-5)	A4 Not classifiable as a human carcinogen.

Distillates (petroleum), Solvent-refined Heavy Paraffinic MINERAL OIL, EXCLUDING METAL WORKING FLUIDS, PURE, HIGHLY AND SEVERELY REFINED, INHALABLE FRACTION (CAS 64741-88-4)	A4 Not classifiable as a human carcinogen.
White Mineral Oil (petroleum) MINERAL OIL, EXCLUDING METAL WORKING FLUIDS, PURE, HIGHLY AND SEVERELY REFINED, INHALABLE FRACTION (CAS 8042-47-5)	A4 Not classifiable as a human carcinogen.

IARC Monographs. Overall Evaluation of Carcinogenicity

MINERAL OILS, HIGHLY-REFINED (CAS 8042-47-5)	3 Not classifiable as to carcinogenicity to humans.

12. Ecological Information

Ecotoxicological data

Product	Test Results
Termalene Heavy Duty Construction Grease (Mixture)	EC50 Daphnia: 72954.55 mg/l 48 hours estimated

* Estimates for product may be based on additional component data not shown.

Ecotoxicity	Components of this product are hazardous to aquatic life.
Environmental effects	Harmful to aquatic organisms. An environmental hazard cannot be excluded in the event of unprofessional handling or disposal.
Persistence and degradability	Not available.

13. Disposal Considerations

Waste codes	D005: Waste Barium
Disposal instructions	Collect and reclaim or dispose in sealed containers at licensed waste disposal site. Incinerate the material under controlled conditions in an approved incinerator. Do not allow this material to drain into sewers/water supplies. Dispose in accordance with all applicable regulations.
Contaminated packaging	Empty containers should be taken to an approved waste handling site for recycling or disposal.

14. Transport Information

DOT

Not regulated as dangerous goods.

IATA

Not regulated as dangerous goods.

IMDG

Not regulated as dangerous goods.

15. Regulatory Information

US federal regulations

This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard 29 CFR 1910.1200.
One or more components are not listed on TSCA.

US EPCRA (SARA Title III) Section 313 - Toxic Chemical: De minimis concentration

Antimony Tris[o,o-dipropyl] Tris(dithiophosphate) (CAS 15874-48-3)	1.0 % N010

US EPCRA (SARA Title III) Section 313 - Toxic Chemical: Listed substance

Antimony Tris[o,o-dipropyl] Tris(dithiophosphate) (CAS 15874-48-3)	Listed. N010

CERCLA (Superfund) reportable quantity

None

Superfund Amendments and Reauthorization Act of 1986 (SARA)

Hazard categories	Immediate Hazard - Yes Delayed Hazard - Yes Fire Hazard - No Pressure Hazard - No Reactivity Hazard - No
Section 302 extremely hazardous substance	No

Section 311 hazardous chemical	Yes
Clean Water Act (CWA)	Hazardous substance

State regulations

US - California Proposition 65 - CRT: Listed date/Carcinogenic substance

ETHYLBENZENE (CAS 100-41-4)	Listed: June 11, 2004 Carcinogenic.
TITANIUM DIOXIDE (AIRBORNE, UNBOUND PARTICLES OF RESPIRABLE SIZE) (CAS 13463-67-7)	Listed: September 2, 2011 Carcinogenic.

US - New Jersey RTK - Substances: Listed substance

Antimony Tris[o,o-dipropyl] Tris(dithiophosphate) (CAS 15874-48-3)	Listed.
Distillates (petroleum), Hydrotreated Heavy Naphthenic (CAS 64742-52-5)	Listed.
Distillates (petroleum), Hydrotreated Heavy Paraffinic (CAS 64742-54-7)	Listed.
Distillates (petroleum), Solvent-refined Heavy Paraffinic (CAS 64741-88-4)	Listed.
Lubricating Oils (petroleum), Hydrotreated Spent (CAS 64742-58-1)	Listed.

US - Pennsylvania RTK - Hazardous Substances: Listed substance

Distillates (petroleum), Hydrotreated Heavy Naphthenic (CAS 64742-52-5)	Listed.
Distillates (petroleum), Hydrotreated Heavy Paraffinic (CAS 64742-54-7)	Listed.
Lubricating Oils (petroleum), Hydrotreated Spent (CAS 64742-58-1)	Listed.
White Mineral Oil (petroleum) (CAS 8042-47-5)	Listed.

16. Other Information

Further information	HMIS® is a registered trade and service mark of the NPCA.
HMIS® ratings	Health: 1* Flammability: 1 Physical hazard: 0
NFPA ratings	Health: 1 Flammability: 1 Instability: 0
Disclaimer	Bel-Ray Company cannot anticipate all conditions under which this information and its product, or the products of other manufacturers in combination with its product, may be used. It is the user's responsibility to ensure safe conditions for handling, storage and disposal of the product, and to assume liability for loss, injury, damage or expense due to improper use.
Issue date	05-23-2012
This data sheet contains changes from the previous version in section(s):	Product and Company Identification: Bel Ray Custom Labels Hazards Identification: Emergency overview Composition / Information on Ingredients: Ingredients Composition / Information on Ingredients: Composition comments Handling and Storage: Handling Physical & Chemical Properties: Multiple Properties Toxicological Information: Acute effects

MAINTENANCE LOG

Mixer Model_____ Serial #_____

Shaft Diameter and Length_____ Mixer RPM_____

Propeller Diameter_____

Spare Parts Kit #107781 for JG/JD 2.X to 6.X MIXER or #107782 for 7.X to 9.X MIXER (For Mixers using Pin Bolt)
Spare Parts Kit #104619 for JG/JD 2.X to 6.X MIXER or #104652 for JG/JD 7.X to 9.X MIXER (For Mixers using Setscrews)

NEPTUNE CHEMICAL PUMP CO. Tel.: 215-699-8700 • FAX: 215-699-0370

DATE	SERVICED BY	MAINTENANCE PERFORMED

Revision C, ECN-3091

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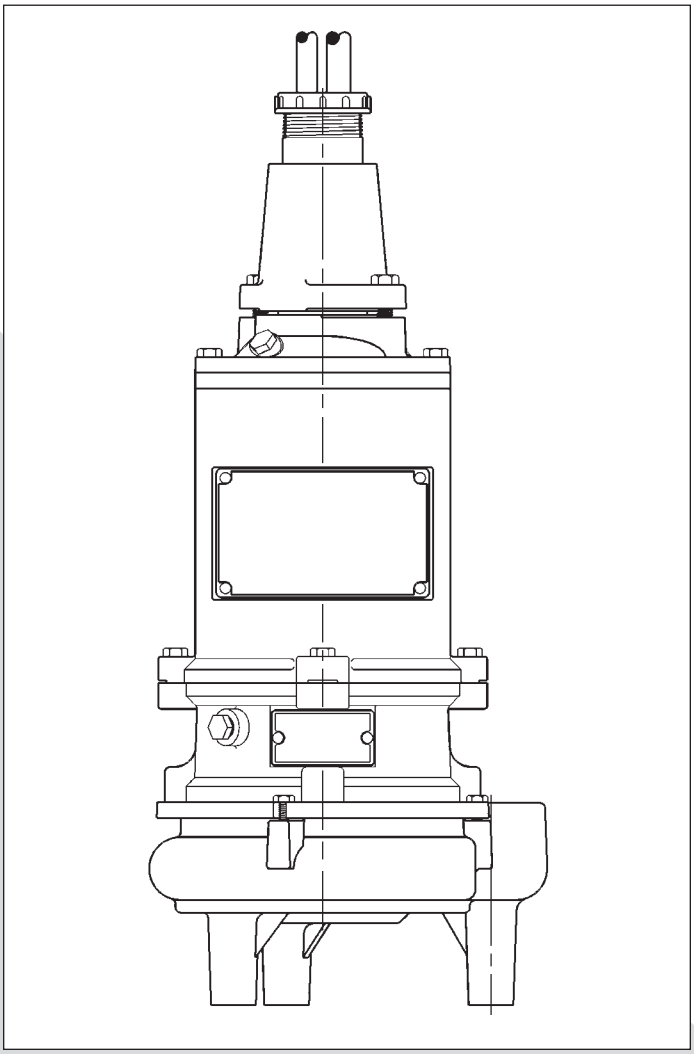
INSTALLATION AND SERVICE MANUAL

SUBMERSIBLE SX SERIES PUMPS

Models
SX
Series
(Class I, Division 1, Group D)



ENGLISH: PAGES 2-16

Installation and Service Manual

NOTE! To the installer: Please make sure you provide this manual to the owner of the equipment or to the responsible party who maintains the system.

The submersible SX Series pumps are CSA approved for use in Class I, Division 1, Group D hazardous locations in wastewater and storm water applications. The SX Series pumps are not intended for applications requiring the pumping of flammable liquids. A triplex system is recommended to reduce the possibility of concentrations of flammable/hazardous liquids entering the main lift station.

PENTAIR
MYERS

WARNING! IMPORTANT SAFETY INSTRUCTIONS! READ CAREFULLY BEFORE INSTALLATION. This manual contains important information for the safe use of this product. Read this manual completely before using this product and refer to it often for continued safe product use. DO NOT THROW AWAY OR LOSE THIS MANUAL. Keep it in a safe place so that you may refer to it often.

DANGER: Risk of Electrical Shock or Electrocution. May result in serious injury or death or fire hazard. Installer must disconnect all electrical sources prior to installation, handling or servicing. Only qualified personnel may install this system. NFPA 70/National Electric Code (NEC) or local codes must be followed. System must be properly grounded according to NEC. Do not lift pump by power cord.

DANGER: Biohazard Risk. Once wastewater source has been connected to system, biohazard risk exists. Installer(s) and/ or service personnel must use proper personal protective equipment and follow handling procedures per OSHA 29 CFR 1910.1030 when handling equipment after wastewater source has been connected to system.

DANGER: Risk of Asphyxiation. Installer(s) and/or service personnel must use proper personal protective equipment and follow OSHA 29 CFR 1910.146 or OSHA 29 CFR 1926. Pump may be installed in a location classified as a confined space.

DANGER: Risk of Fire or Explosion. Do not smoke or use open flames in or around this system. This system is not intended for use in hazardous locations per NFPA 70 National Electric Code. Do not pump flammable liquids. Consult factory for optional equipment rated for hazardous location use.

CALIFORNIA PROPOSITION 65 WARNING:

⚠WARNING This product and related accessories contain chemicals known to the State of California to cause cancer, birth defects or other reproductive harm.

GENERAL

1. Most accidents can be avoided by carefully following the steps outlined in this manual. Comply with all local and regional codes.
2. Read the operation and maintenance instructions manual supplied with the pump.
3. Do not wear loose clothing that can become entangled in the impeller or other moving parts.

ELECTRICAL

4. To reduce risk of electrical shock, disconnect the pump from the power source before handling or servicing.
5. Any wiring to be done on pumps should be done by a qualified electrician.
6. Never operate a pump with a power cord that has frayed or brittle insulation.
7. Never let cords or plugs lie in water.
8. Never handle connected power cords with wet hands.

PUMPS

9. Pump builds up heat and pressure during operation; allow time for pump to cool before handling or servicing.
10. Only qualified personnel should install, operate or repair pump.
11. Keep clear of suction and discharge openings. **DO NOT** insert fingers in pump with power connected.
12. Do not pump hazardous material not recommended for pump (flammable, caustic, etc.).
13. Make sure lifting handles are securely fastened each time before lifting.
14. Do not exceed manufacturer's recommendation for maximum performance, as this could cause the motor to overheat.
15. Secure the pump in its operating position so it cannot tip over, fall or slide.
16. Keep hands and feet away from impeller when power is connected.
17. Submersible pumps are not approved for use in swimming pools, recreational water installations, decorative fountains or any installation where human contact with the pumped fluid is common.
18. Do not operate pump without safety devices in place.
19. For hazardous locations, use pumps that are listed and classified for such locations.

IMPORTANT! Myers is not responsible for losses, injury or death resulting from a failure to observe these safety precautions, misuse or abuse of pumps or equipment.

Motor HP & Voltages: The SX Series pumps are offered in single and three phase. Voltages will vary according to the application, for details consult factory.

Electrical Controls: All of these pump models must be used with a control panel. Myers built control panels are designed to supply the correct electrical controls, motor starting equipment and include the circuitry for moisture and heat sensors. It is recommended that a Myers built control panel be used so that all warranties apply.

General Construction: The submersible SX Series pumps are CSA approved for use in Class I, Division 1, Group D hazardous locations in wastewater and storm water applications. The SX Series pumps are not intended for applications requiring the pumping of flammable liquids. A triplex system is recommend to reduce the possibility of concentrations of flammable/hazardous liquids entering the main lift station.

General Installation: Various configurations and methods of plumbing this series may be used.

Note: If the SX Series hazardous location pumps are used in conjunction with a rail lift-out system, it must be a listed or recognized nonsparking system for hazardous locations.

These pumps are to be used for handling septic tank effluent, sewage, and storm water only. ***Do not*** use in other hazardous locations. These motors must be repaired and serviced only at a Myers authorized service center or at the Myers factory. Any unauthorized field repair voids warranty and the hazardous location rating.

CAUTION: Sewage water gives off methane and hydrogen sulfide gases, which are poisonous. It is for this reason that Myers recommends using the rail lift-out system so that no service is required inside the basin.

Motor: Each motor is provided with heat sensor thermostats attached directly to the motor windings. The thermostats open if the motor windings see excessive heat and, in turn, open the motor contactor in the control panel, breaking the power to the pump. When the motor is stopped due to an overheat condition, it will not start until the motor has cooled and the heat sensor reset button is manually pushed on the front of the Myers control panel. This circuitry is provided in the Myers control panel designs.

The SX Series pumps are equipped with internal thermostats.

Note: Failure to use proper circuitry and to connect the motor overheat protection in the control panel would negate all warranties and CSA Listings.

Motor Seal Failure Warning: The seal chamber is oil filled and provided with moisture sensing probes to detect water leakage through the lower shaft seal. The probes can also detect moisture present in the upper motor housing.

The presence of water energizes a red seal leak warning light at the control panel. This is a warning light only, and does not stop the motor. It indicates a leak has occurred and the pump must be repaired. Normally, this indicates the outboard seal has leaked. Allowing the unit to operate after the warning could cause upper seal leakage along with motor failure.

On the Myers control panels the seal leak test switch tests the seal leak circuit continuity. When pushed the seal leak test bulb should light. If the test bulb does not light it means either the wiring circuitry to the seal leak probes have been broken or the bulb has burned out.

Note: Myers built control panels supply the correct circuitry for moisture and heat sensor connections. Failure to install the correct circuitry with proper connection would negate warranty and CSA Listing.

Motor Power Cord, Control Cord and Cord Cap Assembly: Each motor power cord has 4 conductors – white, black, red and green. For a single phase motor the black is connected to the common lead, the white is connected to the main lead, while the red is connected to the start circuitry, and the green is attached to a good ground. The rotation of a single phase pump is set properly at the factory.

For three phase motor, the black, white, and red conductors are power leads and the green is ground.

Note: Rotation should be clockwise when observed from the top of the pump. This can be checked by noting which direction the pump torques upon initial starting. A properly rotating pump will torque counterclockwise upon start.

ALWAYS CHECK THREE PHASE PUMPS FOR PROPER ROTATION BEFORE INSTALLING PUMPS.

The control cable has 5 conductors – black, white, red, orange and green. White and black connect to the heat sensor terminals in the control panels; red and orange connect to the seal failure terminals in the control panel; and the green connects to the ground in the control panel.

The control and power cables cannot be spliced!

Note: Each cable has a green ground wire and must be properly grounded per the National Electric Code and local codes.

Electrical Motor Controls: All electrical controls and motor starting equipment should be specified from factory. Consult factory for any acceptable alternatives. For hazardous locations the controls and control panel must be installed outside the hazardous area. Only approved controls that are intrinsically safe may be used with these pumps.

Junction Box: If a junction box is used in a hazardous location, it must be an approved type with approved cord connectors. Wires from the junction box must pass through an approved seal connector for hazardous locations.

Level Sensing Controls: Intrinsically safe-type float controls are recommended for all applications and required for hazardous locations. An intrinsically safe control panel relay will limit the current and voltage to the level controls. A Myers control panel can be supplied with this type circuitry. The float level controls maintain the basin water level by controlling pump turn-on and turn-off levels.

1. The lower turn-off control should be set so that the pump stops with the water covering the entire motor housing. Consult the factory for any settings below this point.
2. The upper turn-on control should be set above the lower turn-off control. The exact height between the two controls is determined by the number of pump starts desired and the depth of the basin. A maximum of 10 starts per hour should not be exceeded.
3. The override control is set at a specified height above the upper turn-on control.
4. The alarm control is set about 6" to 12" above the override control.
5. No control should be set above the inlet invert.

Electrical Connections: Complete wiring diagrams are included for use in making the installation. All wires should be checked for shorts to ground with an ohmmeter or megger after the connections are made. This is important, as one grounded wire can cause failure of the pump, control panel or personal injury.

TROUBLESHOOTING

CONDITION	PROBABLE CAUSE
Red light comes on at control box.	This indicates some water has leaked past the lower seal and has entered the seal chamber and made contact with the electrode probe. Pump must be removed for replacement of lower seal. This preventive repair will save an expensive motor.
Overload trips at control box and alarm buzzer or flashing red light comes on due to high water level in basin.	1. Push in on red reset button to reset overload. If overload trips again after short run, pump has some damage and must be removed from basin for checking. 2. Trouble may be from clogged impeller causing motor to overload or could be from failed motor. 3. Trouble may be from faulty component in control box. Always check control box before removing pump.
Yellow run light stays on continuously.	1. Indicates H-O-A switch may be in the Hand position. 2. Level control switch may have failed causing pump to continue to operate when water is below lower control. 3. Impeller may be partially clogged causing pump to operate at very reduced capacity. 4. Gate valve or check valve may be clogged causing low pump flow. 5. Pump may be air locked.
Circuit breaker trips.	1. Reset breaker by pushing completely down on handle then back to On position. If breaker trips again in few seconds it indicates excessive load probably caused by a short in the motor or control box. Check out instructions given with control box before pulling pump. 2. If this condition happens after an electrical storm, motor or control box may be damaged by lightning. 3. Resistance reading of the motor with lead wires disconnected from the control box can determine if trouble is in motor or control box.
Pump is noisy and pump rate is low.	1. Impeller may be partially clogged with some foreign objects causing noise and overload on the motor. 1. Lower control switch may be set too high.
Grease and solids have accumulated around pump and will not pump out of basin.	2. Run pump on Hand operation for several minutes with small amount of water running into basin to clean out solids and grease. This allows pump to break suction and surge which will break up the solids. If level switch is set properly this condition generally will not occur. 3. Trash and grease may have accumulated around floats causing pump to operate erratically.

CAUTION – DISCONNECT ALL POWER AND CONTROL WIRES TO MOTOR AT CONTROL PANEL BEFORE STARTING DISASSEMBLY OPERATIONS. NEVER RELY ON OPENING CIRCUIT BREAKER ONLY.

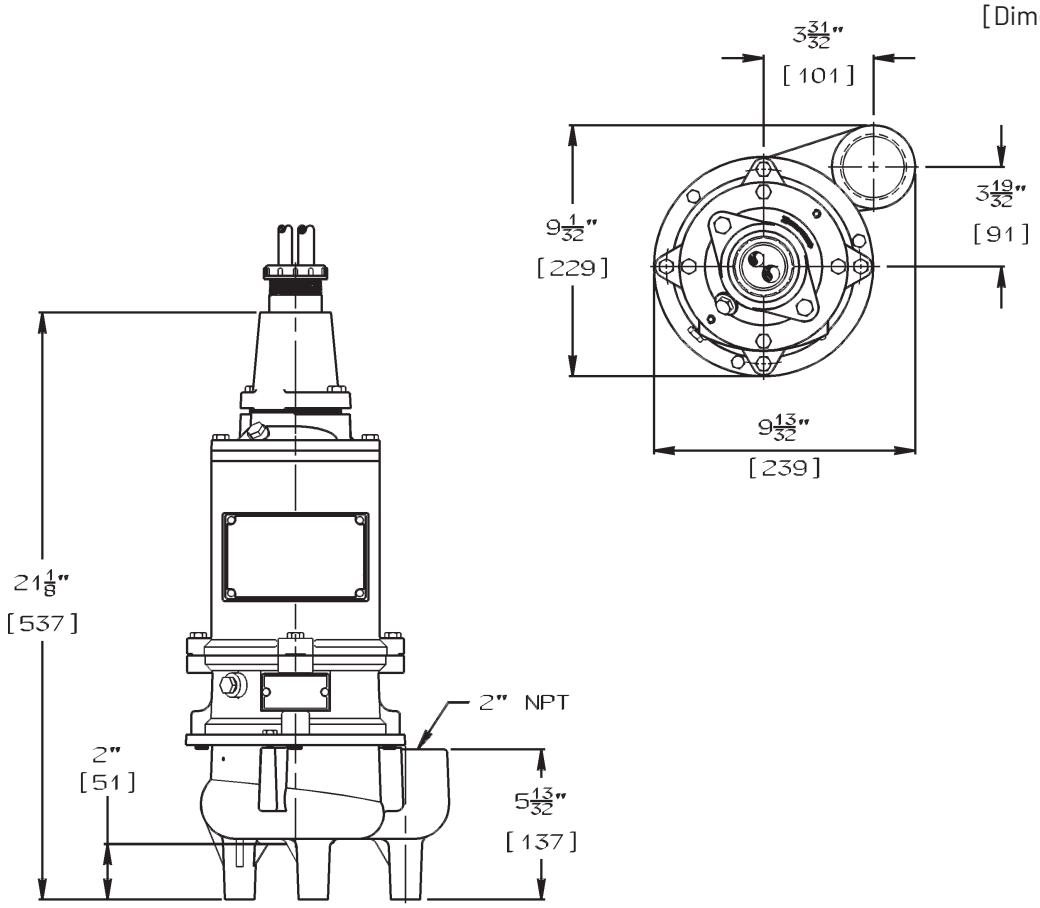
SX Series Standard Configurations

MODEL	UPC #	ENG. NO.	HP	VOLTS	PHASE	Amps	DISCHARGE IN. (mm)	SOLIDS HANDLING IN. (mm)	SWITCH	Cord Length Ft. (m)	Weight Lbs. (kg)
SX50-21	054128305264	26857E611	1/2	230	1	4.9	2" (50.8)	2" (50.8)	M*	20' (6.1)	83 (37.6)
SX50H-21	054128305271	26858E611	1/2	230	1	4.9	1-1/2" (38.1)	3/4" (19.1)	M*	20' (6.1)	83 (37.6)
SX50-01	054128305257	26857E610	1/2	200	1	4.5	2" (50.8)	2" (50.8)	M*	20' (6.1)	85 (38.6)
SX50H-01	054128305431	26858E610	1/2	200	1	4.5	1-1/2" (38.1)	3/4" (19.1)	M*	20' (6.1)	85 (38.6)
SX50-03	054128830971	26857E612	1/2	200	3	3.6	2" (50.8)	2" (50.8)	M*	20' (6.1)	82 (37.2)
SX50H-03	054128305318	26858E612	1/2	200	3	3.6	1-1/2" (38.1)	3/4" (19.1)	M*	20' (6.1)	82 (37.2)
SX50-23	054128305288	26857E613	1/2	230	3	3.2	2" (50.8)	2" (50.8)	M*	20' (6.1)	84 (38.1)
SX50H-23	054128305295	26858E613	1/2	230	3	3.2	1-1/2" (38.1)	3/4" (19.1)	M*	20' (6.1)	83 (37.6)
SX50-43	054128305325	26857E614	1/2	460	3	1.6	2" (50.8)	2" (50.8)	M*	20' (6.1)	82 (37.2)
SX50H-43	054128305301	26858E614	1/2	460	3	1.6	1-1/2" (38.1)	3/4" (19.1)	M*	20' (6.1)	84 (38.1)
SX50-53	054128305332	26857E615	1/2	575	3	1.3	2" (50.8)	2" (50.8)	M*	20' (6.1)	83 (37.6)
SX50H-53	054128305349	26858E615	1/2	575	3	1.3	1-1/2" (38.1)	3/4" (19.1)	M*	20' (6.1)	84 (38.1)
SX150H-01	-	28210E600	1-1/2	200	1	12	1-1/2" (38.1)	3/4" (19.1)	M*	20' (6.1)	103 (46.7)
SX150H-21	-	28210E601	1-1/2	230	1	9.5	1-1/2" (38.1)	3/4" (19.1)	M*	20' (6.1)	103 (46.7)
SX150H-03	-	28210E602	1-1/2	200	3	6.7	1-1/2" (38.1)	3/4" (19.1)	M*	20' (6.1)	103 (46.7)
SX150H-23	-	28210E603	1-1/2	230	3	5.4	1-1/2" (38.1)	3/4" (19.1)	M*	20' (6.1)	103 (46.7)
SX150H-43	-	28210E604	1-1/2	460	3	2.2	1-1/2" (38.1)	3/4" (19.1)	M*	20' (6.1)	103 (46.7)
SX150H-53	-	28210E605	1-1/2	575	3	1.4	1-1/2" (38.1)	3/4" (19.1)	M*	20' (6.1)	103 (46.7)
SX200H-01	-	28210E610	2	200	1	15	1-1/2" (38.1)	3/4" (19.1)	M*	20' (6.1)	103 (46.7)
SX200H-21	-	28210E611	2	230	1	12.5	1-1/2" (38.1)	3/4" (19.1)	M*	20' (6.1)	103 (46.7)
SX200H-03	-	28210E612	2	200	3	9.7	1-1/2" (38.1)	3/4" (19.1)	M*	20' (6.1)	103 (46.7)
SX200H-23	-	28210E613	2	230	3	8.4	1-1/2" (38.1)	3/4" (19.1)	M*	20' (6.1)	103 (46.7)
SX200H-43	-	28210E614	2	460	3	4.2	1-1/2" (38.1)	3/4" (19.1)	M*	20' (6.1)	103 (46.7)
SX200H-53	-	28210E615	2	575	3	3.4	1-1/2" (38.1)	3/4" (19.1)	M*	20' (6.1)	103 (46.7)

**Must be used with CEX panels - Sold Separately*

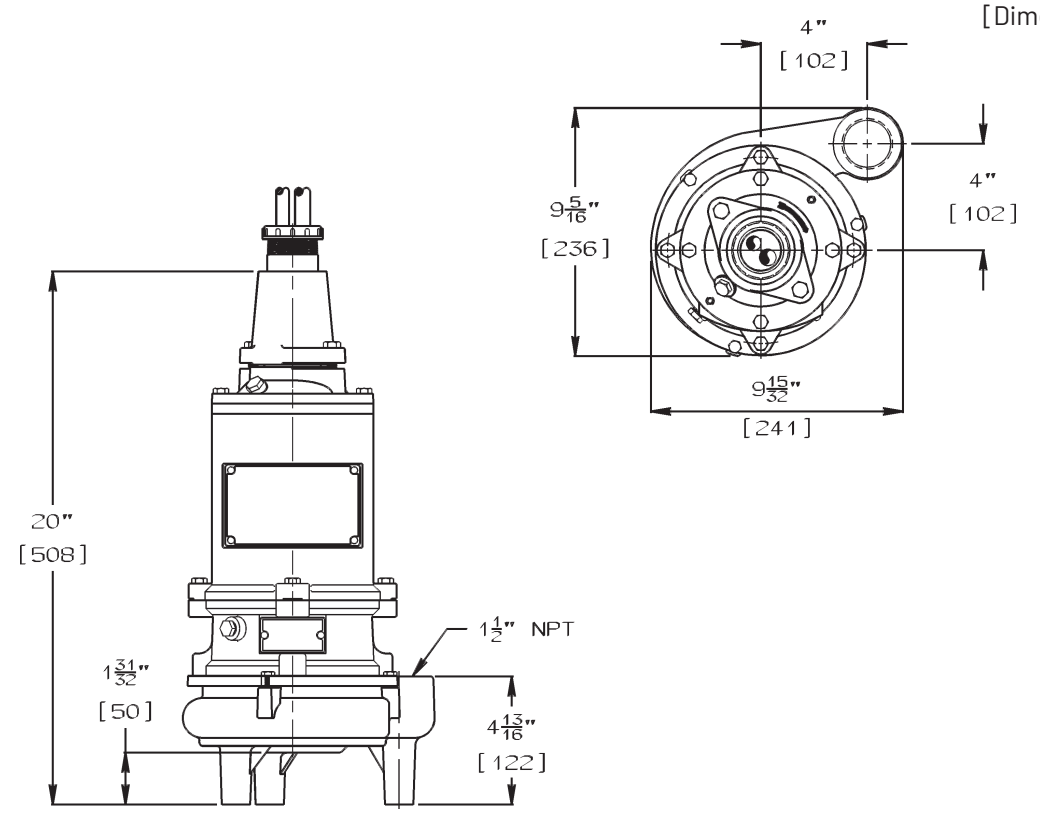
SX50 DIMENSIONS

[Dimensions in mm]

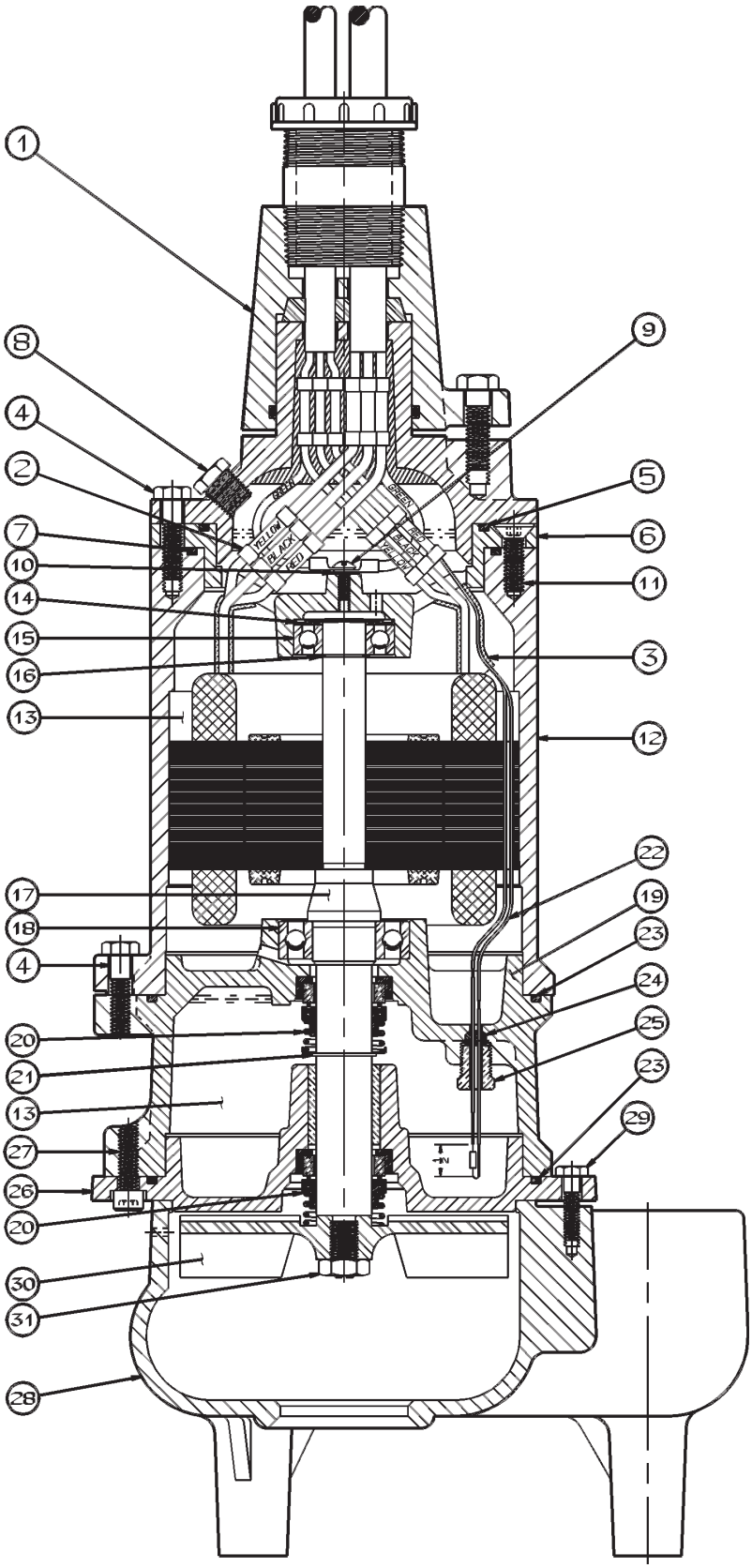


SX50H, SX150H and SX200H DIMENSIONS

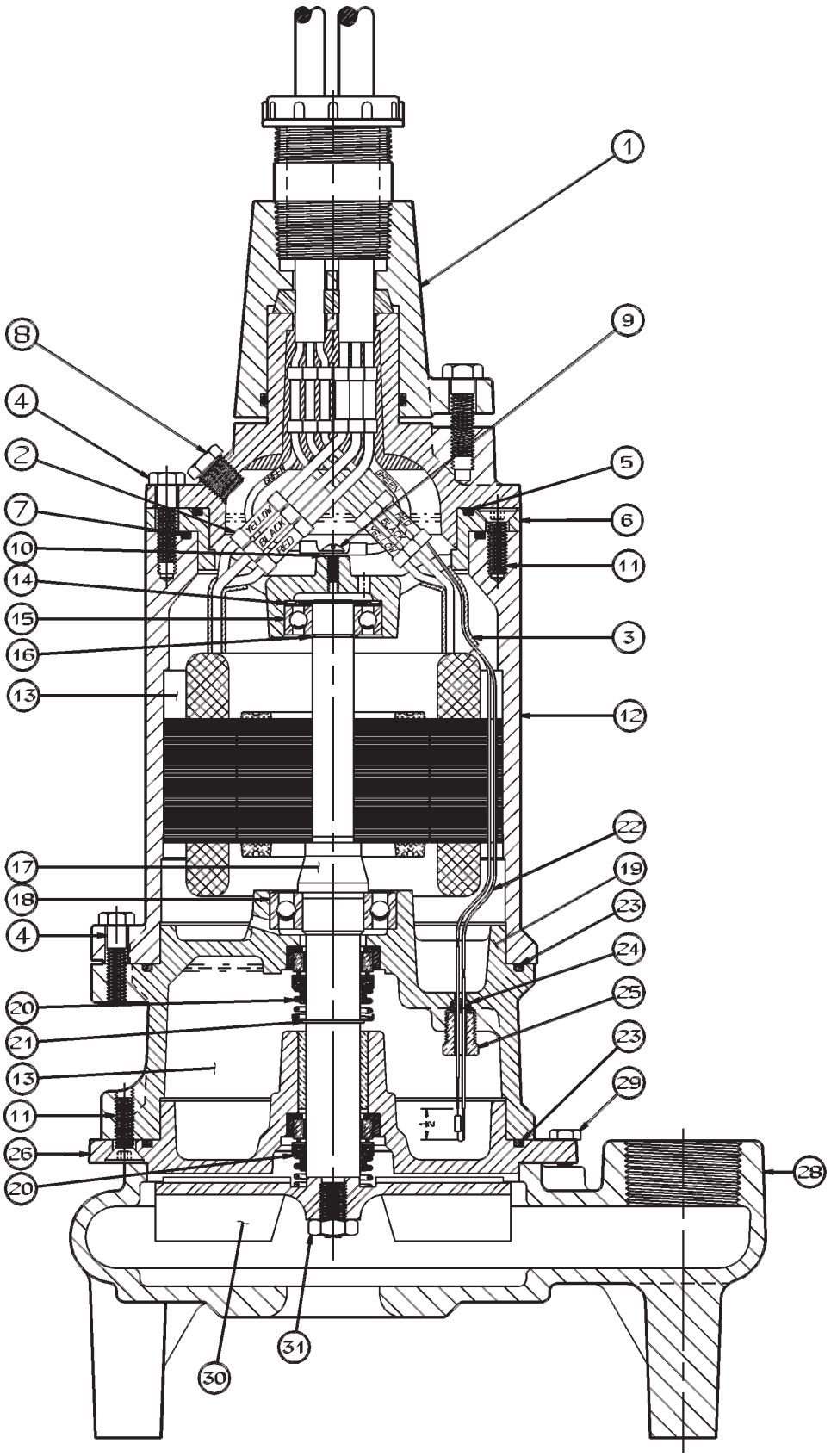
[Dimensions in mm]



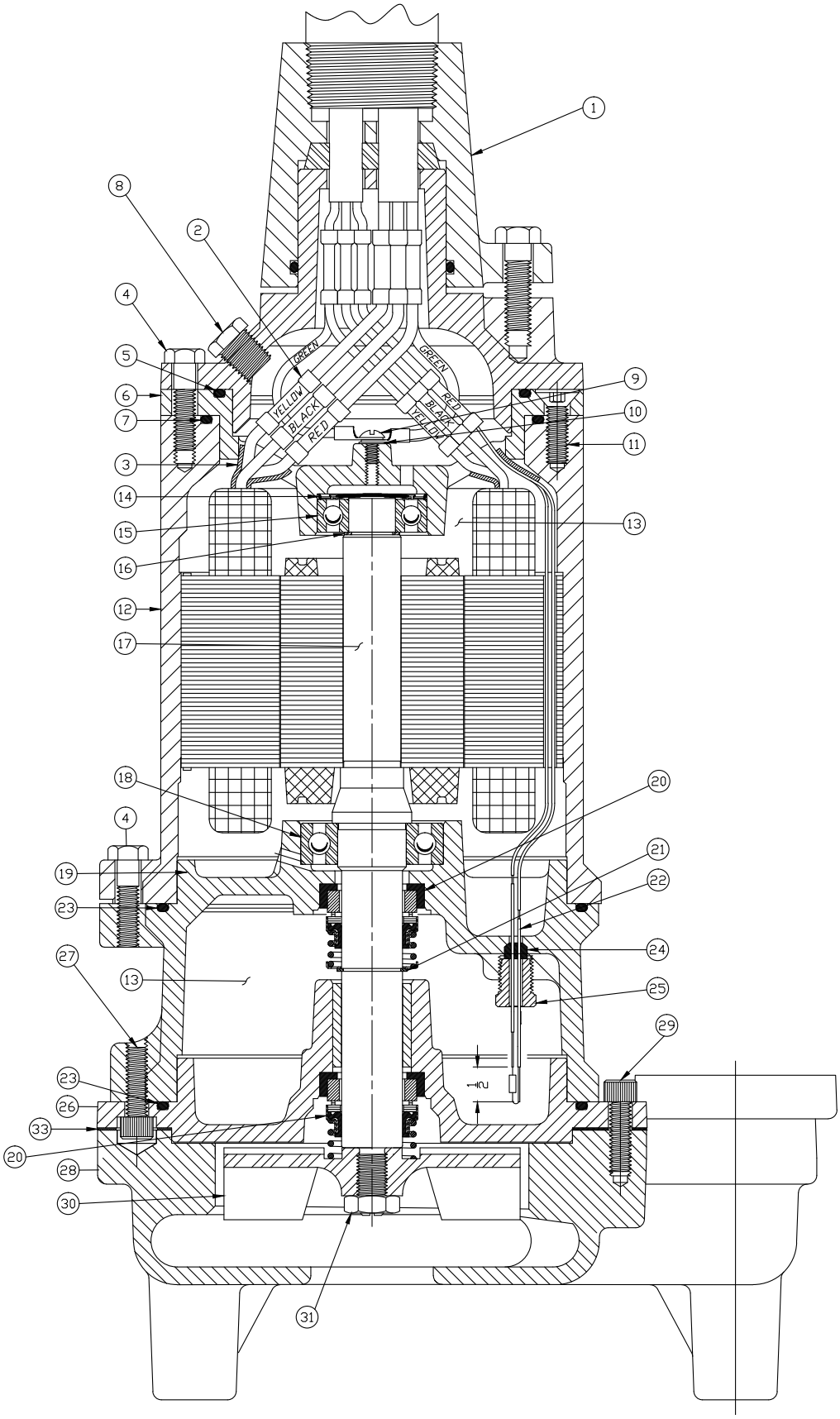
SX50 PUMP PARTS



SX50H PUMP PARTS



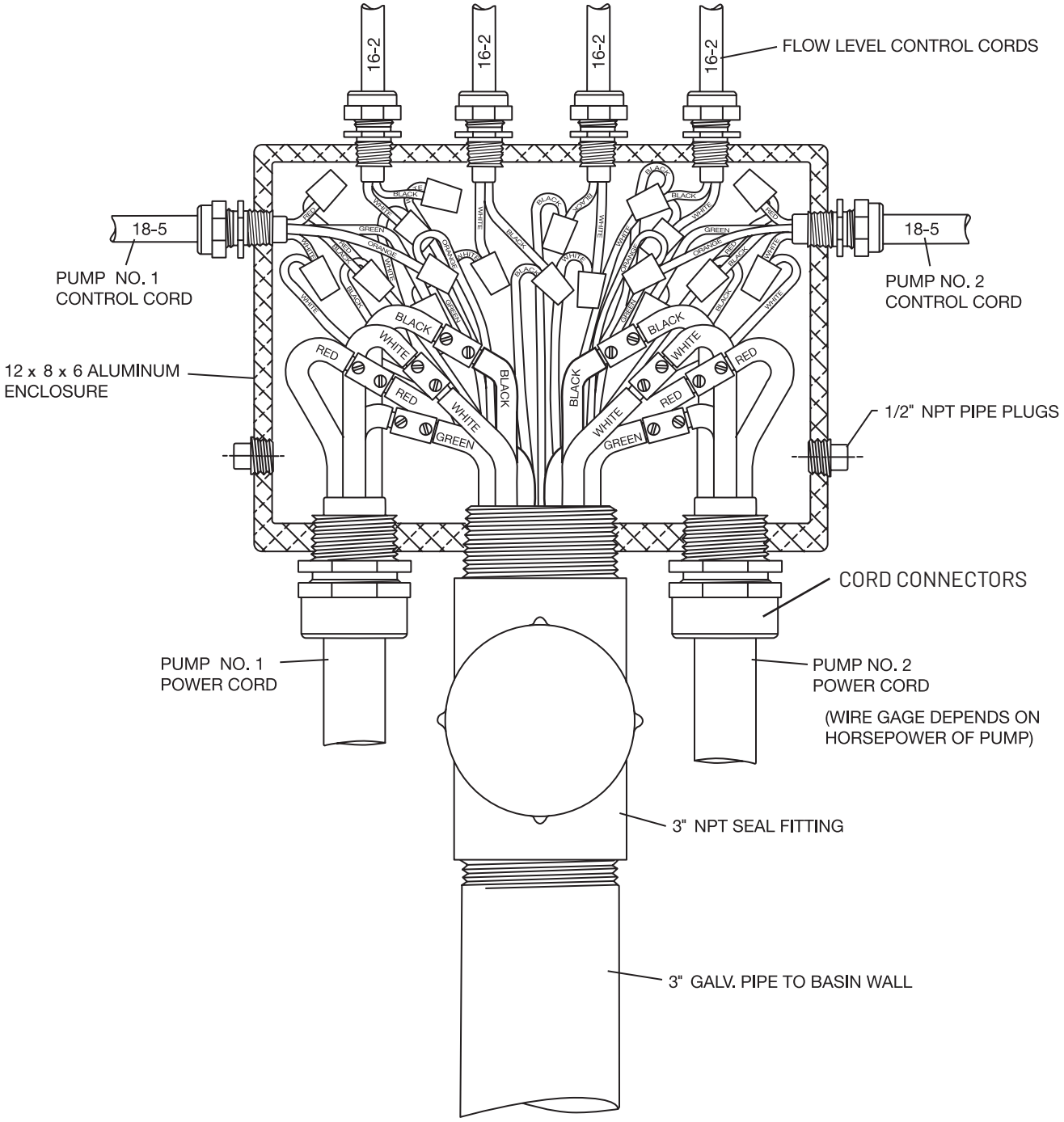
SX150H and SX200H PUMP PARTS



SX SERIES PARTS LIST

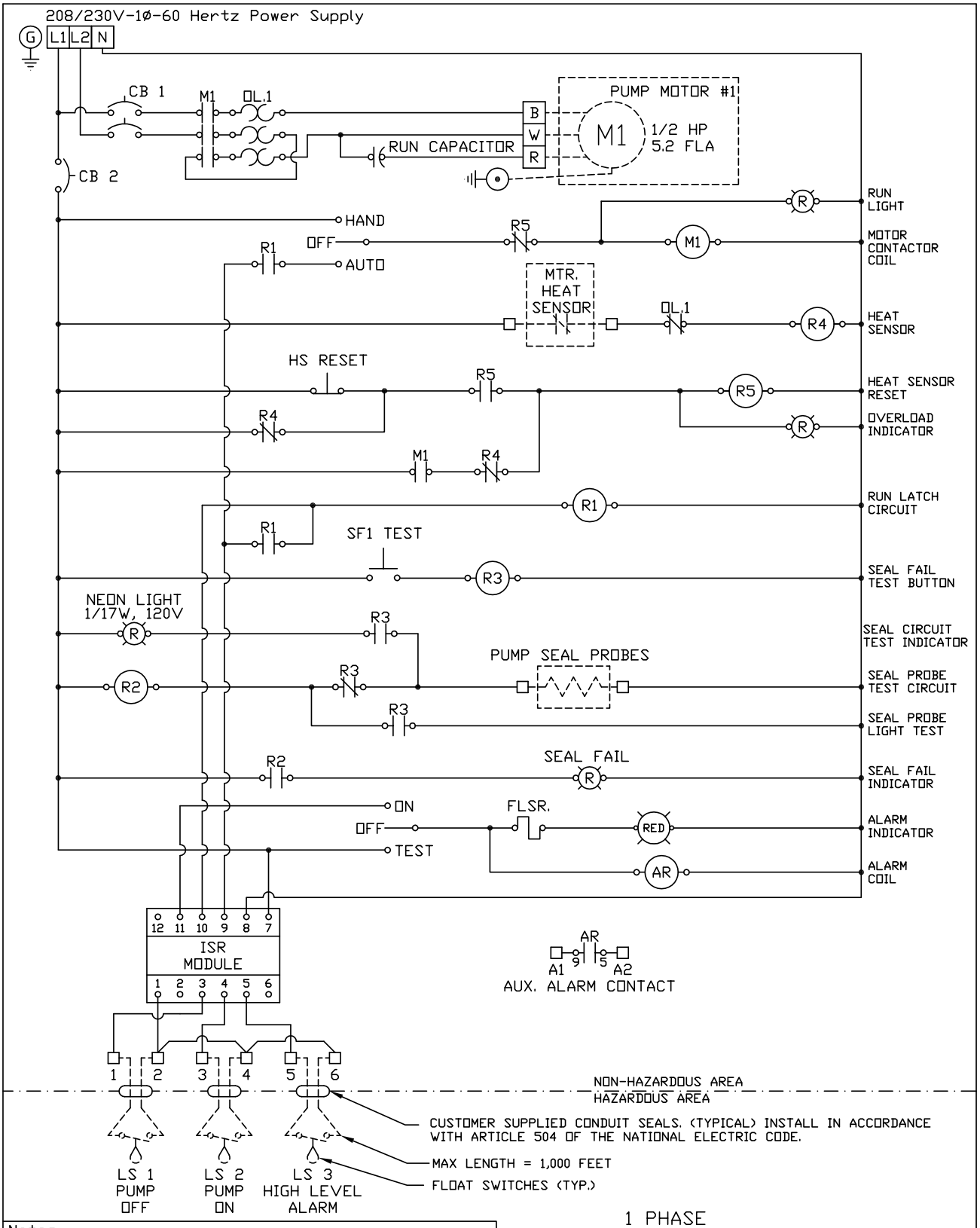
Ref.	Description	Qty.	SX50	SX50H	SX150H/SX200H
1	CAP, CORD	1	22407C602	22407C602	22407C602
2	CONNECTOR	7	12762A001	12762A001	12762A001
3	TUBE, PLASTIC x 1-1/4" LG.	2	10649A102	10649A102	10649A102
4	SCREW, CAP 5/16 x 1-1/4" LG.	8	19100A012	19100A012	19100A012
5	O-RING, 4-1/2" x 4-1/4" x 1/8"	1	05876A122	05876A122	05876A122
6	CAP, UPPER BEARING	1	21570B100X	21570B100X	21570B100X
7	O-RING, 4-7/8" x 4-5/8" x 1/8"	1	05876A123	05876A123	05876A123
8	PLUG, PIPE 1/4" NPT	2	05022A054	05022A054	05022A054
9	SCREW, MACH. #10 x 1/2" LG.	1	05434A034	05434A034	05434A034
10	WASHER, LOCK	1	06107A015	06107A015	06107A015
11	SCREW, MACH. 5/16 x 1" LG. (SX50)	2	07597A017	——-	——-
11	SCREW, MACH. 5/16 x 1" LG. (SX50H)	6	——-	07597A017	07597A017
12	HOUSING W/STATOR (1Ø)	1	21571D150K	21571D150K	21571D120K
	HOUSING W/STATOR (3Ø) 230/460V	1	21571D152K	21571D152K	21571D130K
	HOUSING, MOTOR		21571D100X	21571D100X	21571D100X
	STATOR ONLY (1Ø)		21656C103	21656C103	21573C100
	STATOR ONLY (3Ø) 230/460V	1	21656C106	21656C106	21573C102
13	OIL, TRANSFORMER (1 GAL. CAN)	1.06 gal.	11009A008K	11009A008K	11009A008K
14	WASHER, SPRING	2	19331A005	19331A005	19331A005
15	BEARING, BALL (UPPER)	1	08565A013	08565A013	08565A013
16	RING, RETAINING	1	11816A006	11816A006	11816A006
17	ROTOR W/SHAFT (1Ø)	1	26859C101X	26859C101X	26859C106X
	ROTOR W/SHAFT (3Ø)	1	26859C104X	26859C104X	26859C104X
18	BEARING, BALL (LOWER)	1	08565A018	08565A018	08565A018
19	HOUSING, UPPER SEAL	1	21574D100X	21574D100X	21574D100X
20	SEAL, SHAFT	2	21576A010	21576A010	21576A010
21	RING, RETAINING	1	12558A006	12558A006	12558A006
22	ELECTRODE W/RESISTOR	1	22578A003	22578A003	22578A003
23	O-RING, 6-1/8" x 5-7/8" x 1/8"	2	05876A125	05876A125	05876A125
24	FERRULE, RUBBER	1	22579A000	22579A000	22579A000
25	PLUG, SPECIAL	1	21577A000	21577A000	21577A000
26	HOUSING, LOWER SEAL	1	21578C110X	21578C115X	21578C100X
27	SCREW, CAP 5/16 x 1" LG.	4	06106A008	——-	19100A037
28	CASE, VOLUTE	1	21612D000	26226D012	21580D1048
29	SCREW, CAP 1/4 x 1" LG.	-	19099A012 (3)	19099A012 (3)	19100A033 (4)
30	IMPELLER, RECESSED	1	21663C020	21663C010	21663C015 (SX150H) 21663C014 (SX200H)
31	NUT, JAM	1	19109A070	19109A070	19109A070
32	SCREW, SET	2	05013A027	05013A027	05013A027

WIRING DIAGRAMS



NOTE: All components shown must be approved for hazardous locations.

WIRING SCHEMATIC FOR 208/230V, 1Ø SIMPLEX SYSTEM SX50/SX50H ONLY

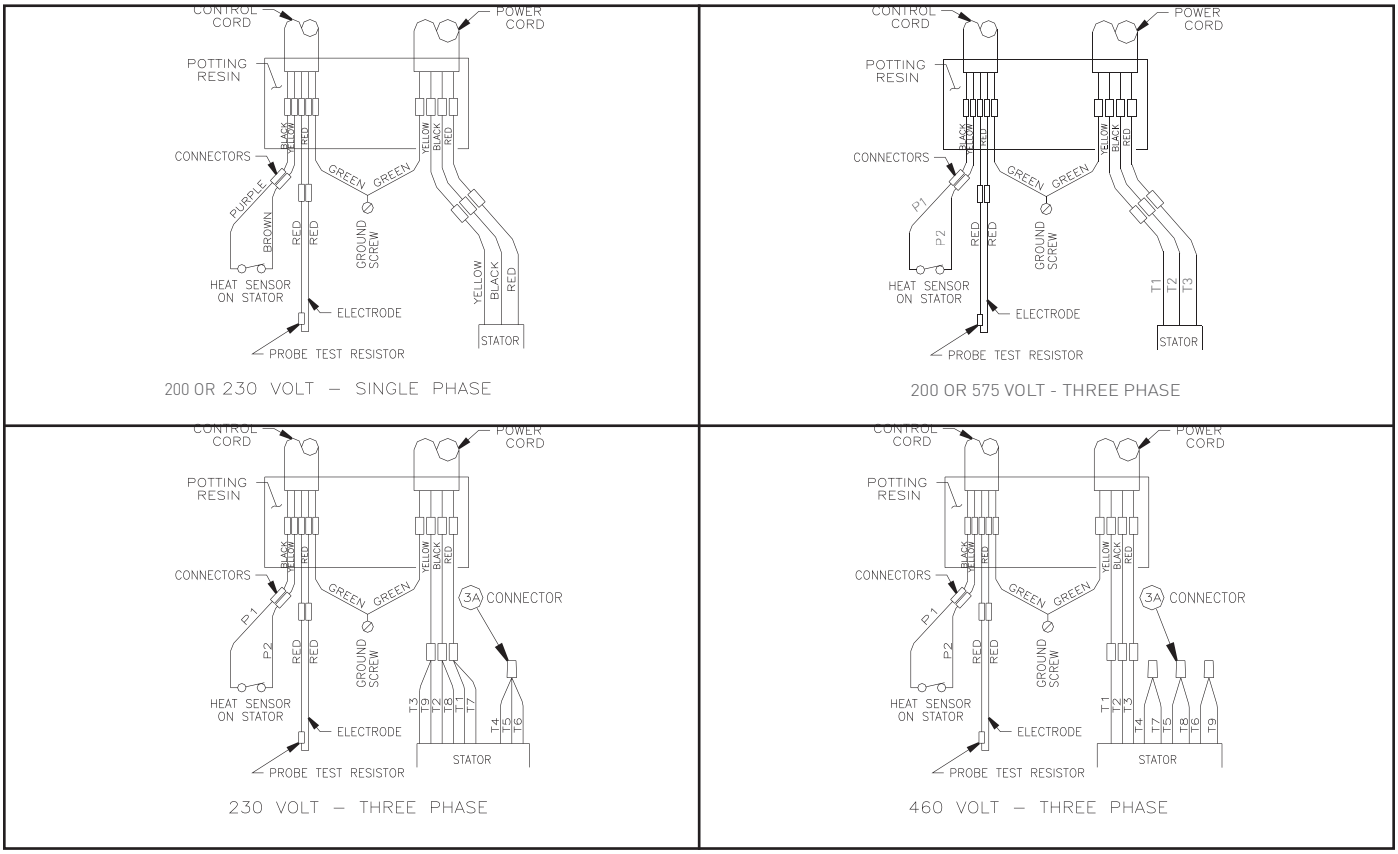


Notes:
1) Level Switches Must Be Rated a Minimum of 2 Amps at 120 Volts
2) Torque all white field wiring terminals to 20 In.Lbs.
3) Field Wiring Must Be 60°C Copper Wire Minimum.
4) -------- = Items Not Supplied In Control Panel.
5) Pump power, heat sensor, and seal probe cables must pass through approved NEC 501.15 conduit seals.

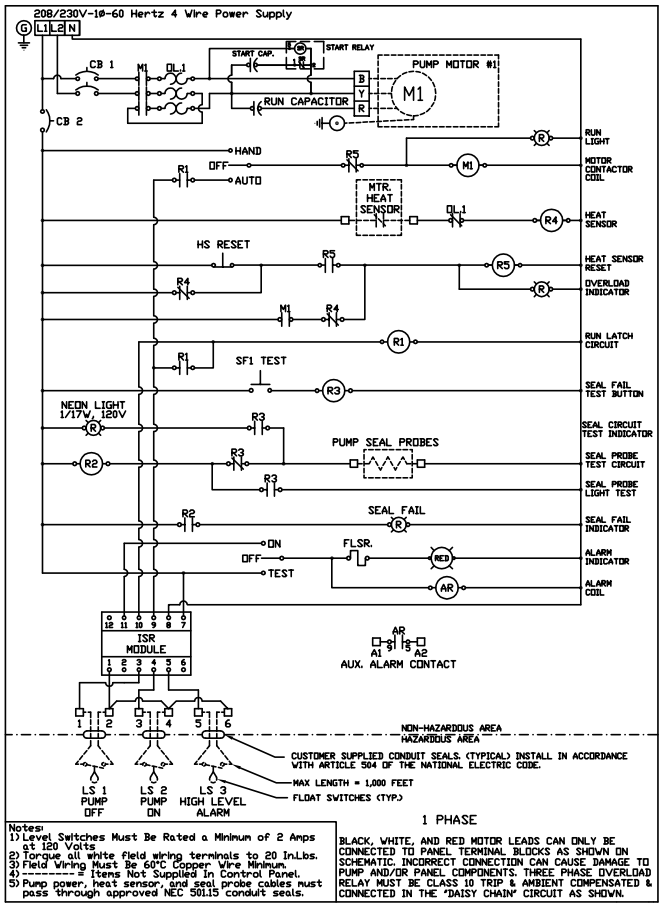
1 PHASE

BLACK, WHITE, AND RED MOTOR LEADS CAN ONLY BE CONNECTED TO PANEL TERMINAL BLOCKS AS SHOWN ON SCHEMATIC. INCORRECT CONNECTION CAN CAUSE DAMAGE TO PUMP AND/OR PANEL COMPONENTS. THREE PHASE OVERLOAD RELAY MUST BE CLASS 10 TRIP & AMBIENT COMPENSATED & CONNECTED IN THE "DAISY CHAIN" CIRCUIT AS SHOWN.

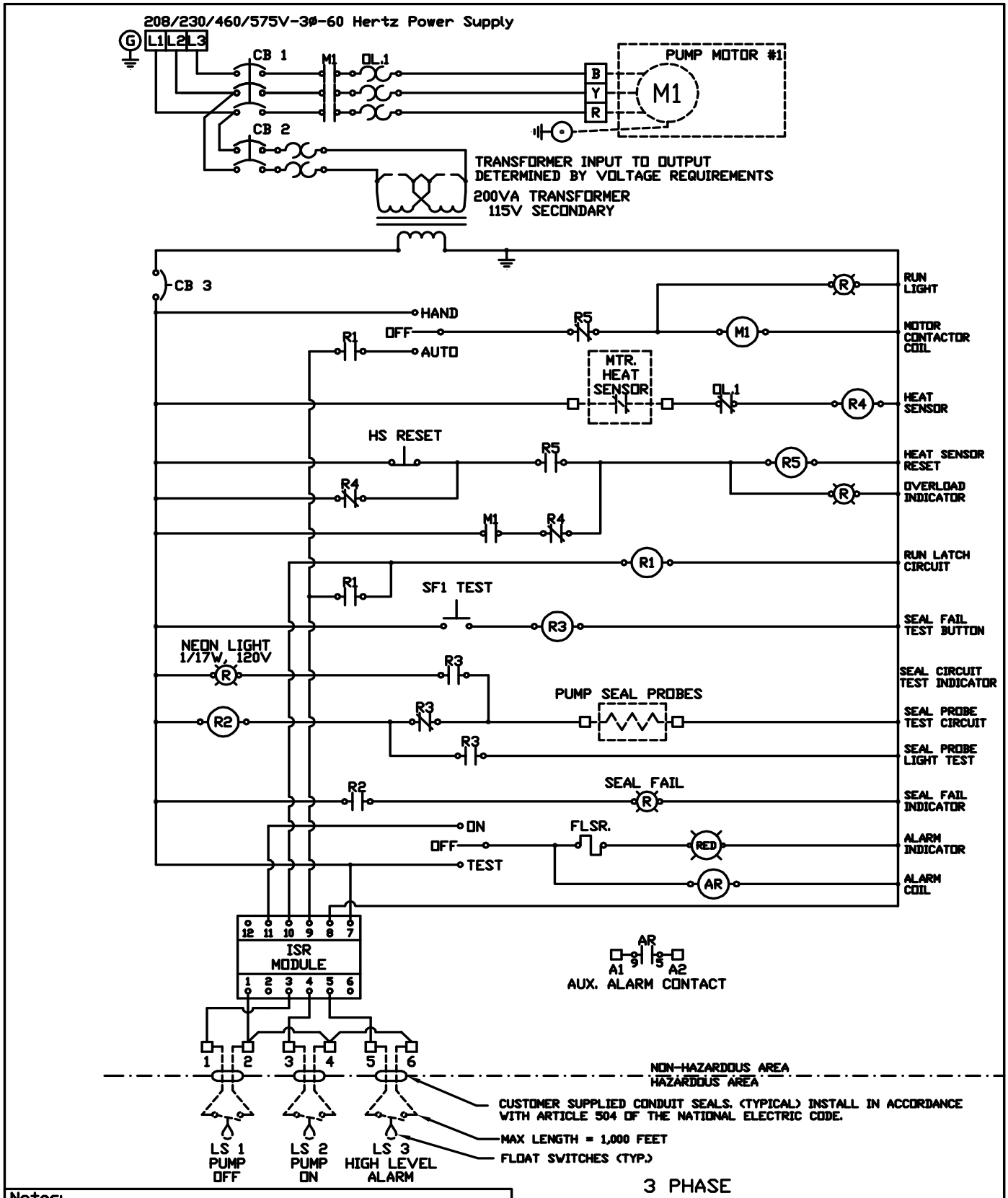
WIRING DIAGRAM



WIRING SCHEMATIC FOR 208/230, 1, Simplex



WIRING SCHEMATIC FOR 3Ø SIMPLEX SYSTEM



Notes:
1) Level Switches Must Be Rated a Minimum of 2 Amps at 120 Volts
2) Torque all white field wiring terminals to 20 In.Lbs.
3) Field Wiring Must Be 60°C Copper Wire Minimum.
4) -------- = Items Not Supplied In Control Panel.
5) Pump power, heat sensor, and seal probe cables must pass through approved NEC 501.15 conduit seals.

Limited Warranty

Myers® warrants to the original consumer purchaser ("Purchaser" or "You") of the products listed below, that they will be free from defects in material and workmanship for the Warranty Period shown below.

Product	**Warranty Period** whichever occurs first:
Jet pumps, small centrifugal pumps, submersible pumps and related accessories	12 months from date of original installation, or 18 months from date of manufacture
Fibrewound Tanks	5 years from date of original installation
Steel Pressure Tanks	5 years from date of original installation
Sump/Sewage/Effluent Products	12 months from date of original installation, or 36 months from date of manufacture
Battery Backup Units	
MBSP-2, MBSP-2C	12 months from date of original installation, or 18 months from date of manufacture
MBSP-3, MBSP-3C	24 months from date of original installation, or 30 months from date of manufacture
Wastewater Solids Handling Pumps	12 months from date of shipment from factory or 18 months from date of manufacture

Our warranty applies only where such products are used in compliance with the requirements of the applicable product catalog and/or manuals. For additional information, please refer to the applicable standard limited warranty featured in the product manual.

Our warranty will not apply to any product that, in our sole judgement, has been subject to negligence, misapplication, improper installation, or improper maintenance. Without limiting the foregoing, operating a three phase motor with single phase power through a phase converter will void the warranty. Note also that three phase motors must be protected by three-leg, ambient compensated, extra-quick trip overload relays of the recommended size or the warranty is void.

Your only remedy, and MYERS's only duty, is that MYERS repair or replace defective products (at MYERS's choice). You must pay all labor and shipping charges associated with this warranty and must request warranty service through the installing dealer as soon as a problem is discovered. No request for service will be accepted if received after the Warranty Period has expired. This warranty is not transferable.

MYERS SHALL NOT BE LIABLE FOR ANY CONSEQUENTIAL, INCIDENTAL, OR CONTINGENT DAMAGES WHATSOEVER.

THE FOREGOING LIMITED WARRANTIES ARE EXCLUSIVE AND IN LIEU OF ALL OTHER EXPRESS AND IMPLIED WARRANTIES, INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THE FOREGOING LIMITED WARRANTIES SHALL NOT EXTEND BEYOND THE DURATION PROVIDED HEREIN.

Some states do not allow the exclusion or limitation of incidental or consequential damages or limitations on the duration of an implied warranty, so the above limitations or exclusions may not apply to You. This warranty gives You specific legal rights and You may also have other rights which vary from state to state.

This Limited Warranty is effective April 1, 2014 and replaces all undated warranties and warranties dated before April 1, 2014.

F.E. MYERS
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SC4500 Controller
Qty (1) provided by WWW

Digital Controller SC4500

Applications

- Wastewater
- Drinking Water
- Industrial Water
- Other

Claros Enabled

Service Protected

Ready for Now. Ready for the Future.

Technologies are advancing rapidly, providing new levels of convenience, accuracy, and efficiency. Which is exactly why the SC4500 Controller from Hach® is designed to integrate easily into your current system while allowing you to upgrade as your capabilities advance, without having to replace inventory. With a wide range of analog and digital connectivity options and the availability of intelligent instrument and data management features, the SC4500 unlocks the future, today.

Easy Adoption

The familiar experience of a modern touchscreen, the ability to use your current Hach sensors, and the same footprint as the SC200, make installation and integration of the SC4500 Controller seamless.

No Time for Downtime

The SC4500's built-in predictive diagnostic software ensures measurement confidence and reduces the risk of unexpected equipment downtime by enabling proactive maintenance planning via MSM, including step-by-step instructions.

The Connectivity Options You Need

The Controller provides local communication to SCADA or a PLC, as well as remote access through a secure, cloud-based connectivity option to integrate with Claros™, the Water Intelligence System from Hach. From analog and advanced digital protocols to wi-fi, cellular or LAN, the SC4500 gives you the flexibility to adapt in a rapidly changing world.

Technical Data*

Description	Microprocessor-controlled and menu-driven controller that operates the sensor
Dimensions	½ DIN - 144 x 144 x 192 mm (5.7 x 5.7 x 7.6 in.)
Weight	3.7 lb (controller only, w/o modules)
Display	3.5-inch TFT color display with capacitive touchpad
Enclosure Rating	UL50E type 4X, IEC/EN 60529–IP 66, NEMA 250 type 4X Metal enclosure with a corrosion-resistant finish
Operating Temperature Range	-20 to 60 °C (-4 to 140 °F) (8 W (AC)/9 W (DC) sensor load) -20 to 45 °C (-4 to 113 °F) (28 W (AC)/20 W (DC) sensor load) Linear derating between 45 and 60 °C (-1.33 W/°C)
Storage Conditions	-20 - 70 °C (-4 - 158 °F), 0 - 95% relative humidity, non-condensing
Altitude	2000 m (6562 ft) maximum
Installation Category	Category II
Pollution Degree	4
Protection Class	I, connected to protective earth
Power requirements	AC controller: 100-240 VAC ±10%, 50/60 Hz; 1 A (28 W sensor load) DC controller: 24 VDC +15% -20%; 2.5 A (20 W sensor load)
Measurements	Two device digital SC connectors
Relays	Two relays (SPDT); Wire gauge: 0.75 to 1.5 mm^2 (18 to 16 AWG) AC controller Maximum switching voltage: 100 - 240 VAC Maximum switching current: 5 A Resistive/1 A Pilot Duty Maximum switching power: 1200 VA Resistive/360 VA Pilot Duty DC controller Maximum switching voltage: 30 VAC or 42 VDC Maximum switching current: 4 A Resistive/1 A Pilot Duty Maximum switching power: 125 W Resistive/28 W Pilot Duty
Communication (optional)	Analog: Five 0-20 mA or 4-20 mA analog outputs on each analog output module Up to two analog Input modules (0-20 mA or 4-20 mA). Each input module replaces a digital sensor input. Digital: Profibus DPV1 module Modbus TCP Profinet IO module Ethernet IP module
Network Connectivity	LAN: Two Ethernet connectors (10/100 Mbps) Cellular: External 4G Wi-Fi
USB Port	Used for data download and software upload. The controller records approximately 20,000 data points for each connected sensor.
Compliance Certifications	CE. ETL certified to UL and CSA safety standards (with all sensor types), FCC, ISED, KC, RCM, EAC, UKCA, SABS, C (Morocco)
Warranty	12 months
Compatible Network Technologies	GSM 3G/4G (e.g. AT&T, T-Mobile, Rogers, Vodafone etc.) CDMA (e.g. Verizon)

**Subject to change without notice.*

Compatible Instruments / Software Version (Release Year)

Amtax sc / V2.30 (2018) or higher

A-ISE sc / V1.02 or higher

AN-ISE sc / V1.08 (2013) or higher

N-ISE sc / V1.02 or higher

Nitratax clear sc, Nitratax eco sc, Nitratax plus sc / V3.13 (2013) or higher

Phosphax sc / V2.30 (2018) or higher

Phosphax sc LR/MR/HR / V1.01 (2018) or higher

TSS sc / V41.73 (2013) or higher

Solitax sc / V2.20 (2013) or higher

TU5300sc, TU5400sc / V1.34 (2017) or higher

SS7 sc (in Bypass) / V1.06 (2006) or higher

Ultraturb sc / V3.06 (2017) or higher

1720E / V2.10 (2006) or higher

Sonatax sc / V1.15 (2016) or higher

CL17sc / V2.7 (2019) or higher

CL10sc / V1.14 (2013) or higher

9184sc, 9185sc, 9187sc* / V2.03 (2013) or higher

Uvas plus sc / V3.01 (2017) or higher

LDO 2 sc* / V1.22 (2013) or higher

3798sc* / V2.03 (2013) or higher

3700sc + Inductive Conductive Digital Gateway 6120800 / V3.00 (2017) or higher

3422sc, Analog 3400 + Contacting Cond. Digital Gateway 6120700 / V3.00 or higher

pHD sc*, pHD-S sc / V3.10 (2016) or higher

1200-S sc* / V2.04 (2013) or higher

pHD analog + Digital Gateway 6120500 / V3.00 (2017) or higher

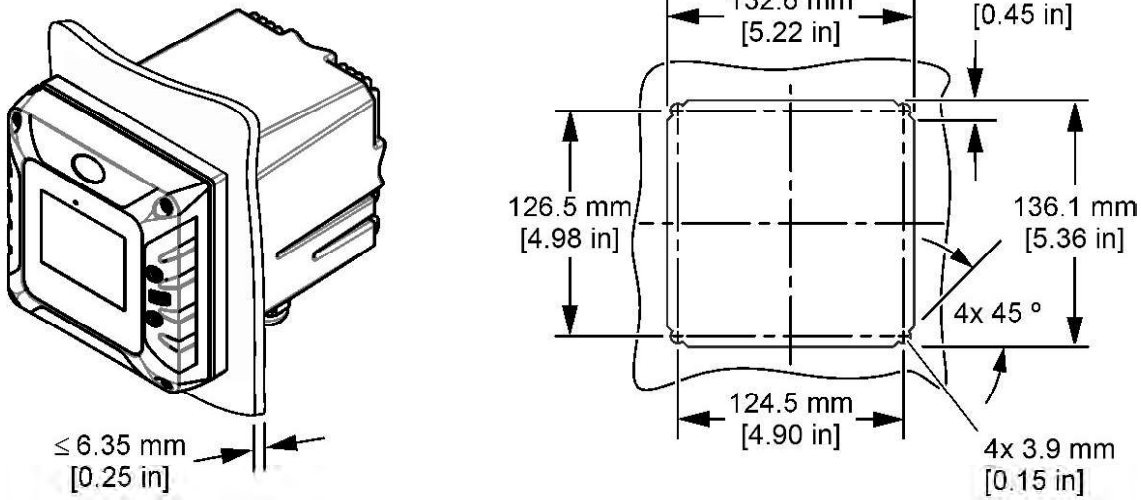
RC and PC analog sensor + Digital Gateway for conventional analog pH and ORP sensors 6120600 / V3.00 (2017) or higher

8362sc* / V3.00 (2017) or higher

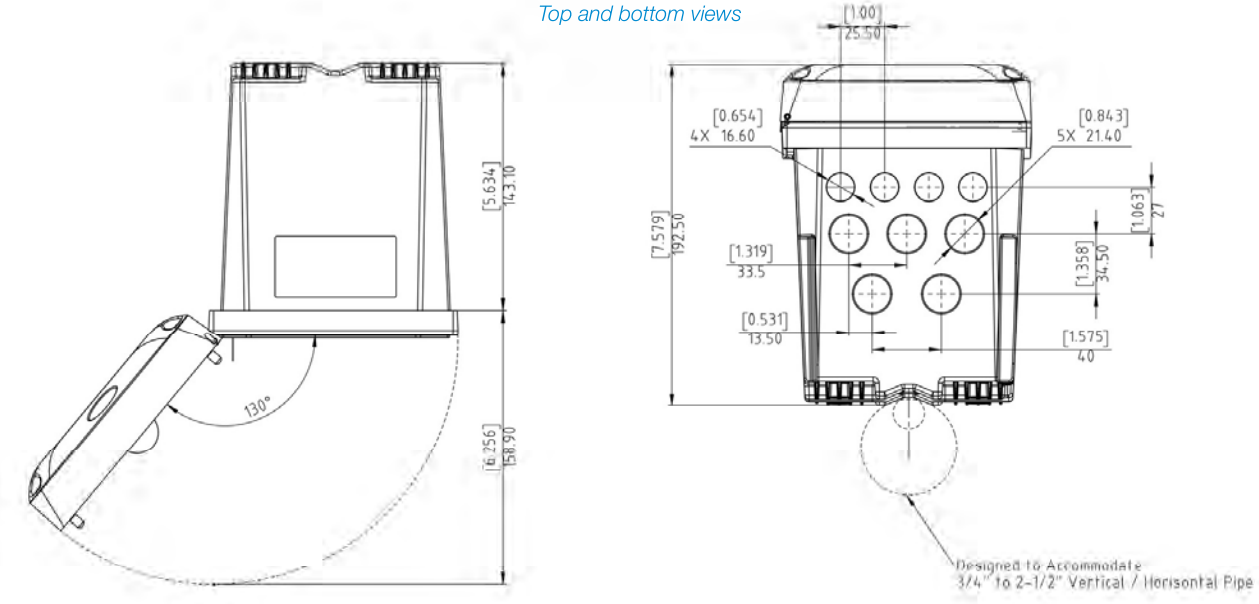
Hardware Version1 of instrument is not supported

Dimensions

Panel mounting dimensions



Top and bottom views



Order Information

Controller

LXV525.99A11551	SC4500 Controller, Prognosys, 5x mA Output, 2 digital Sensors, without plug
~~**LXV525.99E11551**~~	~~SC4500 Controller, Prognosys, 5x mA Output, 2 digital Sensors, US plug~~
~~**LXV525.99A11541**~~	~~SC4500 Controller, Prognosys, 5x mA Output, 1 digital Sensor, 1 mA Input, without plug~~
~~**LXV525.99E11541**~~	~~SC4500 Controller, Prognosys, 5x mA Output, 1 digital Sensor, 1 mA Input, US plug~~
~~**LXV525.99AA1551**~~	~~SC4500 Controller, Claros enabled, 5x mA Output, 2 digital Sensors, without plug~~
~~**LXV525.99EA1551**~~	~~SC4500 Controller, Claros enabled, 5x mA Output, 2 digital Sensors, US plug~~
~~**LXV525.99AA1541**~~	~~SC4500 Controller, Claros enabled, 5x mA Output, 1 digital Sensor, 1 mA Input, without plug~~
~~**LXV525.99EA1541**~~	~~SC4500 Controller, Claros enabled, 5x mA Output, 1 digital Sensor, 1 mA Input, US plug~~

Additional configurations are available. Please contact Hach Technical Support or your Hach representative.

Accessories

~~**LXZ525.99.D0001**~~	~~SC4500 mA Input Module~~
~~**LXZ525.99.D0002**~~	~~SC4x00 mA Output Module (5 Outputs)~~
~~**LXZ525.99.C0002**~~	~~SC4500 Ethernet IP Upgrade Kit~~
~~**LXZ525.99.C0003**~~	~~SC4500 Modbus TCP/IP Upgrade Kit~~
~~**LXZ525.99.00026**~~	~~SC4500 Ethernet Cable M12 to M12 / C1D2, 10 m~~
~~**LXZ525.99.00017**~~	~~SC4500 USB Stick~~
~~**LXZ524.99.00004**~~	~~SC4x00 UV Protection Screen~~
~~**LXZ524.99.00005**~~	~~SC4x00 UV Protection Screen with Sunroof~~
~~**LXZ524.99.00033**~~	~~SC4x00 Sunroof Visor~~
~~**LXZ524.99.00036**~~	~~SC4x00 Mounting Hardware Sunroof with Visor~~
~~**LXZ524.99.00037**~~	~~SC4x00 Sunroof with Visor~~

Claros Enabled

This instrument connects to Claros, Hach's innovative Water Intelligence System. Claros allows you to seamlessly connect and manage instruments, data, and process – anywhere, anytime. The result is greater confidence in your data and improved efficiencies in your operations. To unlock the full potential of Claros, insist on Claros Enabled instruments.

Service Protected

With Hach Service, you have a global partner who understands your needs and cares about delivering timely, high-quality service you can trust. Our Service Team brings unique expertise to help you maximize instrument uptime, ensure data integrity, maintain operational stability, and reduce compliance risk.

DOC053.53.35316.Aug21

Hach World Headquarters: Loveland, Colorado USA
United States: 800-227-4224 tel 970-669-2932 fax orders@hach.com
Outside United States: 970-669-3050 tel 970-461-3939 fax int@hach.com
hach.com

HACH® Be Right

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DO Probe
Qty. (1) provided by WWW

Dissolved Oxygen: Hach LDO sc Probe, Model 2

Applications

- Wastewater
- Industrial
- Drinking Water

Claros Enabled

Service Protected

Accurate monitoring of dissolved oxygen in source water and for precise aeration process control

No Calibration Required

The Hach LDO sc probe uses luminescent dissolved oxygen technology. Traditional membrane-style DO probes require sensor calibration, which increase maintenance requirements.

No Membranes to Replace

There is virtually no maintenance with Hach's breakthrough luminescent technology. There are no membranes to replace, no electrolyte solution to replenish, and no anode or cathode to clean.

No Missed Cleaning Cycles

The Hach LDO sc probe is equipped with Prognosys, a predictive diagnostic system, that allows you to be proactive in your maintenance by alerting you to upcoming instrument issues. Know with confidence whether changes in your dissolved oxygen level measurements are due to changes in your instrument or your water. To make sure routine cleaning cycles are never missed, the probe offers operators customizable diagnostic alert indicators, ensuring the probe can operate at its maximum performance level.

Customizable service indicators trigger a service message so that a cleaning cycle is never missed.

No Drift Technology

Cutting-edge 3D calibration procedure is conducted prior to shipping, the DO probe will not drift and is more accurate than ever before, compared to membrane style probes.

No Complications

Our newest Model 2 DO probe has a robust design with a smaller footprint allows for easier handling with enhanced durability.

Technical Data*

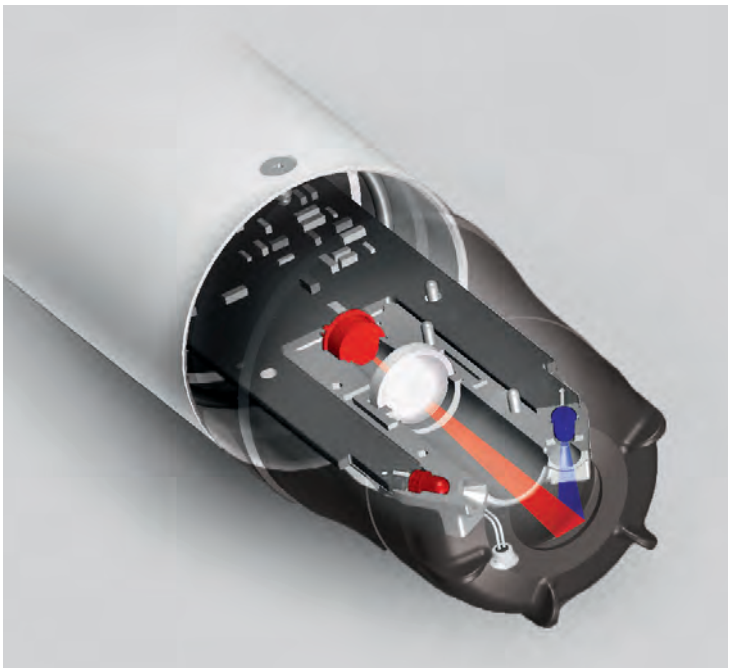
Range	0 - 20.00 ppm 0 - 20.00 mg/L 0 - 200% saturation
Accuracy	± 0.05 ppm Below 5 ppm ± 0.1 ppm Above 5 ppm
Response Time	T_{90} < 40 s T_{95} < 60 s
Resolution	0.01 ppm (mg/L) 0.1% saturation
Repeatability	± 0.1 ppm (mg/L)
Flow Rate	None required
Sensor Immersion Depth	Down to 34 m (112 ft.), 345 kPa (50 psi), maximum; accuracy may not be maintained at this depth
Transmission Distance	400 m (1312 ft.) maximum when used with a termination box
Cable Length	10 m (options with 30 m, 60 m)
Dimensions (D x L)	48.25 mm x 254 mm
Weight	1 kg (2.2 lbs), probe only
Warranty	36 months

**Subject to change without notice.*

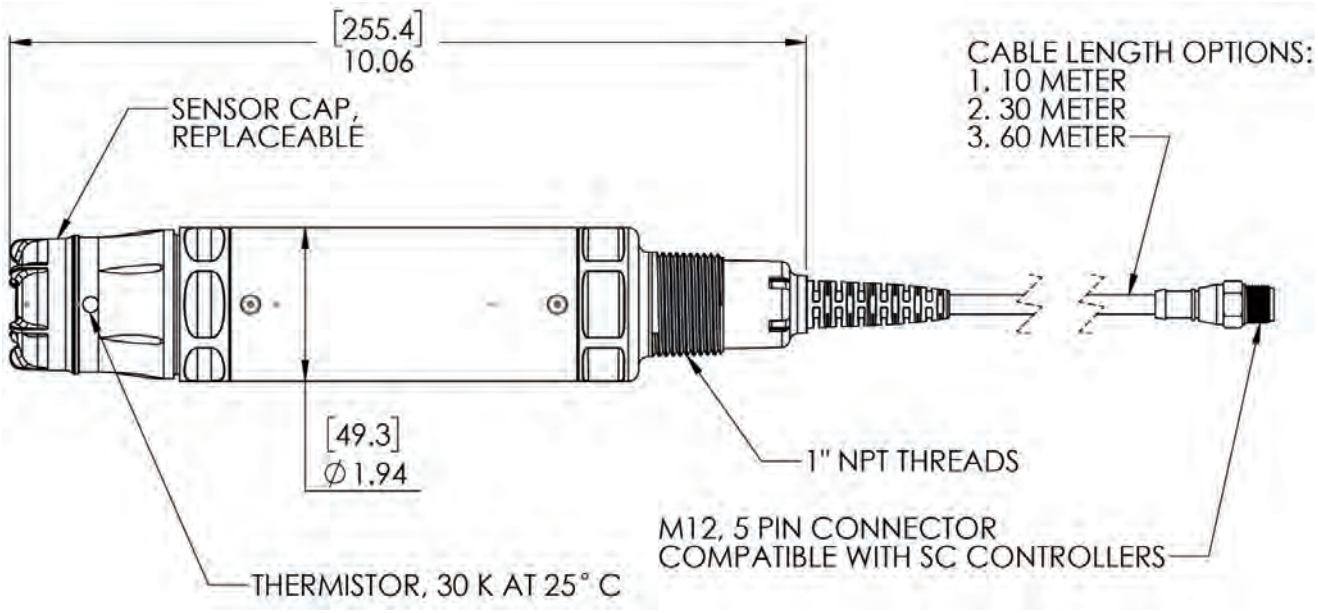
Principle of Operation

The Hach LDO sc sensor is coated with a luminescent material. Blue light from an LED is transmitted to the sensor surface. The blue light excites the luminescent material. As the material relaxes it emits red light. The time it takes for the red light to be emitted is measured. Between the flashes of blue light, a red LED is flashed on the sensor and used as an internal reference.

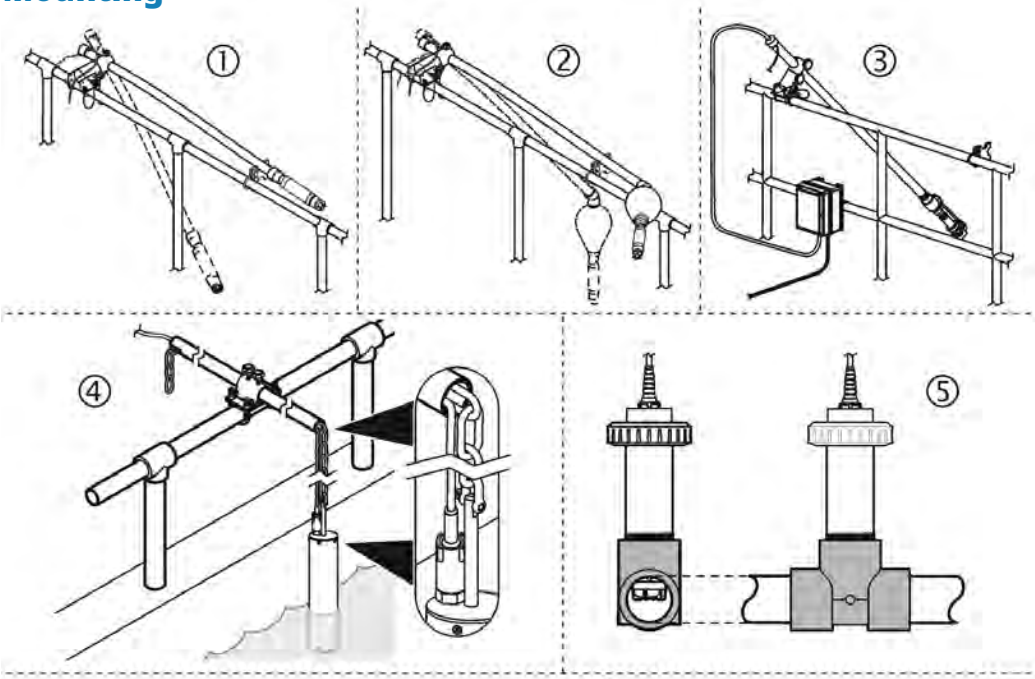
Increased oxygen in the sample decreases the time it takes for the red light to be emitted. The time measurements correlate to the oxygen concentration.



Dimensions



Installation / Mounting



1 Rail mount

2 Float mount

3 Air blast system mount

4 Chain mount

5 Union mount

6 Flow cell mount

Order Information

Sensor

9020000	Hach LDO 2 sc Dissolved Oxygen Probe
~~9020000-UPGRADE~~	~~Hach LDO 2 sc Dissolved Oxygen Probe, with Mounting Conversion Adapter~~

Please note that a Hach SC controller is required to operate the LDO sc Sensor, controller must be purchased separately.

Accessories

~~5867000~~	~~Digital Termination Box~~
~~5796000~~	~~Digital Extension Cable, 7.7 m (25 ft.)~~
~~5796100~~	~~Digital Extension Cable, 15 m (50 ft.)~~
~~5796200~~	~~Digital Extension Cable, 30 m (100 ft.)~~
~~6860000~~	~~High Output Air Blast Cleaninn System, 115 VAC~~
~~6860100~~	~~High Output Air Blast Cleaning System, 230 Vac~~
~~9253500~~	~~Air Blast Hardware Components~~

Replacements and Parts

9021100	LDO sc Model 2 Sensor Cap Replacement Kit

Mounting Kits

9253000	Pole Mount Kit, PVC
~~9253100~~	~~Ball Float Mount Kit, PVC~~
~~9257000~~	~~Union Mount Kit, PVC~~
~~9253400~~	~~Mounting Conversion Adapter, LDO sc Model 1 to LDO sc Model 2~~
~~7300800~~	~~1" NPT sc Sensors Flow Cell~~

Controllers

SC4500 Digital Controllers

LXV525.99A11551	SC4500 Controller, Prognosys, 5x mA Output, 2 digital Sensors, without plug
~~LXV525.99A11541~~	~~SC4500 Controller, Prognosys, 5x mA Output, 1 digital Sensor, 1 mA Input, without plug~~
~~LXV525.99A11501~~	~~SC4500 Controller, Prognosys, 5x mA Output, 1 digital Sensor, 100-240 VAC, without power cord~~

~~SC1000 Digital Controllers~~

~~LXV402.99.00002~~	~~SC1000 Display Module~~
~~LXV400.99.1R572~~	~~SC1000 Probe Module, 4 Sensors, 4x 4-20mA Out, 4x 4-20mA In, 4x Relays, 100-240 V AC with Conduits~~
~~LXV400.99.1B572~~	~~SC1000 Probe Module, 4 Sensors, 4x 4-20mA Out, 4x 4-20mA In, Modbus® RS485, 4x Relays, 100-240 V AC with Conduits~~
~~LXV400.99.1F572~~	~~SC1000 Probe Module, 4 Sensors, 4x 4-20mA Out, 4x 4-20mA In, Profibus® DP, 4x Relays, 100-240 V AC with Conduits~~
~~LXV400.99.1R582~~	~~SC1000 Probe Module, 6 Sensors, 4x 4-20mA Out, 4x 4-20mA In, 4x Relays, 100-240 V AC with Conduits~~

Additional controller configurations are available. Please contact Hach Technical Support or your Hach representative.

For reference only. Not supplied.

Claros Enabled

This instrument connects to Claros, Hach's innovative Water Intelligence System. Claros allows you to seamlessly connect and manage instruments, data, and process – anywhere, anytime. The result is greater confidence in your data and improved efficiencies in your operations. To unlock the full potential of Claros, insist on Claros Enabled instruments.

Service Protected

With Hach Service, you have a global partner who understands your needs and cares about delivering timely, high-quality service you can trust. Our Service Team brings unique expertise to help you maximize instrument uptime, ensure data integrity, maintain operational stability, and reduce compliance risk.

World Headquarters: Loveland, Colorado USA | hach.com

United States **800-227-4224** fax: 970-669-2932 email: orders@hach.com
Outside United States **970-669-3050** fax: 970-461-3939 email: int@hach.com

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Electric Actuated Ball Valve

2-piece Stainless Steel, Full Port
1/4" to 4" NPT-Explosion Proof

SERIES
5852
5853
5854
5855

Construction Features

Auxiliary Limit Switches(2) for confirming valve position, on-off versions

Heavy duty integral motor design significantly reduces physical size of actuator

Rugged durable painted aluminum Type 4X/ IP67 weatherproof enclosure.

Triple PTFE/Viton live loaded stem seals

RTFE (Reinforced Teflon) ball seats

High strength glass position indicator

Circular field joints for superior explosion-proof reliability

Manual Override with protective cover

Self-locking all metal gear drive, no additional brake required

Machined 316SS ball

Investment casting 316 stainless steel valve body and end caps

Pressure Rating

Pressure Rating*: 1000 PSI (69 Bar) (1/4"-2")
800 PSI (55 Bar) (2-1/2"-4") CWP non-shock, Vacuum 29inHg,

* See P/T chart

Visual Valve
Position Indicator

Temperature Rating

Actuator Temperature Rating: -13 to 131° F (-25 to 55° C)

Valve Temperature Rating: -4 to 392° F (-20 to 200°C)

* See P/T chart

Installation Requires-Two 1/2" NPT threaded explosion-proof connectors or pipe for electrical interface (Not included**)**

Specifications (English units)

Stock Number	Pipe Size (NPT)	Orifice Diameter (inch)	Cv Flow Factor*	Max Pressure (PSI)**	Cycle Time/ 90° (seconds)	Voltage	Current (amps)	Duty Cycle	Electrical Dwg.
110 VAC ELECTRIC ACTUATED STAINLESS BALL VALVES, ON-OFF version									
585202	1/4	0.5	6.9	1000	20	110 VAC, 50/60Hz	0.27	70%	B
585203	3/8	0.5	6.9	1000	20	110 VAC, 50/60Hz	0.27	70%	B
585204	1/2	0.6	9.7	1000	20	110 VAC, 50/60Hz	0.27	70%	B
585206	3/4	0.8	18.4	1000	20	110 VAC, 50/60Hz	0.27	70%	B
585208	1	1.0	55.4	1000	20	110 VAC, 50/60Hz	0.27	70%	B
585210	1-1/4	1.3	89.7	1000	20	110 VAC, 50/60Hz	0.27	70%	B
585212	1-1/2	1.5	144.2	1000	20	110 VAC, 50/60Hz	0.27	70%	B
585216	2	2.0	226.0	1000	20	110 VAC, 50/60Hz	0.27	70%	B
585220	2-1/2	2.6	289.0	800	30	110 VAC, 50/60Hz	0.63	70%	B
585224	3	3.1	454.0	800	30	110 VAC, 50/60Hz	0.63	70%	B
585232	4	3.9	710.0	800	30	110 VAC, 50/60Hz	0.63	70%	B
24 VDC ELECTRIC ACTUATED STAINLESS BALL VALVES, ON-OFF version									
585302	1/4	0.5	6.9	1000	20	DC24	1.28	70%	G
585303	3/8	0.5	6.9	1000	20	DC24	1.28	70%	G
585304	1/2	0.6	9.7	1000	20	DC24	1.28	70%	G
585306	3/4	0.8	18.4	1000	20	DC24	1.28	70%	G
585308	1	1.0	55.4	1000	20	DC24	1.28	70%	G
585310	1-1/4	1.3	89.7	1000	20	DC24	1.28	70%	G
585312	1-1/2	1.5	144.2	1000	20	DC24	1.28	70%	G
585316	2	2.0	226.0	1000	20	DC24	1.28	70%	G
585320	2-1/2	2.6	289.0	800	30	DC24	3.12	70%	G
585324	3	3.1	454.0	800	30	DC24	3.12	70%	G
585332	4	3.9	710.0	800	30	DC24	3.12	70%	G

Cv = The GPM of water at 60° F that will pass through the valve with 1 PSI pressure drop

* Pressure @ 0-100° F (reduced pressure at higher temperatures—see P/T chart)

• Torque at 0 PSI and 75°F

Specifications (English units)

Stock Number	Pipe Size (NPT)	Orifice Diameter (inch)	Cv Flow Factor*	Max Pressure (PSI)**	Cycle Time/ 90° (seconds)	Voltage	Current (amps)	Duty Cycle	Electrical Dwg.
110 VAC ELECTRIC ACTUATED STAINLESS BALL VALVES, EPS POSITIONER 4-20mA input									
585402	1/4	0.5	6.9	1000	20	110 VAC, 50/60Hz	0.27	70%	E
585403	3/8	0.5	6.9	1000	20	110 VAC, 50/60Hz	0.27	70%	E
585404	1/2	0.6	9.7	1000	20	110 VAC, 50/60Hz	0.27	70%	E
585406	3/4	0.8	18.4	1000	20	110 VAC, 50/60Hz	0.27	70%	E
585408	1	1.0	55.4	1000	20	110 VAC, 50/60Hz	0.27	70%	E
585410	1-1/4	1.3	89.7	1000	20	110 VAC, 50/60Hz	0.27	70%	E
585412	1-1/2	1.5	144.2	1000	20	110 VAC, 50/60Hz	0.27	70%	E
585416	2	2.0	226.0	1000	20	110 VAC, 50/60Hz	0.27	70%	E
585420	2-1/2	2.6	289.0	800	30	110 VAC, 50/60Hz	0.63	70%	E
585424	3	3.1	454.0	800	30	110 VAC, 50/60Hz	0.63	70%	E
585432	4	3.9	710.0	800	30	110 VAC, 50/60Hz	0.63	70%	E
24 VDC ELECTRIC ACTUATED STAINLESS BALL VALVES, EPS POSITIONER 4-20mA input									
585502	1/4	0.5	6.9	1000	20	DC24	1.28	70%	GEY
585503	3/8	0.5	6.9	1000	20	DC24	1.28	70%	GEY
585504	1/2	0.6	9.7	1000	20	DC24	1.28	70%	GEY
585506	3/4	0.8	18.4	1000	20	DC24	1.28	70%	GEY
585508	1	1.0	55.4	1000	20	DC24	1.28	70%	GEY
585510	1-1/4	1.3	89.7	1000	20	DC24	1.28	70%	GEY
585512	1-1/2	1.5	144.2	1000	20	DC24	1.28	70%	GEY
585516	2	2.0	226.0	1000	20	DC24	1.28	70%	GEY
585520	2-1/2	2.6	289.0	800	30	DC24	3.12	70%	GEY
585524	3	3.1	454.0	800	30	DC24	3.12	70%	GEY
585532	4	3.9	710.0	800	30	DC24	3.12	70%	GEY

Cv = The GPM of water at 60° F that will pass through the valve with 1 PSI pressure drop

* Pressure @ 0-100° F (reduced pressure at higher temperatures—see P/T chart)

• Torque at 0 PSI and 75°F

Specifications (Metric units)

Stock Number	Pipe Size (NPT)	Orifice Diameter	Kv Flow Factor*	Max Pressure (Bar)**	Cycle Time/90° (seconds)	Voltage	Current (amps)	Duty Cycle	Electrical Dwg.
110 VAC ELECTRIC ACTUATED STAINLESS BALL VALVES, ON-OFF version									
585202	1/4	11.5	5.9	69	20	110 VAC, 50/60Hz	0.27	70%	B
585203	3/8	12.5	5.9	69	20	110 VAC, 50/60Hz	0.27	70%	B
585204	1/2	15	8.4	69	20	110 VAC, 50/60Hz	0.27	70%	B
585206	3/4	20	15.9	69	20	110 VAC, 50/60Hz	0.27	70%	B
585208	1	25	47.9	69	20	110 VAC, 50/60Hz	0.27	70%	B
585210	1-1/4	32	77.6	69	20	110 VAC, 50/60Hz	0.27	70%	B
585212	1-1/2	38	124.7	69	20	110 VAC, 50/60Hz	0.27	70%	B
585216	2	50	195.5	69	20	110 VAC, 50/60Hz	0.27	70%	B
585220	2-1/2	65	250.0	55	30	110 VAC, 50/60Hz	0.63	70%	B
585224	3	80	392.7	55	30	110 VAC, 50/60Hz	0.63	70%	B
585232	4	100	614.2	55	30	110 VAC, 50/60Hz	0.63	70%	B
24 VDC ELECTRIC ACTUATED STAINLESS BALL VALVES, ON-OFF version									
585302	1/4	11.5	5.9	69	20	DC24	1.28	70%	G
585303	3/8	12.5	5.9	69	20	DC24	1.28	70%	G
585304	1/2	15	8.4	69	20	DC24	1.28	70%	G
585306	3/4	20	15.9	69	20	DC24	1.28	70%	G
585308	1	25	47.9	69	20	DC24	1.28	70%	G
585310	1-1/4	32	77.6	69	20	DC24	1.28	70%	G
585312	1-1/2	38	124.7	69	20	DC24	1.28	70%	G
585316	2	50	195.5	69	20	DC24	1.28	70%	G
585320	2-1/2	65	250.0	55	30	DC24	3.12	70%	G
585324	3	80	392.7	55	30	DC24	3.12	70%	G
585332	4	100	614.2	55	30	DC24	3.12	70%	G

* Pressure range @ -18 to 38° C (reduced pressure for higher temperatures—see P/T chart)

Specifications (Metric units)

Stock Number	Pipe Size (NPT)	Orifice Diameter (mm)	Kv Flow Factor*	Max Pressure (Bar)**	Cycle Time/90° (seconds)	Voltage	Current (amps)	Duty Cycle	Electrical Dwg.
110 VAC ELECTRIC ACTUATED STAINLESS BALL VALVES, EPS POSITIONER 4-20mA input									
585402	1/4	11.5	5.9	69	20	110 VAC, 50/60Hz	0.27	70%	E
585403	3/8	12.5	5.9	69	20	110 VAC, 50/60Hz	0.27	70%	E
585404	1/2	15	8.4	69	20	110 VAC, 50/60Hz	0.27	70%	E
585406	3/4	20	15.9	69	20	110 VAC, 50/60Hz	0.27	70%	E
585408	1	25	47.9	69	20	110 VAC, 50/60Hz	0.27	70%	E
585410	1-1/4	32	77.6	69	20	110 VAC, 50/60Hz	0.27	70%	E
585412	1-1/2	38	124.7	69	20	110 VAC, 50/60Hz	0.27	70%	E
585416	2	50	195.5	69	20	110 VAC, 50/60Hz	0.27	70%	E
585420	2-1/2	65	250.0	55	30	110 VAC, 50/60Hz	0.63	70%	E
585424	3	80	392.7	55	30	110 VAC, 50/60Hz	0.63	70%	E
585432	4	100	614.2	55	30	110 VAC, 50/60Hz	0.63	70%	E
24 VDC ELECTRIC ACTUATED STAINLESS BALL VALVES, EPS POSITIONER 4-20mA input									
585502	1/4	11.5	5.9	69	20	DC24	1.28	70%	GEY
585503	3/8	12.5	5.9	69	20	DC24	1.28	70%	GEY
585504	1/2	15	8.4	69	20	DC24	1.28	70%	GEY
585506	3/4	20	15.9	69	20	DC24	1.28	70%	GEY
585508	1	25	47.9	69	20	DC24	1.28	70%	GEY
585510	1-1/4	32	77.6	69	20	DC24	1.28	70%	GEY
585512	1-1/2	38	124.7	69	20	DC24	1.28	70%	GEY
585516	2	50	195.5	69	20	DC24	1.28	70%	GEY
585520	2-1/2	65	250.0	55	30	DC24	3.12	70%	GEY
585524	3	80	392.7	55	30	DC24	3.12	70%	GEY
585532	4	100	614.2	55	30	DC24	3.12	70%	GEY

* Pressure range @ -18 to 38° C (reduced pressure for higher temperatures—see P/T chart)

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ASCO™ EF8210G054AC120/60D, 1", 120 VAC

ASCO™ General Service Solenoid Va

Brass or Stainless Steel Bodies | Pilot Operated | 3/8" to 2 1/2"

2/2 SERIES 210

Features

- Wide range of pressure ratings, sizes, and resilient materials provide long service life and low internal leakage
- High flow valves for liquid, corrosive, and air/inert gas service
- Lead-free versions available for Safe Drinking Water Act Section 1417 and NSF/ANSI 372 compliance
- Industrial applications include:
  - Car wash
  - Laundry equipment
  - Air compressors
  - Industrial water control
  - Pumps

Construction

Valve Parts in Contact with Fluids		
Body	Brass	~~304 Stainless Steel*~~
Seals and Discs	NBR ~~or PTFE~~	
Disc-Holder	PA	
Core Tube	305 Stainless Steel	
Core and Plugnut	430F Stainless Steel	
Springs	302 Stainless Steel	
Shading Coil	Copper	~~Silver~~

* Catalog Numbers 8210G127, 8210G129, 8210G132, 8210G133 have 316L Stainless Steel bodies.
** In accordance with the Safe Drinking Water Act (SDWA) Section 1417, and compliant to NSF/ANSI 372 low lead requirements.

Electrical

Standard Coil and Class of Insulation	Watt Rating and Power Consumption				Spare Coil Part Number			
	DC Watts	AC			General Purpose		Explosionproof	
		Watts	VA Holding	VA Inrush	AC	DC	AC	DC
F	-	6.1	16	40	238210	-	238214	-
F	11.6	10.1	25	70	238610	238710	238614	238714
F	15.8	-	-	-	-	501695	-	501696
F	16.8	16.1	35	180	272610	97617	272614	97617
F	-	17.1	40	93	238610	-	238614	-
F	-	20	43	240	99257	-	99257	-
F	-	20.1	48	240	272610	-	272614	-
F	30.8	-	-	-	-	501695	-	501696
H	11.6	-	-	-	-	238910	-	238914
H	40.6	-	-	-	-	238910	-	-

Standard Voltages: 24, 120, 240, 480 volts AC, 60 Hz (or 110, 220 volts AC, 50 Hz). 6, 12, 24, 120, 240 volts DC. Must be specified when ordering.
Other voltages available when required.

Solenoid Enclosures

Standard:
RedHat II - Watertight, Types 1, 2, 3, 3S, 4, and 4X
RedHat - Type I.

Optional:
RedHat II - Explosionproof and Watertight,
Types 3, 3S, 4, 4X, 6, 6P, 7, and 9
Red-Hat - Explosionproof and Watertight,
Types 3, 4, 4X, 7, & 9.
(To order, add prefix "EF" to catalog number, except Catalog Numbers 8210B057, 8210B058, and 8210B059, which are not available with Explosionproof enclosures.)
See Optional Features Section for other available options.

Nominal Ambient Temp. Ranges

RedHat II/RedHat AC: 32˚F to 125˚F (0˚C to 52˚C)
RedHat II DC: 32˚F to 104˚F (0˚C to 40˚C)
RedHat DC: 32˚F to 77˚F (0˚C to 25˚C)
(104˚F/40˚C occasionally)
8210G227 AC: 32˚F to 130˚F (0˚C to 54˚C)
DC: 32˚F to 90˚F (0˚C to 32˚C)
Refer to Engineering Section for details.

Approvals

- UL listed as indicated.
- CSA certified.
- RedHat II meets applicable CE directives. Refer to Engineering Section for details.
- ATEX/IECEx certified with prefix "EV" as listed. Refer to Optional Features Electrical Section for details.
- Compliance with the Safe Drinking Water Act (SDWA) Section 1417 Lead Free Requirements as indicated.
- Compliance with NSF/ANSI 372 low lead requirements.

ASCO™ General Service Solenoid Valves

Brass or Stainless Steel Bodies | Pilot Operated | 3/8" to 2 1/2"

Specifications (English units)

Pipe Size (in)	Orifice Size (in)	Cv Flow Factor	Operating Pressure Differential (psi)							Max. Fluid Temp. °F		Brass Body			Stainless Steel Body			Watt Rating/ Class of Coil Insulation ⑦	
			Min.	Max. AC			Max. DC												
				Air-Inert Gas	Water	Light Oil @ 300 SSU	Air-Inert Gas	Water	Light Oil @ 300 SSU	AC	DC	Catalog Number	Const. Ref. ④	UL ⑤ Listing	Catalog Number	Const. Ref. ④	UL ⑤ Listing	AC	DC
NORMALLY CLOSED (Closed when de-energized), NBR or PTFE ② Seating																			
3/8	3/8	1.5	①	150	125	-	40	40	-	180	150	8210G073 ③	1P	●	8210G036 ③	1P	●	6.1/F	11.6/F
3/8	5/8	3	0	150	150	-	40	40	-	180	150	8210G093 ♦	5D	❍	-	-	-	10.1/F	11.6/F
3/8	5/8	3	5	200	150	135	125	100	100	180	150	8210G001 ▼♦	6D	❍	-	-	-	6.1/F	11.6/F
3/8	5/8	3	5	300	300	300	-	-	-	175	-	8210G006 ✓	5D	❍	-	-	-	17.1/F	-
1/2	7/16	2.2	①	150	125	-	40	40	-	180	150	8210G015 ③	2P	●	8210G037 ③	2P	●	6.1/F	11.6/F
1/2	5/8	4	0	150	150	-	40	40	-	180	150	8210G094 ✓♦	5D	❍	-	-	-	10.1/F	11.6/F
1/2	5/8	4	0	150	150	125	40	40	-	175	150	-	-	-	8210G087 ✓	7D	●	17.1/F	11.6/F
1/2	5/8	4	5	200	150	135	125	100	100	180	150	8210G002 ▼♦	6D	❍	-	-	-	6.1/F	11.6/F
1/2	5/8	4	5	300	300	300	-	-	-	175	-	8210G007	5D	❍	-	-	-	17.1/F	-
1/2	3/4	4	5	-	300	-	-	300	-	130	90	8210G227	5D	❍ †	-	-	-	17.1/F	40.6/H
3/4	5/8	4.5	0	150	150	125	40	40	-	175	150	-	-	-	8210G088 ✓	7D	●	17.1/F	11.6/F
3/4	3/4	5	5	125	125	125	100	90	75	180	150	8210G009 ▼♦	9D	❍	-	-	-	6.1/F	11.6/F
3/4	3/4	5	0	150	150	-	40	40	-	180	150	8210G095 ✓♦	8D	❍	-	-	-	10.1/F	11.6/F
3/4	3/4	6.5	5	250	150	100	125	125	125	180	150	8210G003 ▼	11D	❍	-	-	-	6.1/F	11.6/F
3/4	3/4	6	0	350	300	200	200	200	200	200	180	8210G026 ② ‡◆	40P/10D	●	-	-	-	16.1F	30.8/F
1	1	13	0	150	125	125	135	120	120	180	180	8210G054 ‡◆♦	41D/31D ⑪	●	8210G089 ‡◆	45D/15D ⑪	●	16.1/F	30.8/F
1	1	13	5	150	150	100	125	125	125	180	150	8210G004 ▼♦	12D	❍	-	-	-	6.1/F	11.6/F
1	1	13.5	0	300	225	115	-	-	-	200	-	8210G027	42P ⑪	●	-	-	-	20.1/F	-
1	1	13.5	10	300	300	300	-	-	-	175	-	8210G078 ②	13P	-	-	-	-	17.1/F	-
1 1/4	1 1/8	15	0	150	125	125	135	120	120	180	180	8210G055 ‡◆	43D/32D ⑪	●	-	-	-	16.1/F	30.8/F
1 1/4	1 1/8	15	5	150	150	100	125	125	125	180	150	8210G008 ▼♦	16D	❍	-	-	-	6.1/F	11.6/F
1 1/2	1 1/4	22.5	0	150	125	125	135	120	120	180	180	8210G056 ‡◆	44D/33D ⑪	●	-	-	-	16.1/F	30.8/F
1 1/2	1 1/4	22.5	5	150	150	100	125	125	125	180	150	8210G022 ▼♦	18D	❍	8210G127	52D ⑪	●	6.1/F	11.6/H
2	1 3/4	43	5	150	125	90	50	50	50	180	150	8210G100 ♦	20P	●	8210G129	53P	●	6.1/F	11.6/H
2 1/2	1 3/4	45	5	150	125	90	50	50	50	180	150	8210G101	21P	●	-	-	-	6.1/F	11.6/F
NORMALLY OPEN (Open when de-energized), NBR Seating (PA Disc-Holder, except as noted)																			
3/8	5/8	3	0	150	150	125	125	125	80	180	150	8210G033	23D	●	-	-	-	10.1/F	11.6/F
3/8	5/8	3	5	250	200	200	250	200	200	180	180	8210G011 ⑧⑨	39D	●	-	-	-	10.1/F	11.6/F
1/2	5/8	4	0	150	150	125	125	125	80	180	150	8210G034 ✓♦	23D	●	-	-	-	10.1/F	11.6/F
1/2	5/8	3	0	150	150	100	125	125	80	180	150	-	-	-	8210G030 ✓	37D	●	10.1/F	11.6/F
1/2	5/8	4	5	250	200	200	250	200	200	180	180	8210G012 ⑧⑨	39D	●	-	-	-	10.1/F	11.6/F
3/4	3/4	5.5	0	150	150	125	125	125	80	180	150	8210G035 ✓♦	25D	●	-	-	-	10.1/F	11.6/F
3/4	5/8	3	0	150	150	100	125	125	80	180	150	-	-	-	8210G038 ✓	38D	●	10.1/F	11.6/F
3/4	3/4	6.5	5	250	200	200	250	200	200	180	180	8210G013	46D/52D	●	-	-	-	16.1/F	15.8/F
1	1	13	0	125	125	125	-	-	-	180	-	8210B057 ⑥⑩	34D ⑪	●	-	-	-	20/F	-
1	1	13	5	150	150	125	150	150	125	180	180	8210G014 ♦	47D/53D	●	-	-	-	16.1/F	15.8/F
1 1/4	1 1/8	15	0	125	125	125	-	-	-	180	-	8210B058 ⑥⑩	35D ⑪	●	-	-	-	20/F	-
1 1/4	1 1/8	15	5	150	150	125	150	150	125	180	-	8210G018 ♦	48D/54D	●	-	-	-	16.1/F	15.8/F
1 1/2	1 1/4	22.5	0	125	125	125	-	-	-	180	-	8210B059 ⑥⑩	36D ⑪	●	-	-	-	20/F	-
1 1/2	1 1/4	22.5	5	150	150	125	150	150	125	180	180	8210G032 ♦	49D/55D	●	8210G132	29D	●	16.1/F	15.8/F
2	1 3/4	43	5	150	125	125	150	150	125	180	180	8210G103 ♦	50P/56P	●	8210G133	30P	●	16.1/F	15.8/F
2 1/2	1 3/4	45	5	150	125	125	150	150	125	180	180	8210G104	51P/57P	●	-	-	-	16.1/F	15.8/F

① 5 psi on Air; 1 psi on Water.
② Valve provided with PTFE main disc.
③ Valve includes Ultem (G.E. trademark) piston.
④ Letter "D" = diaphragm construction; "P"= piston construction.
⑤ ❍ Safety Shutoff Valve; ● General Purpose Valve. Refer to Engineering Section (Approvals) for details.
⑥ Valves not available with Explosionproof enclosures.
⑦ On 50 hertz service, the watt rating for the 6.1/F solenoid is 8.1 watts.
⑧ AC construction also has PA seating.
⑨ No disc-holder.
⑩ Stainless steel disc-holder.
⑪ Constructions with NPT size 1" and larger are not offered with MB option (mounting bracket).

† UL listed for fire protection systems per UL429A 120/60, 110/50 24VDC, no prefix and voltage options offered.
‡ DC constructions must have solenoid mounted vertical and upright.
✓ ATEX/IECEx certified solenoid with prefix "EV".
▼ ATEX/IECEx certified solenoid for DC only with prefix "EV".
◆ Not available in 6 Volt DC. EF and HB prefix only.
♦ Valve available with lead-free brass body and bonnet using suffix "LF". The term "Lead-Free" for brass materials is defined by SDWA 1417 as having a maximum weighted average lead content of 0.25% on the wetted surface area. Valves are compliant to NSF/ANSI 372 low lead requirements.

Specifications (Metric units)

Pipe Size (in)	Orifice Size (mm)	Kv Flow Factor (m^3/hr)	Operating Pressure Differential (bar)							Max. Fluid Temp. °C		Brass Body			Stainless Steel Body			Watt Rating/ Class of Coil Insulation ⑦	
			Min.	Max. AC			Max. DC												
				Air-Inert Gas	Water	Light Oil @ 300 SSU	Air-Inert Gas	Water	Light Oil @ 300 SSU	AC	DC	Catalog Number	Const. Ref. ④	UL ⑤ Listing	Catalog Number	Const. Ref. ④	UL ⑤ Listing	AC	DC
NORMALLY CLOSED (Closed when de-energized), NBR or PTFE ② Seating																			
3/8	10	1.3	①	10	9	-	3	3	-	82	65	8210G073 ③	1P	●	8210G036 ③	1P	●	6.1/F	11.6/F
3/8	16	2.6	0	10	10	-	3	3	-	82	65	8210G093 ♦	5D	❍	-	-	-	10.1/F	11.6/F
3/8	16	2.6	0.3	14	10	9	9	7	7	82	65	8210G001 ▼♦	6D	❍	-	-	-	6.1/F	11.6/F
3/8	16	2.6	0.3	21	21	21	-	-	-	79	-	8210G006 ✓	5D	❍	-	-	-	17.1/F	-
1/2	11	1.9	①	10	9	-	3	3	-	82	65	8210G015 ③	2P	●	8210G037 ③	2P	●	6.1/F	11.6/F
1/2	16	3.4	0	10	10	-	3	3	-	82	65	8210G094 ✓♦	5D	❍	-	-	-	10.1/F	11.6/F
1/2	16	3.4	0	10	10	9	3	3	-	79	65	-	-	-	8210G087 ✓	7D	●	17.1/F	11.6/F
1/2	16	3.4	0.3	14	10	9	9	7	7	82	65	8210G002 ▼♦	6D	❍	-	-	-	6.1/F	11.6/F
1/2	16	3.4	0.3	21	21	21	-	-	-	79	-	8210G007	5D	❍	-	-	-	17.1/F	-
1/2	19	3.4	0.3	-	21	-	-	21	-	54	32	8210G227	5D	❍ †	-	-	-	17.1/F	40.6H
3/4	16	3.9	0	10	10	9	3	3	-	79	65	-	-	-	8210G088 ✓	7D	●	17.1/F	11.6/F
3/4	19	4.3	0.3	9	9	9	7	6	5	82	65	8210G009 ▼♦	9D	❍	-	-	-	6.1/F	11.6/F
3/4	19	4.3	0	10	10	-	3	3	-	82	65	8210G095 ✓♦	8D	❍	-	-	-	10.1/F	11.6/F
3/4	19	5.6	0.3	17	10	7	9	9	9	82	65	8210G003 ▼	11D	❍	-	-	-	6.1/F	11.6/F
3/4	19	5.1	0	24	21	14	14	14	14	93	82	8210G026 ② ‡◆	40P/10D	●	-	-	-	16.1F	30.8/F
1	25	11	0	10	9	9	9	8	8	82	82	8210G054 ‡◆♦	41D/31D ⑪	●	8210G089 ‡◆	45D/15D ⑪	●	16.1/F	30.8/F
1	25	11	0.3	10	10	7	9	9	9	82	65	8210G004 ▼♦	12D	❍	-	-	-	6.1/F	11.6/F
1	25	11.5	0	21	16	8	-	-	-	93	-	8210G027	42P ⑪	●	-	-	-	20.1/F	-
1	25	11.5	0.7	21	21	21	-	-	-	79	-	8210G078 ②	13P	-	-	-	-	17.1/F	-
1 1/4	29	13	0	10	9	9	9	8	8	82	82	8210G055 ‡◆	43D/32D ⑪	●	-	-	-	16.1/F	30.8/F
1 1/4	29	13	0.3	10	10	7	9	9	9	82	65	8210G008 ▼♦	16D	❍	-	-	-	6.1/F	11.6/F
1 1/2	32	19.5	0	10	9	9	9	8	8	82	82	8210G056 ‡◆	44D/33D ⑪	●	-	-	-	16.1/F	30.8/F
1 1/2	32	19.5	0.3	10	10	7	9	9	9	82	65	8210G022 ▼♦	18D	❍	8210G127	52D ⑪	●	6.1/F	11.6/H
2	44	37	0.3	10	9	6	3	3	3	82	65	8210G100 ♦	20P	●	8210G129	53P	●	6.1/F	11.6H
2 1/2	44	39	0.3	10	9	6	3	3	3	82	65	8210G101	21P	●	-	-	-	6.1/F	11.6/F
NORMALLY OPEN (Open when de-energized), NBR Seating (PA Disc-Holder, except as noted)																			
3/8	16	2.6	0.0	10	10	9	9	9	6	82	65	8210G033	23D	●	-	-	-	10.1/F	11.6/F
3/8	16	2.6	0.3	17	14	14	17	14	14	82	82	8210G011 ⑧⑨	39D	●	-	-	-	10.1/F	11.6/F
1/2	16	3.4	0	10	10	9	9	9	6	82	65	8210G034 ✓♦	23D	●	-	-	-	10.1/F	11.6/F
1/2	16	2.6	0	10	10	7	9	9	6	82	65	-	-	-	8210G030 ✓	37D	●	10.1/F	11.6/F
1/2	16	3.4	0.3	17	14	14	17	14	14	82	82	8210G012 ⑧⑨	39D	●	-	-	-	10.1/F	11.6/F
3/4	19	4.7	0	10	10	9	9	9	6	82	65	8210G035 ✓♦	25D	●	-	-	-	10.1/F	11.6/F
3/4	16	2.6	0	10	10	7	9	9	6	82	65	-	-	-	8210G038 ✓	38D	●	10.1/F	11.6/F
3/4	19	5.6	0.3	17	14	14	17	14	14	82	82	8210G013	46D/52D	●	-	-	-	16.1/F	15.8/F
1	25	11	0	9	9	9	-	-	-	82	-	8210B057 ⑥⑩	34D ⑪	●	-	-	-	20/F	-
1	25	11	0.3	10	10	9	10	10	9	82	82	8210G014 ♦	47D/53D	●	-	-	-	16.1/F	15.8/F
1 1/4	29	13	0	9	9	9	-	-	-	82	-	8210B058 ⑥⑩	35D ⑪	●	-	-	-	20/F	-
1 1/4	29	13	0.3	10	10	9	10	10	9	82	-	8210G018 ♦	48D/54D	●	-	-	-	16.1/F	15.8/F
1 1/2	32	19.5	0	9	9	9	-	-	-	82	-	8210B059 ⑥⑩	36D ⑪	●	-	-	-	20/F	-
1 1/2	32	19.5	0.3	10	10	9	10	10	9	82	82	8210G032 ♦	49D/55D	●	8210G132	29D	●	16.1/F	15.8/F
2	44	37	0.3	10	9	9	10	9	9	82	82	8210G103 ♦	50P/56P	●	8210G133	30P	●	16.1/F	15.8/F
2 1/2	44	39	0.3	10	9	9	10	9	9	82	82	8210G104	51P/57P	●	-	-	-	16.1/F	15.8/F

① 5 psi on Air; 1 psi on Water.
② Valve provided with PTFE main disc.
③ Valve includes Ultem (G.E. trademark) piston.
④ Letter "D" = diaphragm construction; "P"= piston construction.
⑤ ❍ Safety Shutoff Valve; ● General Purpose Valve. Refer to Engineering Section (Approvals) for details.
⑥ Valves not available with Explosionproof enclosures.
⑦ On 50 hertz service, the watt rating for the 6.1/F solenoid is 8.1 watts.
⑧ AC construction also has PA seating.
⑨ No disc-holder.
⑩ Stainless steel disc-holder.
⑪ Constructions with NPT size 1" and larger are not offered with MB option (mounting bracket).

† UL listed for fire protection systems per UL429A 120/60, 110/50 24VDC, no prefix and voltage options offered.
‡ DC constructions must have solenoid mounted vertical and upright.
✓ ATEX/IECEx certified solenoid with prefix "EV".
▼ ATEX/IECEx certified solenoid for DC only with prefix "EV".
◆ Not available in 6 Volt DC. EF and HB prefix only.
♦ Valve available with lead-free brass body and bonnet using suffix "LF". The term "Lead-Free" for brass materials is defined by SDWA 1417 as having a maximum weighted average lead content of 0.25% on the wetted surface area. Valves are compliant to NSF/ANSI 372 low lead requirements.

ASCO™ General Service Solenoid Valves

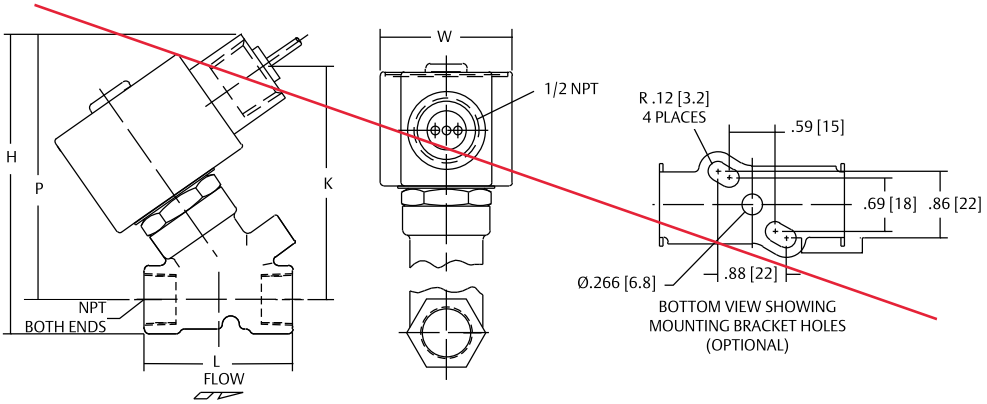
Brass or Stainless Steel Bodies | Pilot Operated | 3/8" to 2 1/2"

Dimensions: inches (mm)

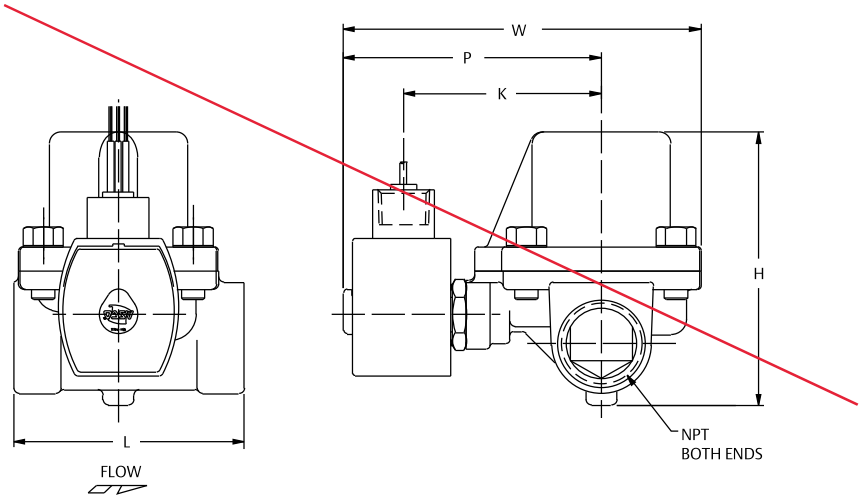
Const. Ref.		H	K	L	P	W
1*	in	3.85	3.00	1.91	3.41	1.69
	mm	98	76	49	87	43
2*	in	4.17	3.25	2.28	3.63	1.69
	mm	106	83	58	92	43
5	in	3.84	2.31	2.75	3.28	2.28
	mm	98	59	70	83	58
6*	in	3.38	1.94	2.75	2.80	2.28
	mm	86	49	70	71	58
7	in	4.19	2.50	2.81	3.47	2.39
	mm	106	64	71	88	61
8	in	4.13	2.47	2.81	3.44	2.29
	mm	105	63	71	87	58
9*	in	3.66	2.10	2.81	2.96	2.28
	mm	93	53	71	75	58
10*	in	5.20	3.40	2.80	4.50	2.50
	mm	131	86	71	114	62
11*	in	4.16	2.66	3.84	3.52	2.75
	mm	106	68	98	89	70
12	in	5.64	3.15	3.75	4.01	3.36
	mm	143	80	95	102	85
13	in	4.44	3.22	3.75	4.19	5.81
	mm	113	82	95	106	147
15*	in	5.20	3.30	3.80	4.40	3.80
	mm	133	83	98	111	98
16	in	5.64	3.15	3.66	4.01	3.56
	mm	143	80	93	102	90
18*	in	6.11	3.30	4.38	4.16	3.92
	mm	155	84	111	106	100
20*	in	7.33	3.71	5.06	4.57	4.87
	mm	186	94	129	116	124
21*	in	7.33	3.71	5.50	4.57	4.87
	mm	186	94	140	116	124
23	in	4.35	2.65	2.75	3.79	2.28
	mm	110	67	70	96	58
24	in	5.06	X	3.78	4.44	2.75
	mm	129	X	96	113	70
25	in	4.64	2.81	2.81	3.94	2.28
	mm	118	71	71	100	58
26	in	6.53	X	3.75	4.91	3.19
	mm	166	X	95	125	81
27	in	8.22	X	5.50	5.47	4.87
	mm	209	X	140	139	124
28	in	6.53	X	3.66	4.91	3.19
	mm	166	X	93	125	81
29	in	7.03	X	4.38	5.06	4.40
	mm	179	X	111	129	112

* DC dimensions slightly larger.
IMPORTANT: Valves may be mounted in any position, except as noted in specifications table.

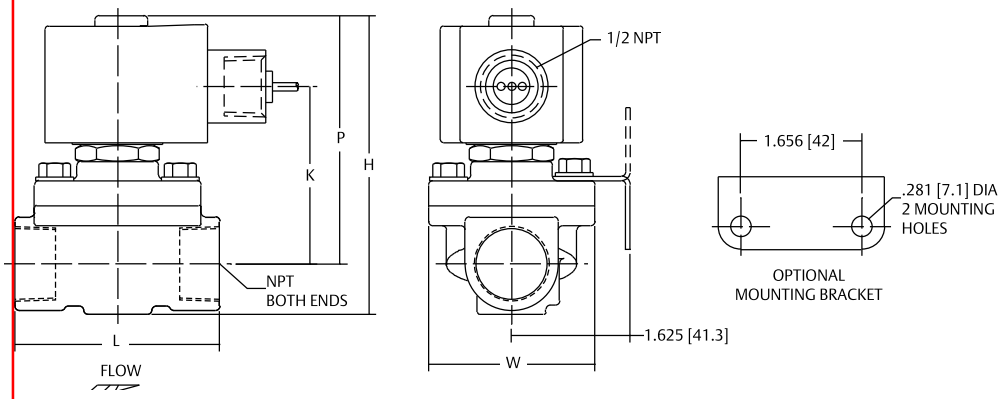
Const. Ref. 1, 2



Const. Ref. 13



Const. Ref. 5-9, 11, 23 , 25, 37,38, 40-46, 52

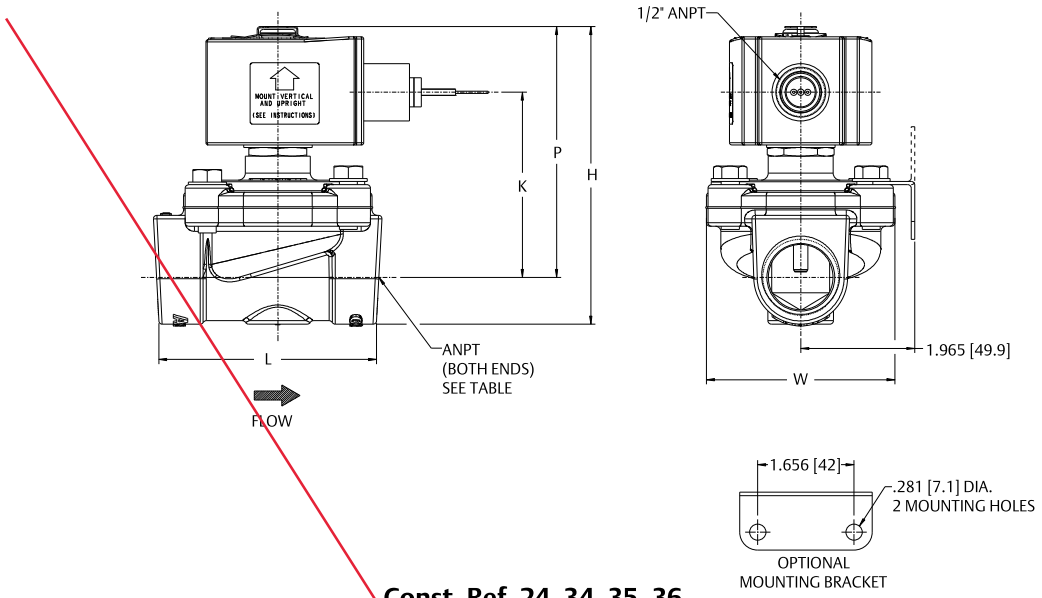


Dimensions: inches (mm)

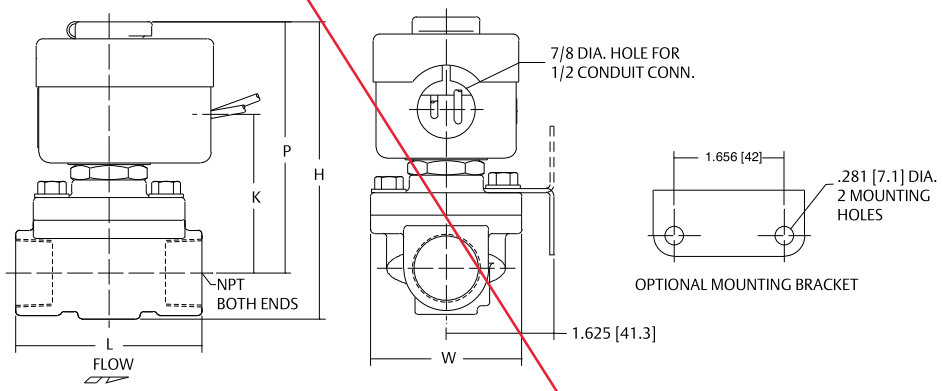
Const. Ref.		H	K	L	P	W
30	in	8.22	X	5.06	5.47	4.87
	mm	209	X	129	139	124
31	in	5.13	3.19	3.76	4.32	3.27
	mm	130	81	95	110	83
32	in	5.60	3.44	3.66	4.57	3.27
	mm	142	87	93	116	83
33	in	5.92	3.66	4.51	4.80	3.89
	mm	150	93	115	122	99
34	in	6.91	X	3.75	6.09	3.25
	mm	176	X	95	155	83
35	in	7.34	X	3.66	6.34	3.25
	mm	186	X	93	161	83
36	in	7.66	X	4.38	6.56	3.91
	mm	1.95	X	111	167	99
37	in	4.61	2.75	2.81	3.89	2.39
	mm	117	70	71	99	61
38	in	4.61	2.75	2.81	3.89	2.39
	mm	117	70	71	99	61
39	in	5.42	2.31	2.75	4.86	3.80
	mm	138	59	70	123	97
40	in	5.20	3.29	2.81	4.50	2.28
	mm	132	83	71	114	58
41	in	5.13	3.10	3.75	4.32	3.25
	mm	130	79	95	110	83
42	in	6.43	4.40	3.93	5.62	3.25
	mm	163	112	100	143	83
43	in	5.57	3.35	3.66	4.57	3.25
	mm	142	85	93	116	83
44	in	5.90	3.57	4.38	4.79	3.91
	mm	150	91	111	122	99
45	in	5.26	3.17	3.75	4.38	3.84
	mm	134	81	95	111	98
46	in	4.95	3.10	3.84	4.31	2.75
	mm	126	79	98	110	70
47	in	6.43	3.59	3.75	4.81	3.52
	mm	163	91	95	122	90
48	in	6.43	3.59	3.66	4.81	3.73
	mm	163	91	93	122	95

IMPORTANT: Valves may be mounted in any position, except as noted in specifications table.

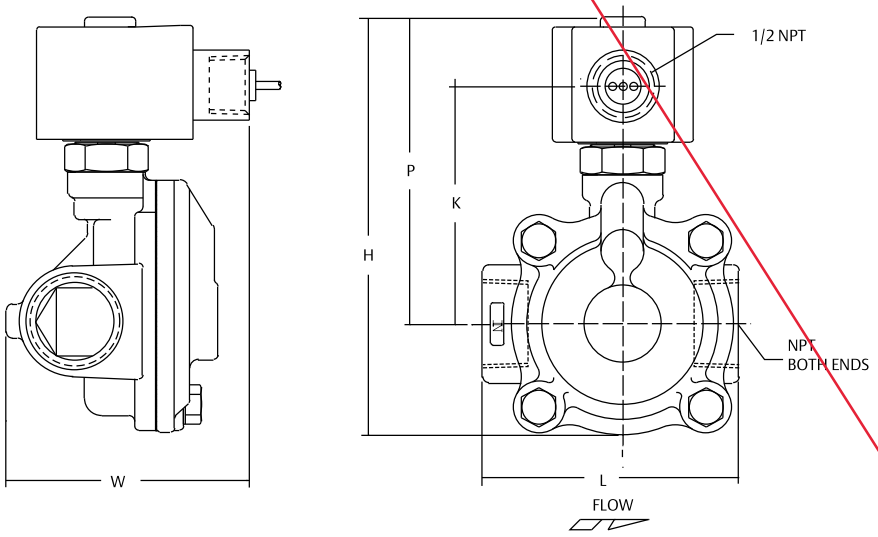
Const. Ref. 10, 15, 31, 32, 33



Const. Ref. 24, 34, 35, 36



Const. Ref. 12, 16, 26, 28, 47, 48, 53, 54, 55

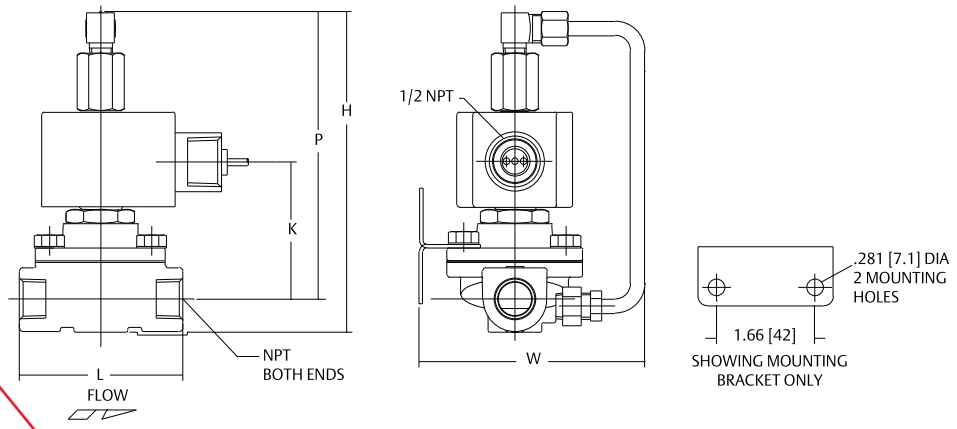


Dimensions: inches (mm)

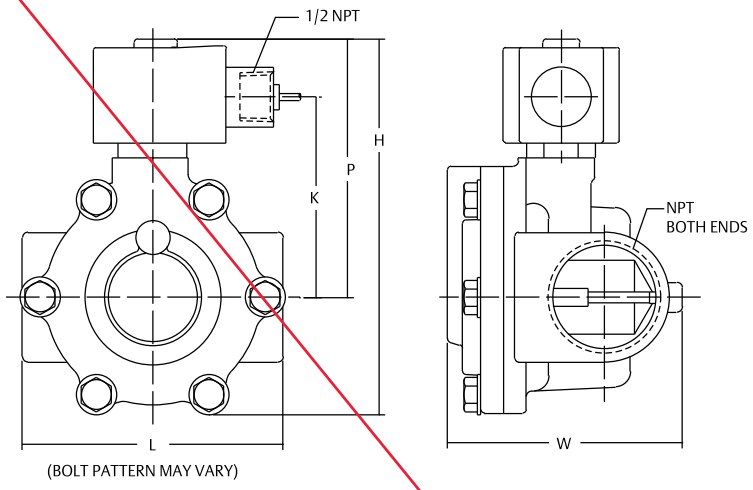
Const. Ref.		H	K	L	P	W
49	in	6.91	3.75	4.38	4.96	4.40
	mm	176	95	111	126	112
50	in	8.13	4.15	5.06	5.37	4.87
	mm	207	105	129	136	124
51	in	8.13	4.15	5.50	5.37	5.18
	mm	207	105	140	136	132
52	in	5.00	3.08	3.84	4.33	3.18
	mm	127	110	98	110	81
53	in	6.46	3.57	3.75	4.83	3.74
	mm	164	91	95	123	95
54	in	6.47	3.57	3.66	4.83	3.94
	mm	164	91	93	123	100
55	in	6.93	3.72	4.38	4.98	4.30
	mm	176	95	111	126	109
56	in	8.17	4.13	5.06	5.39	4.71
	mm	208	105	129	137	120
57	in	8.17	4.13	5.50	5.39	5.21
	mm	208	105	140	137	132

IMPORTANT: Valves may be mounted in any position, except as noted in specifications table.

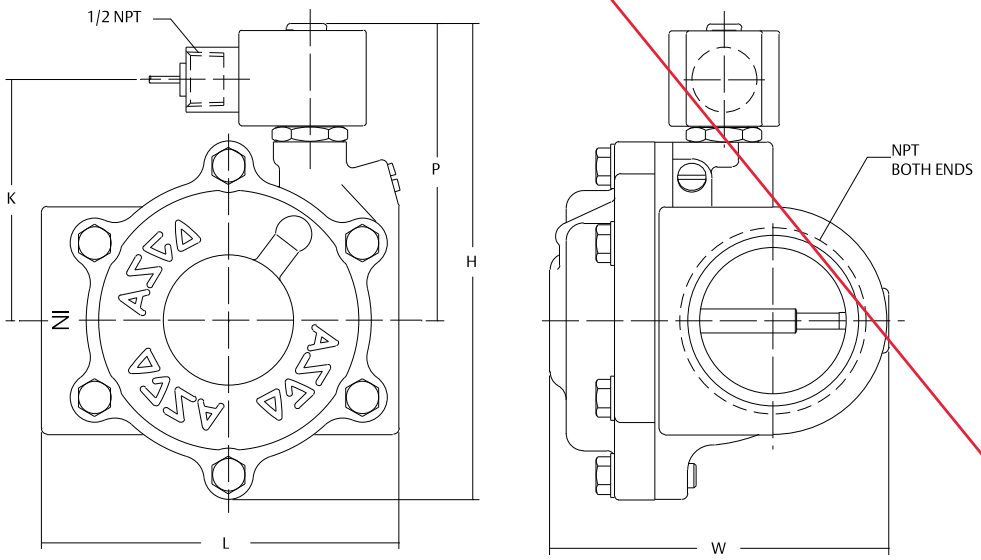
Const. Ref. 39



Const. Ref. 18, 29, 49



Const. Ref. 20, 21, 27, 30, 50, 51, 56, 57



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TB Series
True Union Ball Valves

1/4" TO 3/8" PVC AND
1/2" TO 2" PVC, CPVC AND GFPP

KEY FEATURES

- Available in PVC, CPVC and GFPP
- Full Port Design
- Reversible PTFE Seats
- Double O-Ring Stem Seals
- Easily Actuated
- NSF / ANSI 61 and NSF / ANSI 372 Listed

OPTIONS

- Pneumatic and Electric Actuators

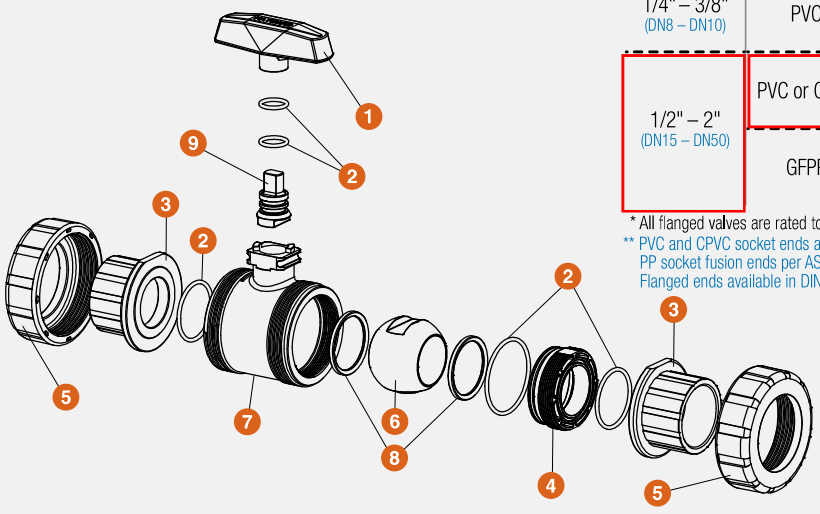
MATERIALS

- PVC Cell Class 12454 per ASTM D1784
- CPVC Cell Class 23447 per ASTM D1784
- GFPP Cell Class 85580 per ASTM D4101
- FPM and EPDM O-Ring Seals

Certified to NSF/ANSI 61 & 372 PVC and CPVC

TECHNICAL INFORMATION

EXPLODED VIEW



SELECTION CHART

SIZE	MATERIAL	END CONNECTION	SEALS	PRESSURE RATING
1/4" – 3/8" (DN8 – DN10)	PVC	Socket and Threaded	FPM or EPDM	250 PSI @ 70°F 16 Bar @ 21°C Non-Shock
1/2" – 2" (DN15 – DN50)	PVC or CPVC	Socket and Threaded or Flanged*		
	GFPP	Threaded, Socket Fusion or Flanged		150 PSI @ 70°F 10 Bar @ 21°C Non-Shock

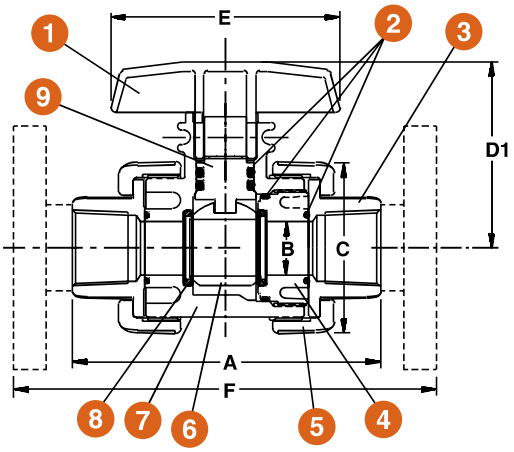
* All flanged valves are rated to 150 PSI @ 70°F Non-Shock (10 Bar @ 21°C)
** PVC and CPVC socket ends available to ISO 727-1 and threaded ends to BS21. PP socket fusion ends per ASTM F2389 and threaded ends per BS21. Flanged ends available in DIN / EN PN10.

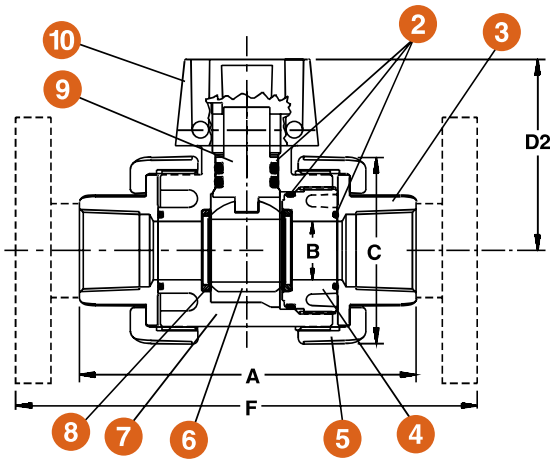
TECHNICAL INFORMATION, *CONTINUED*

PARTS LIST

1. Handle
2. O-Ring Seals
3. End Connector
4. Seal Retainer
5. Union Nut
6. Ball
7. Body
8. PTFE Seat
9. Stem
10. Actuator Mounting Pad

* Mounting bracket sold separately





DIMENSIONS

SIZE in / DN	A in / mm	B in / mm	C in / mm	D1 in / mm	D2 in / mm	E in / mm	F in / mm	WEIGHT lbs / kg SOC / THD	WEIGHT lbs / kg FLANGED
1/4 / 8	4.77 / 121	.50 / 13	2.25 / 57	2.81 / 71	2.63 / 67	3.50 / 89	N/A	.75 / .34	N/A
3/8 / 10	4.77 / 121	.50 / 13	2.25 / 57	2.81 / 71	2.63 / 67	3.50 / 89	N/A	.75 / .34	N/A
1/2 / 15*	4.77 / 121	.50 / 13	2.25 / 57	2.81 / 71	2.63 / 67	3.50 / 89	6.75 / 171	.75 / .34	1.00 / .45
3/4 / 20*	4.85 / 123	.75 / 19	2.63 / 67	3.02 / 77	2.81 / 71	3.50 / 89	7.13 / 181	.75 / .34	1.00 / .45
1 / 25*	5.44 / 138	.93 / 24	3.00 / 76	3.26 / 83	3.05 / 77	4.00 / 102	8.09 / 205	1.15 / .52	2.15 / .98
1-1/4 / 32*	6.30 / 160	1.50 / 38	4.00 / 102	3.92 / 100	3.48 / 88	5.00 / 127	9.19 / 233	2.15 / .98	3.50 / 1.59
1-1/2 / 40*	6.85 / 174	1.50 / 38	4.00 / 102	3.92 / 100	3.48 / 88	5.00 / 127	9.88 / 251	2.15 / .98	3.75 / 1.70
2 / 50*	8.00 / 203	1.94 / 49	4.75 / 121	4.43 / 113	4.00 / 102	5.00 / 127	11.4 / 290	3.80 / 1.72	6.30 / 2.86

Dimensions are subject to change without notice – consult factory for installation information

* Metric End Connections Available In: BSP – Straight Thread, BSP TR – Tapered Thread and Metric Socket

Cv VALUES

SIZE in / DN	Cv VALUES	SIZE in / DN	Cv VALUES
1/4 / 8	1.0	1 / 25	29.0
3/8 / 10	2.8	1-1/4 / 32	75.0
1/2 / 15	8.0	1-1/2 / 40	90.0
3/4 / 20	16.0	2 / 50	150.0

PRESSURE LOSS CALCULATION FORMULA

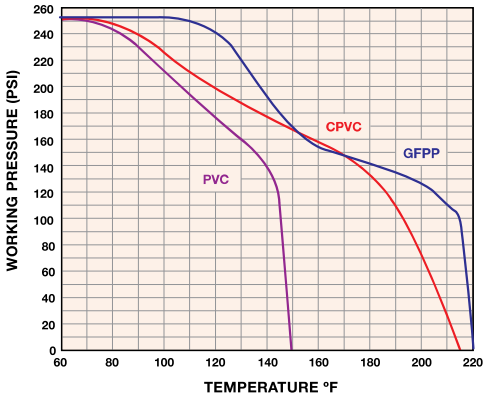
$$\Delta P = \left[\frac{Q}{Cv}\right]^2$$

ΔP = Pressure Drop

Q = Flow in GPM

Cv = Flow Coefficient

OPERATING TEMPERATURE/PRESSURE



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Float Level Switches

UL Listed

anchor scientific inc.

Priced From $47.00

Priced From $47.00

roto-float — TYPE S - SUSPENDED & TYPE P - PIPE MOUNTED

TYPES - SUSPENDED & TYPE P - PIPE MOUNTED

The ROTO-FLOAT is a direct acting float switch. Each ROTO-FLOAT contains a single pole mercury switch which actuates when the longitudinal axis of the float is horizontal, and deactuates when the liquid level falls 1" below the actuation elevation.

The float is a chemical resistant polypropylene casing with a firmly bonded electrical cable protruding. One end of the cable is permanently connected to the enclosed mercury switch and the entire assembly is encapsulated to form a completely watertight and impact resistant unit. Type S - Suspended has built-in weight.

ROTO-FLOATS can be mounted on a support pipe (type P) or suspended from above (type S). Advantages of the ROTO-FLOAT are low cost, simplicity and reliability.

NOTE: Mercury switches are not to be used in potable water.

MATERIALS OF CONSTRUCTION
Float housing.....Polypropylene
Cable clamp.....Polypropylene
Cable jacket.....P.V.C

Applications
- Pilot Duty
- Industrial Control Equipment

CABLE
P.V.C. type STO #18 conductors (41 strand) rated 600 volts
- Various lengths available
- See table of models
- Non-standard lengths also available on special order.

Ordering information

Switch Arrangement No.	Cable Length	Suspended Type S Model No .	Pipe Mounted Type P Model
Normally Open	20	S20NO	P20NO
	30	S30NO	P30NO
	40	S40NO	P40NO
Normally	20	S20NC	P20NC
	30	S30NC	P30NC

Priced From $27.50

eco-float — Model G

Applications

The Eco-Float can be used in a variety of liquid level monitoring applications including sumps, sewage ejectors, septic tanks, vaults, lift stations, and tanks. Eco-Floats are ruggedly constructed of corrosion resistant materials, enabling them to be used in a variety of different liquids. Some applications are subject to additional requirements described in the National Electric Code.

Description

The Eco-float is a **mercury-free** float switch for controlling liquid levels in a variety of applications. A snap-action switch is activated by a steel ball rolling back and forth within a switching tube in a plastic float housing. There is a minimum differential between “on” and “off” of approximately 3.5 inches. Greater differentials can be achieved when the pipe mounted or externally

FEATURES
- **Mercury Free**
- **Variety of Mounting Styles**
- **Variety of Circuit Configurations**
- **Installation Easy**
- **Differential In One Float**
- **Replaces Diaphragm and Mercury Switches**

Ordering information

Model	Mounting Style	Cable Length*	Circuit Configuration
G	SE (external weight) SI (internal weight) P (pipe mounted)	10” 15” 20” 30” 40” 50”	NO (normally open) NC (normally closed) NONC (normally open/normally closed)

* Custom lengths available.
Example: GSI 20NO - Eco-Float, suspended internal wt. 20’, normally opens contacts.

Priced From $28.00

solo-float

DESCRIPTION

The new Solo-Float" is a direct acting **mercury-free** float switch for controlling 11/2 HP and smaller pump motors. The new Solo-Float has been completely redesigned and uses a metal ball rolling back and forth in a tube to actuate a reliable, snap-action switch. An adjustable, plastic clamp with stainless steel hose clamp is provided for attaching the Solo-Float at the appropriate level on the pump discharge pipe. By varying the tether length, a pumping range of 8" - 14" can be achieved. The Solo-Float is available with a piggyback plug in either a 115 volt or 230 volt configuration. It is also available blunt cut, without a plug, for wiring to an Anchor Scientific JX junction box.

FEATURES
- **Reliability**
- **Adjustable Pumping Range**
- **Manual Operation**
- **Non-mercury Element**
- **Converts Nonautomatic Pumps To Automatic**
- **Replaces Diaphragm Pressure Switches**
- **Easy Installation**
- **In Stock, Low Cost**

Ordering information

Model	Cable Length*	Circuit Configuration	Plug Voltage
D	10’ 15’ 20’ 25’ 30’	NO (normally open) NC (normally closed)	115 for 115 volt 230 for 230 volt

* Custom lengths available.

Example:

Model	Cable Length*	Circuit Configuration	Plug Voltage
D	20’	NO (normally open)	115 for 115 volt

12 APPENDIX B: EQUIPMENT DRAWINGS

WWTP UPGRADE
PROCESS & INSTRUMENTATION DRAWINGS

PO#: 23-880-2 R0
JOB#: 23-053

HEEIA KEA HARBOR-MBBR PACKAGE PLANT
KANEOHE,HI
HONOLULU HAWAII 96744
USA

WORLD WATER WORKS
4000 SOUTHWEST 113TH STREET
OKLAHOMA CITY, OK 73173
USA

REV	DATE	DESCRIPTION	BY
0			SWE.8

World water works
1-800-607-PURE
4000 SW 113th • OKLAHOMA CITY, OK 73137

CLIENT: HEEIA KEA HARBOR-MBBR PACKAGE PLANT
LOCATION: HONOLULU HAWAII 96744
FILE NAME: WWW-HEEIA KEA HARBOR-KANEOHEHI-MBBR PACKAGE PLANT
DESCRIPTION: WWTP UPGRADE

FOR APPROVAL

P.O.#:	23-880-2 R0
DRAWN BY:	SWE.8
CHECKED BY:	
DATE:	8/11/2023
SCALE:	N/A
JOB #:	23-053
DRAWING #:	0601
SHEET:	1 OF 8 SHEETS

06-P&ID

Drawing	Description
01	COVER PAGE
02	DRAWING LIST
03	P&ID KEY
04	PACKAGE PLANT
05	BLOWERS
07	EQUIPMENT LIST
08	EQUIPMENT LIST
09	EQUIPMENT LIST

REV	DATE	DESCRIPTION	BY
0			SWE.8

1-800-607-PURE
World water works
4000 SW 113th • OKLAHOMA CITY, OK 73137

CLIENT: HEEIA KEA HARBOR-MBBR PACKAGE PLANT
LOCATION: HONOLULU HAWAII 96744
FILE NAME: WWW-HEEIA KEA HARBOR-KANEOHEHI-MBBR PACKAGE PLANT
DESCRIPTION: DRAWING LIST

FOR APPROVAL

P.O.#: 23-880-2 R0
DRAWN BY: SWE.8
CHECKED BY:
DATE: 8/11/2023
SCALE: N/A
JOB #: 23-053
DRAWING #: 0602
SHEET: 2 OF 8 SHEETS

LINE IDENTIFICATION

- WASTEWATER / MAIN PROCESS
- WASTEWATER / SLUDGE / AIR
- CHEMICAL / PNEUMATIC TUBING
- FLEXIBLE HOSE / INSTRUMENT CABLE
- ELECTRICAL / CONTROLS
- PROCESS - HEAT TRACED
- PROCESS - INSULATED
- DRAIN / SEWER

CONNECTION / SPECIAL FITTINGS IDENTIFICATION

- FLANGED
- BLIND FLANGE
- HOSE COUPLING
- NPT COUPLING
- SILENCER
- IN-LINE FILTER
- STRAINER
- EXPANSION JOINT

EQUIPMENT SCOPE IDENTIFICATION

WWW EQUIPMENT
BATTERY LIMITS

VALVE IDENTIFICATION & SYMBOLS

- NC — VALVE NORMALLY CLOSED
- KNIFE VALVE
- GATE VALVE
- BALL VALVE
- DIAPHRAGM VALVE
- GLOBE VALVE
- BUTTERFLY VALVE
- NEEDLE VALVE
- CHECK VALVE
- 3-WAY VALVE
- PINCH VALVE
- PLUG VALVE

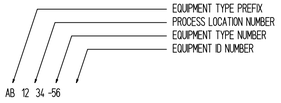
IN-LINE INSTRUMENTS AND ACCESSORIES

- IA / AFC — DIAPHRAGM ACTUATED CONTROL VALVE WITH ELECTROPNEUMATIC CONVERTOR OR ELECTROPNEUMATIC POSITIONER
- M — ELECTRICAL ACTUATED CONTROL VALVE M=MOTOR S=SOLENOID
- SPRING LOADED / MASS LOADED — RELIEF VALVE, SAFETY VALVE
- VENTURI TUBE, FLOW NOZZLE
- FLOW ORIFICE
- DOUBLE ACTING PNEUMATIC ACTUATOR
- SPRING RETURN PNEUMATIC ACTUATOR

INSTRUMENTATION / CONTROL SYMBOLS

- LICSA 101 — LOCALLY MOUNTED INSTRUMENT
- LICSA — FREEZE PROTECTED INSTRUMENT
- VFDxx xx-xx — VARIABLE FREQUENCY DRIVE
- xIC xx-xx — CONTROL PARAMETER INDICATED CONTROL (PRESSURE, FLOW, LEVEL, ETC)
- IA — INSTRUMENT AIR CONNECTION POINT
- PW — POTABLE WATER CONNECTION POINT
- CONTROLS INTERLOCK

TAG NUMBER IDENTIFICATION



EQUIPMENT TYPE PREFIX

LETTERS	EQUIPMENT TYPE
AC	AFTER COOLER HEAT EXCHANGER
AE	ANALYSIS METER (pH, DO, TURBIDITY etc.)
AFR	AIR FLOW REGULATOR
AG	AERATION GRID COMPONENTS
BL	BLOWER
BM	BIOMEDIA
C	COMPRESSOR, FAN
CP	CHEMICAL PUMP
CV	CONTROL VALVE
DAF	DISSOLVED AIR FLOTATION UNIT
DP	DISSOLVED AIR GENERATOR PUMP
DW	DE-WATERING UNIT / SLUDGE FILTER PRESS
FE	FLOW METER
FS	FLOW SWITCH
LE	LEVEL TRANSMITTER
LS	LEVEL SWITCH
M	MOTOR
MX	AGITATOR, MIXER
PE	PRESSURE TRANSMITTER
PS	PRESSURE SWITCH
RG	RAKE GEAR
RP	RECIRCULATION PUMP
SM	SOLENOID MANIFOLD
SP	SLUDGE PUMP
SV	SOLENOID VALVE
TK	TANK / BASIN
TP	TRANSFER PUMP
V	MANUAL VALVE
_IT	INSTRUMENT CONTROLLER / TRANSMITTER
__S	SCREEN OR SIEVE

PROCESS /EQ TYPE NUMBER

NUMBER	PROCESS LOCATION	EQ TYPE NUMBER
01		MAJOR EQUIPMENT
02	TRANSFER SYSTEM	TANKS
03	PRE-SCREENING	AERATION GRID COMPONENT
04	TRANSFER SYSTEM	MANUAL VALVES
05	EQUALIZATION	CONTROL VALVES (ON/OFF)
06	TRANSFER SYSTEM	DISCREET OUTPUT
07	PRIMARY SEPARATION	DISCREET INPUT
08	TRANSFER SYSTEM	ANALOG OUTPUT
09	BIOLOGICAL PROCESS	ANALOG INPUT
10	SECONDARY SEPARATION	PUMPS
11	TRANSFER SYSTEM	CHEMICAL PUMPS
12	FILTRATION	BLOWERS
13	TRANSFER SYSTEM	COMPRESSORS
14	WATER REUSE	HEAT EXCHANGERS
15	SLUDGE STORAGE	MIXERS
16	DEWATERING	
17		
18		
19		
20		MISCELLANEOUS

EQUIPMENT SYMBOLS

- CENTRIFUGAL / DAG PUMP
- AERATION BLOWER
- CHEMICAL METERING PUMP
- CHEMICAL PERISTALTIC PUMP
- STATIC MIXER
- DISSOLVED AIR FLOTATION
- ROTARY SCREEN
- SIDEHILL SCREEN
- MIXER
- BAR SCREEN
- BIOMEDIA
- AFTERCOOLER

ELECTRICAL SYMBOLS

- FIELD-MOUNTED START PUSH-BUTTON
- FIELD-MOUNTED STOP PUSH-BUTTON
- SS — FIELD-MOUNTED SAFETY STOP PUSH-BUTTON
- FIELD-MOUNTED START/STOP PUSH BUTTON
- FIELD-MOUNTED SELECTOR SWITCH
- PANEL-MOUNTED PILOT LIGHT "RUNNING"
- PANEL-MOUNTED PILOT LIGHT "ALARM"
- PANEL-MOUNTED START/STOP PUSH-BUTTONS
- PANEL-MOUNTED SELECTOR SWITCH
- M — MOTOR
- G — GENERATOR

REV	DATE	DESCRIPTION	BY
0			SWE.8

World water works
1-800-607-PURE
4000 SW 113th * OKLAHOMA CITY, OK 73137

CLIENT: HEEIA KEA HARBOR-MBBR PACKAGE PLANT
LOCATION: HONOLULU HAWAII 96744
FILE NAME: WWW-HEEIA KEA HARBOR-KANEOHEHI-MBBR PACKAGE PLANT
DESCRIPTION: P&ID KEY

FOR APPROVAL

P.O.#: 23-880-2 R0
DRAWN BY: SWE.8
CHECKED BY:
DATE: 8/11/2023
SCALE: N/A
JOB #: 23-053
DRAWING #: 0603
SHEET: 3 OF 8 SHEETS

2. CUSTOMER PIPING SHALL BE INDEPENDENTLY SUPPORTED
3. BLOWER PIPING/ARRANGEMENT TO BE CONFIRMED BY ENGINEER
4. LOCAL DISCONNECTS BY OTHERS

AIR
CHEMICAL
ELECTRICAL
EHT & INSUL
SLUDGE

PLC CONTROL PANEL

FROM BL0912-01*

FROM BL0912-02*

FROM BL0912-03*

ENERGIZE DO — SV 306-01
HIGH LEVEL AI — LSH 507-01
PMP 510-01: IN REMOTE DI, IN LOCAL DI, LEAK DETECT DI, OVER TEMP DI, COMMON FAIL DI, RUNNING DI, START DO
PMP 520-01: IN REMOTE DI, IN LOCAL DI, LEAK DETECT DI, OVER TEMP DI, COMMON FAIL DI, RUNNING DI, START DO
FLOW AI — FIT 609-01
LEVEL INDICATION AI — LIT 609-01
HIGH LEVEL DI — LSH 607-01
VLV 608-01: IN REMOTE DI, IN LOCAL DI, POSITION INDICATION AI, POSITION CONTROL AO, OPENED DI, CLOSED DI
RUN SPEED AO — CP 011-01
DO TRANSMITTER AI — AE 909-01
MIX 015-01: IN REMOTE DI, IN LOCAL DI, RUNNING DI, FAIL DI, START COMMAND DO
START COMMAND DO — CP 011-04
RUN SPEED AI — CP 011-03
FAULT DI — CP 011-02
RUNNING DI — CP 011-01
MIX 015-01: IN REMOTE DI, IN LOCAL DI, RUNNING DI, FAIL DI, START COMMAND DO
HIGH LEVEL DI — LSH 011-01
PMP 010-01: IN REMOTE DI, IN LOCAL DI, LEAK DETECT DI, OVER TEMP DI, COMMON FAIL DI, RUNNING DI, START DO
PMP 020-01: IN REMOTE DI, IN LOCAL DI, LEAK DETECT DI, OVER TEMP DI, COMMON FAIL DI, RUNNING DI, START DO
LOW-LOW LEVEL AI — LSLL 507-02
LOW LEVEL AI — LSL 507-01
HIGH LEVEL AI — LSH 507-02
HIGH-HIGH LEVEL AI — LSHH 507-03
FLOW AI — FIT 809-01

INFLUENT(BY OTHERS)

WP — 1" — SV0306-01 120VAC — 4"

SHS0301-01
SCREEN-SHS 1838
PP
SIDE HILL SCREEN

6"

FROM TP0510-01
OR TP0510-02

LS0507-01 24 VDC — LS
PV0609-01
PV0611-01
PV0610-01
FIT0609-01
PV0608-01
LIT0509-01
S0909-02
TP0510-01
TP0520-01
HP
HP
AG0503-01
S0909-03

TK0502-01
EQ TANK
POLYPROPYLENE
8'-0" W x 5'-0" L x 7'-0" H x 5'-0" SWD (~ 2,100 GALLONS)

LS0907-01 — LS
S0909-01
S0909-05
AG0903-01

TK0902-01
MBBR 1
POLYPROPYLENE
8'-0" W x 3'-0" L x 6'-0" H x 4'-0" SWD (~ 1,100 GALLONS)

CP1011-01
POLYMER
120 VAC

CP0911-01
ANTI-FOAM
120 VAC

AIT — AIT0909-01
AE0909-01 DO — AE
S0909-04
S0909-06
AG0903-02

TK0902-02
MBBR 2
POLYPROPYLENE
8'-0" W x 3'-0" L x 6'-0" H x 4'-0" SWD (~ 1,100 GALLONS)

MX1015-02
MX1015-01

LS-1011-01 — LS
PV1015-01
PV1016-01
TP1010-01
TP1020-01
HP
HP

TK1002-01
CLARIFIER
POLYPROPYLENE
8'-0" W x 4'-0" L x 8'-0" H x 6'-0" SWD (~ 1,450 GALLONS)

LS1507-04 24 VDC — LS
LS1507-03 24 VDC — LS
LS1507-02 24 VDC — LS
LS1507-01 24 VDC — LS
6"
6" X 3" By Others
3"
FIT0809-01
AG01503-01

TK1502-01
SLUDGE STORAGE
POLYPROPYLENE
8'-0" W x 10'-0" L x 8'-0" H x 7'-0" SWD (~ 4,200 GALLONS)

EFFLUENT(BY OTHERS)

WWW CONFIDENTIAL

REV	DATE	DESCRIPTION
0		

World water works
1-800-807-PURE
4000 SW 113th • OKLAHOMA CITY, OK 73137

CLIENT: HEEIA KEA HARBOR-MBBR PACKAGE PLANT
LOCATION: HONOLULU HAWAII 96744
FILE NAME: WWW-HEEIA KEA HARBOR-KANEOHEHI-MBBR PACKAGE PLANT
DESCRIPTION: PACKAGE PLANT

FOR APPROVAL
P.O.#: 23-880-2 R0
DRAWN BY: SWE.8
CHECKED BY:
DATE: 8/11/2023
SCALE: N/A
JOB #: 23-053
DRAWING # 0604
SHEET 4 OF 8 SHEETS

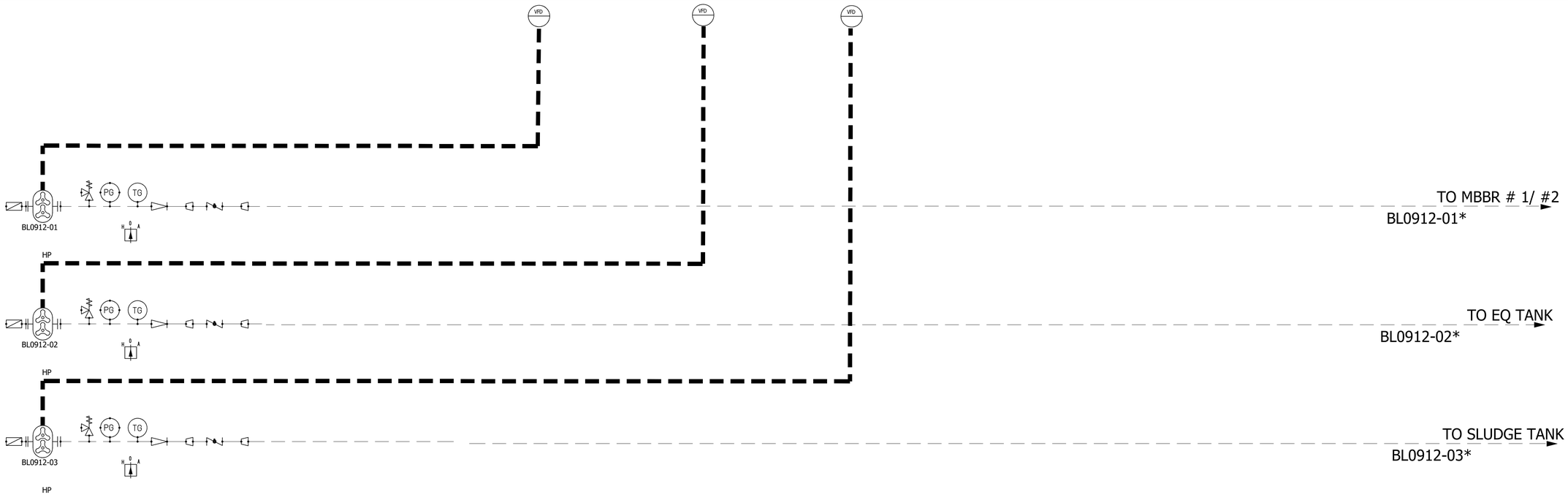
NOT FOR CONSTRUCTION

1. WWW SCOPE DEFINED BY RED DOTTED LINES
2. CUSTOMER PIPING SHALL BE INDEPENDENTLY SUPPORTED
3. BLOWER PIPING/ARRANGEMENT TO BE CONFIRMED BY ENGINEER

MAIN
SECONDARY
FLEX
AIR
CHEMICAL
ELECTRICAL

BL R12-01J DI OVER TEMPERATURE	BL R12-02J DI OVER TEMPERATURE	BL R12-03J DI OVER TEMPERATURE
BL R12-01H DI OFF	BL R12-02H DI OFF	BL R12-03H DI OFF
BL R12-01G AO SPEED CONTROL	BL R12-02G AO SPEED CONTROL	BL R12-03G AO SPEED CONTROL
BL R12-01F AI SPEED FEEDBACK	BL R12-02F AI SPEED FEEDBACK	BL R12-03F AI SPEED FEEDBACK
BL R12-01E DO START COMMAND	BL R12-02E DO START COMMAND	BL R12-03E DO RUN
BL R12-01D DI DRIVE ALARM/FAULT	BL R12-02D DI DRIVE ALARM/FAULT	BL R12-03D DI DRIVE ALARM/FAULT
BL R12-01C DI COMMON FAIL	BL R12-02C DI COMMON FAIL	BL R12-03C DI COMMON FAIL
BL R12-01B DI RUNNING	BL R12-02B DI RUNNING	BL R12-03B DI RUNNING
BL R12-01A DI REMOTE	BL R12-02A DI REMOTE	BL R12-03A DI REMOTE

PLC CONTROL PANEL



WWW CONFIDENTIAL

REV	DATE	DESCRIPTION	BY
0			SWE.8

World water works
1-800-807-PURE
4008 SW 113th • OKLAHOMA CITY, OK 73137

CLIENT: HEEIA KEA HARBOR-MBBR PACKAGE PLANT
LOCATION: HONOLULU HAWAII 96744
FILE NAME: WWW-HEEIA KEA HARBOR-KANEOHEHI-MBBR PACKAGE PLANT
DESCRIPTION: BLOWERS

FOR APPROVAL

P.O.#:	23-880-2 R0
DRAWN BY:	SWE.8
CHECKED BY:	
DATE:	8/11/2023
SCALE:	N/A
JOB #:	23-053
DRAWING #:	0605
SHEET: OF	5 8 SHEETS

01-MAJOR EQUIPMENTS

TAG NUMBER	EQUIPMENT LOCATION	EQUIPMENT NAME	WWW PART NUMBER	MANUFACTURER	MODEL NUMBER	MATERIAL OF CONSTRUCTION	MAX FLOW	MAX PRESSURE	DIMENSIONS	PROCESS FLUID	HP	VOLTAGE
MEDIA	MBBR1,MBBR2	MBBR MEDIA	87555	WWW	WWW-01V	HDPE			650 M2/M3			
SHS0301-01	SCREENING	SIDE HILL SCREEN	71082	WWW	SCREEN-SHS 1838	PP	150 MAX GPM	TBD' TDH	18 Inch W x 38 Inch H	WASTEWATER		

02-TANKS

TAG NUMBER	EQUIPMENT LOCATION	EQUIPMENT NAME	WWW PART NUMBER	MANUFACTURER	MODEL NUMBER	MATERIAL OF CONSTRUCTION	MAX FLOW	MAX PRESSURE	DIMENSIONS	PROCESS FLUID	HP	VOLTAGE
J01XX-32	POLYMER	WELDED	88042	WWW								
TK0502-01	EQ TANK	RECTANGULAR TANK	88058	WWW	TANK-PPR-2100	POLYPROPYLENE			8'-0" W x 5'-0" L x 7'-0" H x 5'-0" SWD (~ 2,100 GALLONS)	WASTEWATER		
TK0902-01	MBBR 1	RECTANGULAR TANK	88058	WWW	TANK-PPR-1100	POLYPROPYLENE			8'-0" W x 3'-0" L x 6'-0" H x 4'-0" SWD (~ 1,100 GALLONS)	WASTEWATER		
TK0902-02	MBBR 2	RECTANGULAR TANK	88058	WWW	TANK-PPR-1100	POLYPROPYLENE			8'-0" W x 3'-0" L x 6'-0" H x 4'-0" SWD (~ 1,100 GALLONS)	WASTEWATER		
TK1002-01	CLARIFIER	RECTANGULAR TANK	88058	WWW	TANK-PPR-1600	POLYPROPYLENE			8'-0" W x 4'-0" L x 8'-0" H x 6'-0" SWD (~ 1,450 GALLONS)	WASTEWATER		
TK1502-01	SLUDGE STORAGE	RECTANGULAR TANK	88059	WWW	TANK-PPR-3800	POLYPROPYLENE			8'-0" W x 10'-0" L x 8'-0" H x 7'-0" SWD (~ 4,200 GALLONS)	WASTEWATER		

05-AERATION MANIFOLDS

TAG NUMBER	EQUIPMENT LOCATION	EQUIPMENT NAME	WWW PART NUMBER	MANUFACTURER	MODEL NUMBER	MATERIAL OF CONSTRUCTION	MAX FLOW	MAX PRESSURE	DIMENSIONS	PROCESS FLUID	HP	VOLTAGE
AG0503-01	EQ TANK	COARSE BUBBLE	89900	WWW	TBD	SS316			6"	AIR		
AG0903-01	MBBR 1	COARSE BUBBLE	89900	WWW	TBD	SS316			6"	AIR		
AG0903-02	MBBR 2	COARSE BUBBLE	89900	WWW	TBD	SS316			6"	AIR		
AG01503-01	SLUDGE STORAGE	COARSE BUBBLE	89900	WWW	TBD	SS316			6"	AIR		

06-MIXERS

TAG NUMBER	EQUIPMENT LOCATION	EQUIPMENT NAME	WWW PART NUMBER	MANUFACTURER	MODEL NUMBER	MATERIAL OF CONSTRUCTION	MAX FLOW	MAX PRESSURE	DIMENSIONS	PROCESS FLUID	HP	VOLTAGE
MX1015-01	CLARIFIER	TOP MOUNT MIXER	TBD	NEPTUNE	JD-3.3						1/2	
MX1015-02	POLYMER MIXING TANK	TOP MOUNT MIXER	TBD	NEPTUNE	JD-3.3						1/2	

07-PUMPS

TAG NUMBER	EQUIPMENT LOCATION	EQUIPMENT NAME	WWW PART NUMBER	MANUFACTURER	MODEL NUMBER	MATERIAL OF CONSTRUCTION	MAX FLOW	MAX PRESSURE	DIMENSIONS	PROCESS FLUID	HP	VOLTAGE
TP0510-01	MBBR FEED	SUBMERSIBLE PUMP	20408	PENTAIR	SX50-03	CAST IRON	35 GPM		2" x 2"		1/2 HP	208 VAC
TP0520-01	MBBR FEED	SUBMERSIBLE PUMP	20408	PENTAIR	SX50-03	CAST IRON	35 GPM		2" x 2"		1/2 HP	208 VAC
TP1010-01	MBBR FEED	SUBMERSIBLE PUMP	20408	PENTAIR	SX50-03	CAST IRON	35 GPM		2" x 2"		1/2 HP	208 VAC
TP1020-01	MBBR FEED	SUBMERSIBLE PUMP	20408	PENTAIR	SX50-03	CAST IRON	35 GPM		2" x 2"		1/2 HP	208 VAC

08-CHEMICAL PUMPS

TAG NUMBER	EQUIPMENT LOCATION	EQUIPMENT NAME	WWW PART NUMBER	MANUFACTURER	MODEL NUMBER	MATERIAL OF CONSTRUCTION	MAX FLOW	MAX PRESSURE	DIMENSIONS	PROCESS FLUID	HP	VOLTAGE
CP0911-01	MBBR 1 & 2 ANTI-FOAM	CHEMICAL PUMP	TBD	LMI	E711-468SI	FLUROFILM			0.375"	ANTI-FOAM		120 VAC

REV	DATE	DESCRIPTION	BY
0			SWE.8

1-800-607-PURE
World water works
4008 SW 113th • OKLAHOMA CITY, OK 73137

CLIENT: HEEIA KEA HARBOR-MBBR PACKAGE PLANT
LOCATION: HONOLULU HAWAII 96744
FILE NAME: WWW-HEEIA KEA HARBOR-KANEOHEHI-MBBR PACKAGE PLANT
DESCRIPTION: EQUIPMENT LIST

FOR APPROVAL

P.O.#: 23-880-2 R0
DRAWN BY: SWE.8
CHECKED BY:
DATE: 8/11/2023
SCALE: N/A
JOB #: 23-053
DRAWING #: 0607
SHEET: 6 OF 8 SHEETS

-> 08-CHEMICAL PUMPS

TAG NUMBER	EQUIPMENT LOCATION	EQUIPMENT NAME	WWW PART NUMBER	MANUFACTURER	MODEL NUMBER	MATERIAL OF CONSTRUCTION	MAX FLOW	MAX PRESSURE	DIMENSIONS	PROCESS FLUID	HP	VOLTAGE
CP1011-01	CLARIFIER POLYMER	CHEMICAL PUMP	TBD	LMI	E711-468SI	FLUROFILM			.375"	POLYMER		120 VAC

09-SIEVES

TAG NUMBER	EQUIPMENT LOCATION	EQUIPMENT NAME	WWW PART NUMBER	MANUFACTURER	MODEL NUMBER	MATERIAL OF CONSTRUCTION	MAX FLOW	MAX PRESSURE	DIMENSIONS	PROCESS FLUID	HP	VOLTAGE
S0909-01	MBBR1	MBBR SIEVE (OVERFLOW)	E-10079	WWW		SS316			12"D x 1'L	WASTEWATER		
S0909-02	MBBR1	MBBR SIEVE (OVERFLOW)	E-10079	FEDERAL SCREEN	MBBR-SIEV-12Other	SS316			12" D X 1' L	WASTEWATER		
S0909-03	MBBR1	MBBR SIEVE (OVERFLOW)	E-10079	FEDERAL SCREEN	MBBR-SIEV-12Other	SS316			12" D X 1' L	WASTEWATER		
S0909-04	MBBR2	MBBR SIEVE (OVERFLOW)	E-10079	WWW		SS316			12"D x 1'L	WASTEWATER		
S0909-05	MBBR2	MBBR SIEVE (OVERFLOW)	E-10079	FEDERAL SCREEN	MBBR-SIEV-12Other	SS316			12" D X 1' L	WASTEWATER		
S0909-06	MBBR2	MBBR SIEVE (OVERFLOW)	E-10079	FEDERAL SCREEN	MBBR-SIEV-12Other	SS316			12" D X 1' L	WASTEWATER		

09-SPECIAL PARTS

TAG NUMBER	EQUIPMENT LOCATION	EQUIPMENT NAME	WWW PART NUMBER	MANUFACTURER	MODEL NUMBER	MATERIAL OF CONSTRUCTION	MAX FLOW	MAX PRESSURE	DIMENSIONS	PROCESS FLUID	HP	VOLTAGE
FIT0609-01	MBBR FEED LINE	GROUNDING RING	40206	ENDRESS+HAUSER	DK5GD-50AEL	316SS			2"	WASTEWATER		
FIT0609-01	MBBR FEED LINE	GROUNDING RING	40206	ENDRESS+HAUSER	DK5GD-50AEL	316SS			2"	WASTEWATER		
FIT0809-01	EFFLUENT LINE	GROUNDING RING	40207	ENDRESS+HAUSER	DK5GD-80AEL	316SS			3"	WASTEWATER		
FIT0809-01	EFFLUENT LINE	GROUNDING RING	40207	ENDRESS+HAUSER	DK5GD-80AEL	316SS			3"	WASTEWATER		

10-VALVES

TAG NUMBER	EQUIPMENT LOCATION	EQUIPMENT NAME	WWW PART NUMBER	MANUFACTURER	MODEL NUMBER	MATERIAL OF CONSTRUCTION	MAX FLOW	MAX PRESSURE	DIMENSIONS	PROCESS FLUID	HP	VOLTAGE
PV0608-01	MBBR FEED LINE	Electric Ball Valve	45236	VALWORX	587722	DUCTILE IRON			2"			24 VDC
PV0609-01	EQ TANK	MANUAL BALL VALVE	55325	HAYWARD	TB1200ST	PVC/VITON			2"			
PV0610-01	EQ TANK	MANUAL BALL VALVE	55325	HAYWARD	TB1200ST	PVC/VITON			2"			
PV0611-01	EQ TANK	MANUAL BALL VALVE	55325	HAYWARD	TB1200ST	PVC/VITON			2"			
PV1015-01	CLARIFIER	MANUAL BALL VALVE	55325	HAYWARD	TB1200ST	PVC/VITON			2"			
PV1016-01	CLARIFIER	MANUAL BALL VALVE	55325	HAYWARD	TB1200ST	PVC/VITON			2"			
SV0306-01	SCREENING	SOLENOID	TBD	ASCO	EF8210G054-120/60	BRASS			1"	WATER		120VAC

11-ANALYTICAL DEVICES

TAG NUMBER	EQUIPMENT LOCATION	EQUIPMENT NAME	WWW PART NUMBER	MANUFACTURER	MODEL NUMBER	MATERIAL OF CONSTRUCTION	MAX FLOW	MAX PRESSURE	DIMENSIONS	PROCESS FLUID	HP	VOLTAGE
AE0909-01	MBBR	DO	36105	HACH	9020000	CPVC, SS316 CAP, ACRYLIC			1" NPT	WASTEWATER		
AE0909-01	MBBR	DO PROBE MOUNTING KIT	36015	HACH	5794400							
AIT0909-01	MBBR	sc4500 TRANSMITTER	40056	HACH	LXV525.99A11551	POLYCARBONATE			1/2" CONDUIT			

REV	DATE	DESCRIPTION	BY
0			SWE.8

World water works
1-800-607-PURE
4008 SW 113th * OKLAHOMA CITY, OK 73137

CLIENT: HEEIA KEA HARBOR-MBBR PACKAGE PLANT
LOCATION: HONOLULU HAWAII 96744
FILE NAME: WWW-HEEIA KEA HARBOR-KANEOHEHI-MBBR PACKAGE PLANT
DESCRIPTION: EQUIPMENT LIST

FOR APPROVAL

P.O.#: 23-880-2 R0
DRAWN BY: SWE.8
CHECKED BY:
DATE: 8/11/2023
SCALE: N/A
JOB #: 23-053
DRAWING #: 0608
SHEET: 7 OF 8 SHEETS

12-INSTRUMENTATION

TAG NUMBER	EQUIPMENT LOCATION	EQUIPMENT NAME	WWW PART NUMBER	MANUFACTURER	MODEL NUMBER	MATERIAL OF CONSTRUCTION	MAX FLOW	MAX PRESSURE	DIMENSIONS	PROCESS FLUID	HP	VOLTAGE
FIT0609-01	MBBR FEED LINE	ELECTROMAGNETIC FLOWMETER	40426	ENDRESS+HAUSER	5W4C50-C6ELHA0DUA1KGA				2"	WASTEWATER		
FIT0809-01	EFFLUENT LINE	ELECTROMAGNETIC FLOWMETER	40427	ENDRESS+HAUSER	5W4C80-C6ELHA0DUA1KGA				3"	WASTEWATER		
LIT0509-01	EQ TANK	LEVEL SENSOR	TBD	WIKA	LM 40.04					WASTEWATER		24 VDC
LS0507-01	EQ TANK	FLOAT LEVEL	89952	ANCHOR SCIENTIFIC	S40NO	POLYPROPYLENE			40' LONG CABLE	WASTEWATER		24 VDC
LS0907-01	MBBR1	FLOAT LEVEL	89952	ANCHOR SCIENTIFIC	S40NO	POLYPROPYLENE			40' LONG CABLE	WASTEWATER		
LS-1011-01	CLARIFIER	FLOAT LEVEL	89952	ANCHOR SCIENTIFIC	S40NO	POLYPROPYLENE			40' LONG CABLE	WASTEWATER		
LS1507-01	SLUDGE TANK	FLOAT LEVEL	89952	ANCHOR SCIENTIFIC	S40NO	POLYPROPYLENE			40' LONG CABLE	WASTEWATER		24 VDC
LS1507-02	SLUDGE TANK	FLOAT LEVEL	89952	ANCHOR SCIENTIFIC	S40NO	POLYPROPYLENE			40' LONG CABLE	WASTEWATER		24 VDC
LS1507-03	SLUDGE TANK	FLOAT LEVEL	89952	ANCHOR SCIENTIFIC	S40NO	POLYPROPYLENE			40' LONG CABLE	WASTEWATER		24 VDC
LS1507-04	SLUDGE TANK	FLOAT LEVEL	89952	ANCHOR SCIENTIFIC	S40NO	POLYPROPYLENE			40' LONG CABLE	WASTEWATER		24 VDC

REV	DATE	DESCRIPTION	BY
0			SWE.8

1-800-607-PURE
World water works
4000 SW 113th • OKLAHOMA CITY, OK 73137

CLIENT: HEEIA KEA HARBOR-MBBR PACKAGE PLANT
LOCATION: HONOLULU HAWAII 96744
FILE NAME: WWW-HEEIA KEA HARBOR-KANEOHEHI-MBBR PACKAGE PLANT
DESCRIPTION: EQUIPMENT LIST

FOR APPROVAL

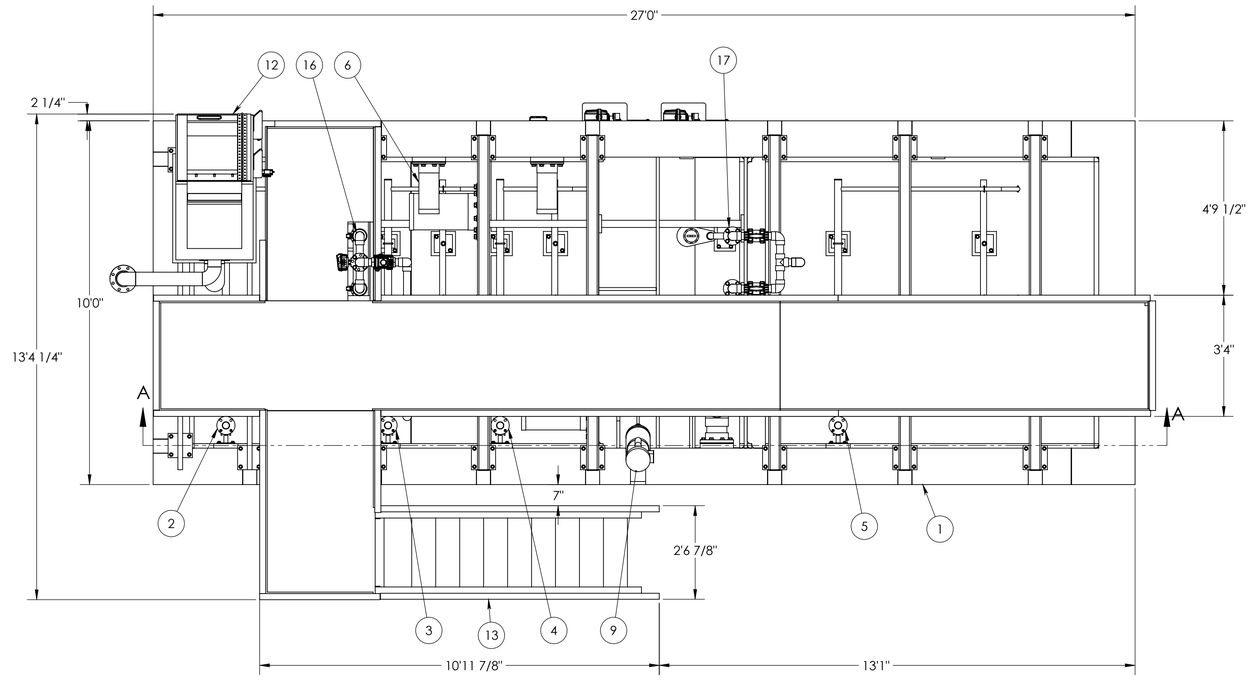
P.O.#: 23-880-2 R0
DRAWN BY: SWE.8
CHECKED BY:
DATE: 8/11/2023
SCALE: N/A
JOB #: 23-053
DRAWING #: 0609
SHEET: 8 OF 8 SHEETS

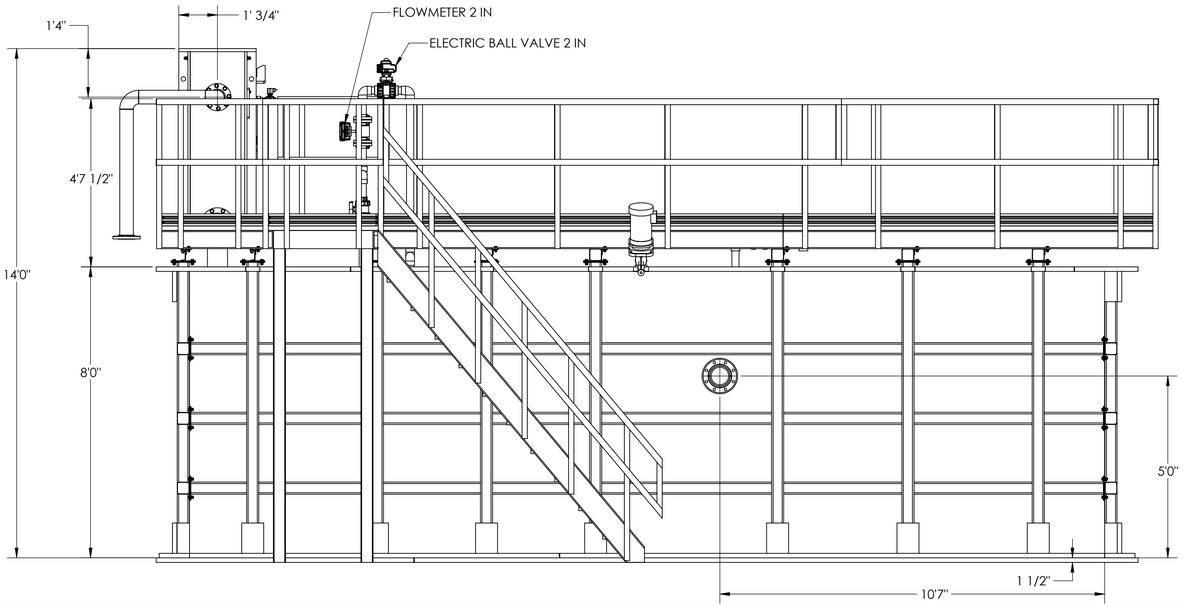
GENERAL NOTES

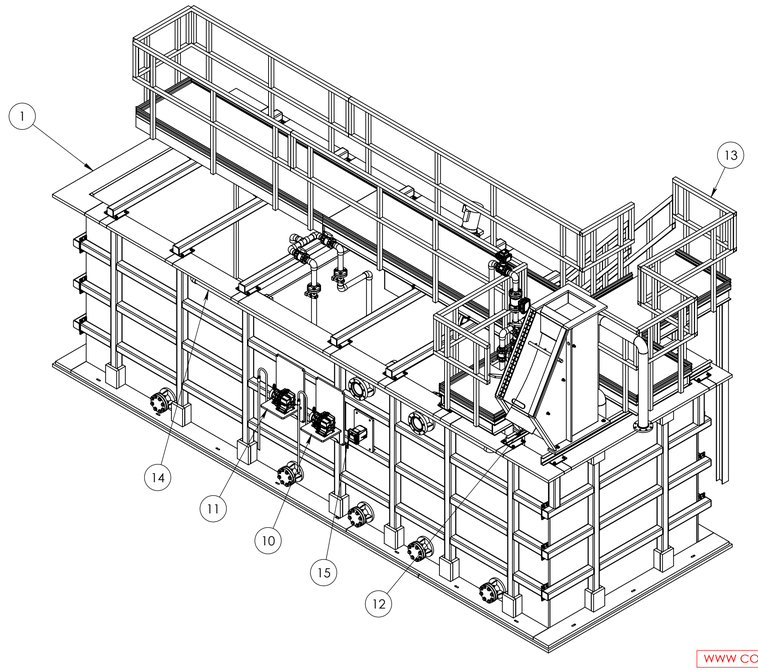
1. ALL IS TO BE CONSTRUCTED GREY FROM HIGH IMPACT NATURAL STRESS RELIEVED, VIRGIN COPOLYMER POLYPROPYLENE. U.O.W.S
2. SERVICE: WASTE WATER @ 40°F ~ 130°F
3. ALL FLANGES TWO-HOLED TO THE CENTER LINE
4. STEEL REINFORCEMENTS TO BE: CARBON STEEL HOT-DIPPED GALVANIZED
5. ALL DIMENSIONS SHOWN APPLY TO AMBIENT TEMPERATURE (NON-EXPAND)
6. A SPREADER BEAM IS REQUIRED TO BE DESIGNED TO ENSURE VERTICAL OR MINIMUM OUTWARD LIFT
7. SOME HIDDEN LINES AND COMPONENTS OMITTED FOR CLARITY
8. ALL GASKET MATERIAL TO BE 3/16" THK. BUNA-N
9. ALL FASTENERS TO BE 304 SS
10. HYDRO. TEST TO BE COMPLETED BEFORE SHIPMENT

MBBR PACKAGE PLANT
27 FT L X 10 FT W X 8 FT H

ITEM NO.	DESCRIPTION
1	TANK ASSY 27 FT L X 10 FT W X 8 FT H
2	AERATION GRID ASSY-2 INCH -3 FT X 6 FT LG -36 IN SPACED RH - SS316 (EQ ZONE)
3	AERATION GRID ASSY-2 INCH -2.5 FT X 6 FT LG -36 IN SPACED RH - SS316 (MBBR #1)
4	AERATION GRID ASSY-2 INCH -2.5 FT X 6 FT LG -36 IN SPACED RH - SS316 (MBBR #2)
5	AERATION GRID ASSY-2 INCH -5 FT X 6 FT LG -36 IN SPACED RH - SS316 (SLUDGE)
6	MBBR OVERFLOW SIEVE, 6 INCH DIA X 12 INCH LG - 2 NOS.
7	MBBR DRAIN SIEVE, 4 INCH DIA X 12 INCH LG - 2 NOS.
8	MBBR SIEVE, 12 INCH DIA X 18 INCH LG - 2 NOS.
9	MIXER - JD 3.3 (1/2 HP, 460 V)
10	CHEMICAL SHELF - ANTI FOAM
11	CHEMICAL SHELF - POLYMER BATCH FEED
12	SHS-18
13	WALKWAY
14	SLUDGE TO EQ ZONE OVERFLOW PIPE - PVC - 2 IN
15	INSTRUMENT CONTROL PANEL
16	EQ TO MBBR TRANSFER PIPING WITH PUMP - 2 IN
17	CLARIFIER TO SLUDGE TRANSFER PIPING WITH PUMP - 2 IN







WWW CONFIDENTIAL

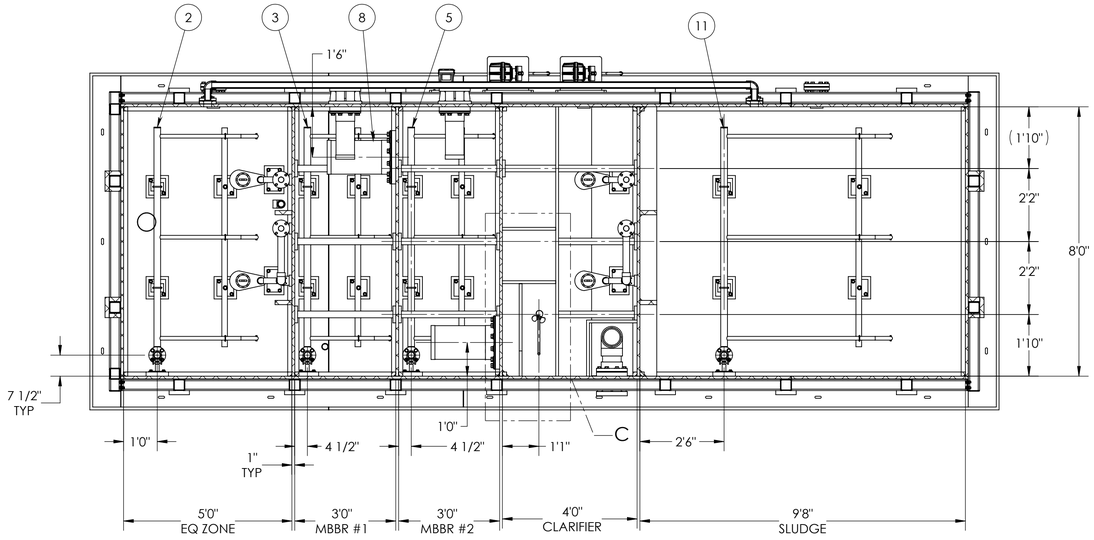
REV	DATE	DESCRIPTION	BY
R00	12/05/23	INTERNAL REVIEW	SRC
R01	01/18/24	FOR APPROVAL	TA

World water works

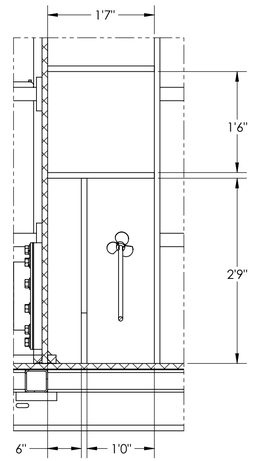
CLIENT: OCEANIC COMPANIES - HEEIA KEA BOAT HARBOR
LOCATION: KAPOLEI - HI
FILE NAME: 23053-0701
DESCRIPTION: GENERAL ARRANGEMENT

FOR APPROVAL

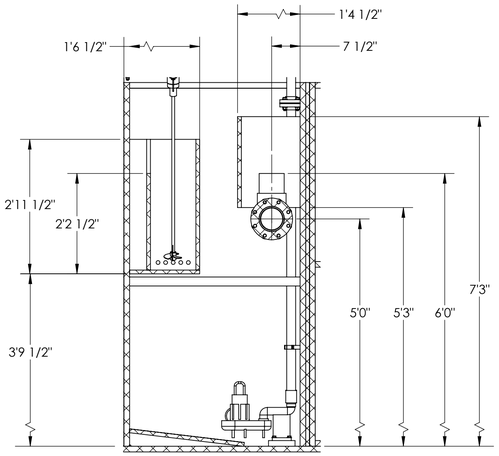
P.O.#: 23-880-2 R0
DRAWN BY: SRC
REVIEWED BY: GH
DATE: 12/05/23
SCALE: 1:50
JOB #: 23-053
DRAWING # 0701
SHEET: 1 OF 2 SHEETS



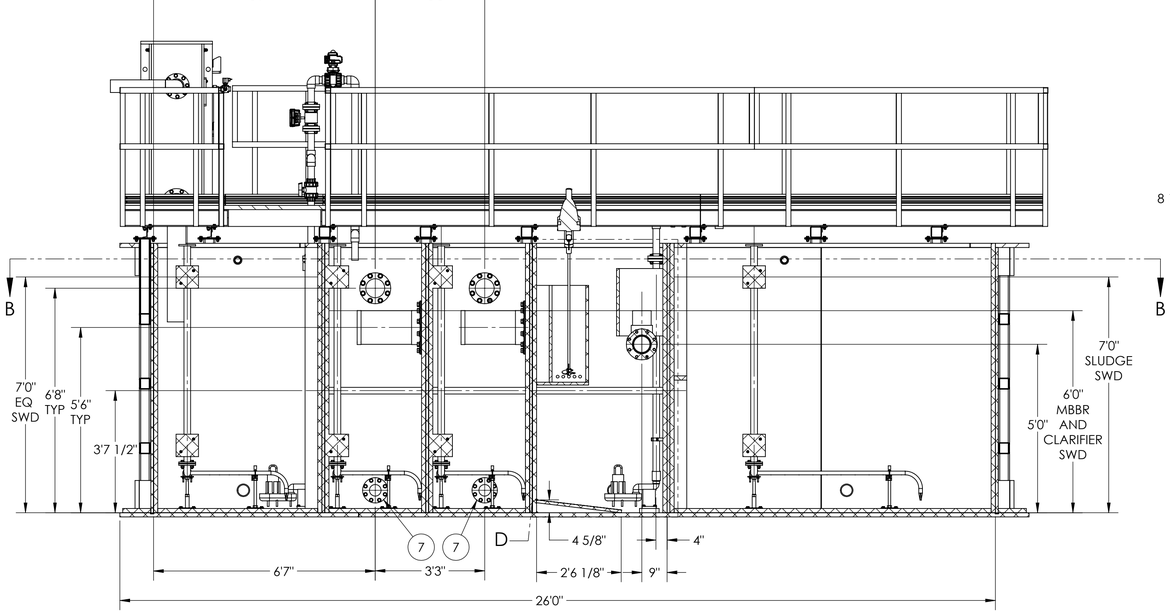
SECTION B-B
SCALE 1 : 27



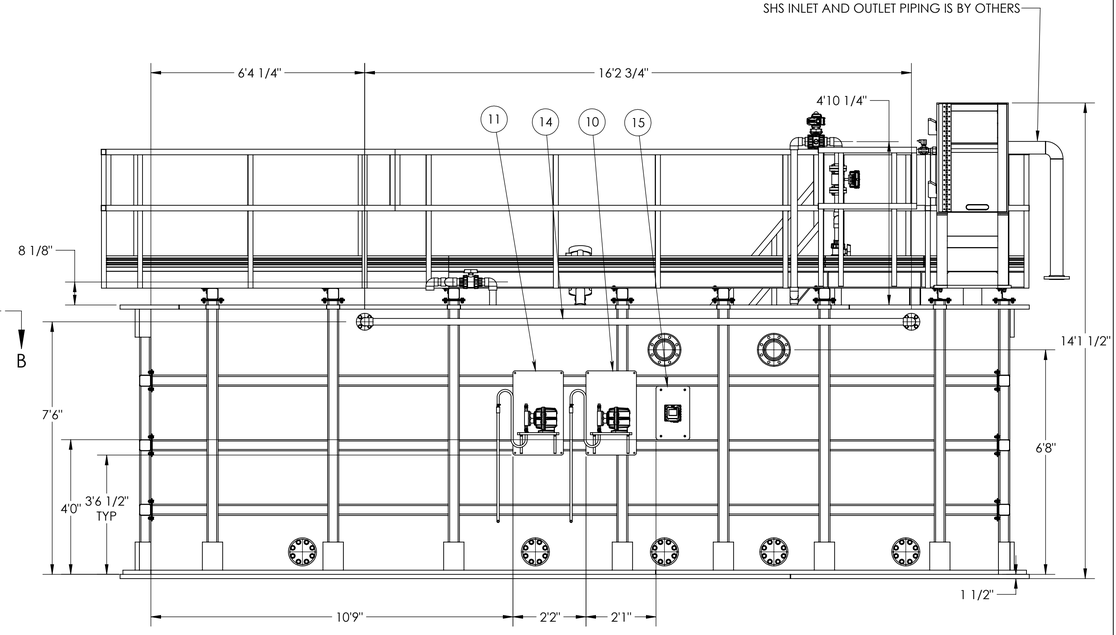
DETAIL C
SCALE 2 : 27



DETAIL D
SCALE 1 : 20



SECTION A-A
SCALE 1 : 27



BACK SIDE VIEW

WWW CONFIDENTIAL

REV	DATE	DESCRIPTION	BY
R00	12/05/23	INTERNAL REVIEW	SRC
R01	01/18/24	FOR APPROVAL	TA

World water works

CLIENT: OCEANIC COMPANIES - HEEIA KEA BOAT HARBOR
LOCATION: KAPOLEI - HI
FILE NAME: 23053-0701
DESCRIPTION: GENERAL ARRANGEMENT

FOR APPROVAL

P.O.#: 23-880-2 R0
DRAWN BY: SRC
REVIEWED BY: GH
DATE: 12/05/23
SCALE: 1:30
JOB #: 23-053
DRAWING # 0701
SHEET: 2 OF 2 SHEETS

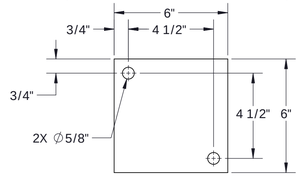
GENERAL NOTES

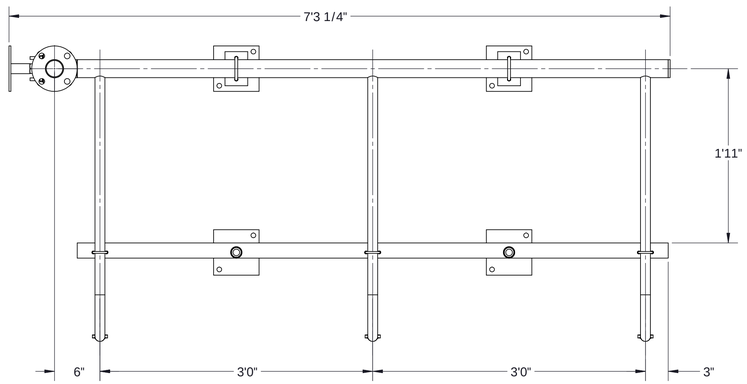
1. ALL IS TO BE CONSTRUCTED FROM 316 STAINLESS STEEL
2. SERVICE: WASTE WATER @ 40 ˚F ~ 130 ˚F
3. ALL FLANGES TWO-HOLED TO THE CENTER LINE
4. ALL DIMENSIONS SHOWN APPLY TO AMBIENT TEMPERATURE (NONEXPAND)
5. SOME HIDDEN LINES AND COMPONENTS OMITTED FOR CLARITY
6. ALL FASTENERS AND ANCHOR BOLTS SHALL TO BE 316 SS.

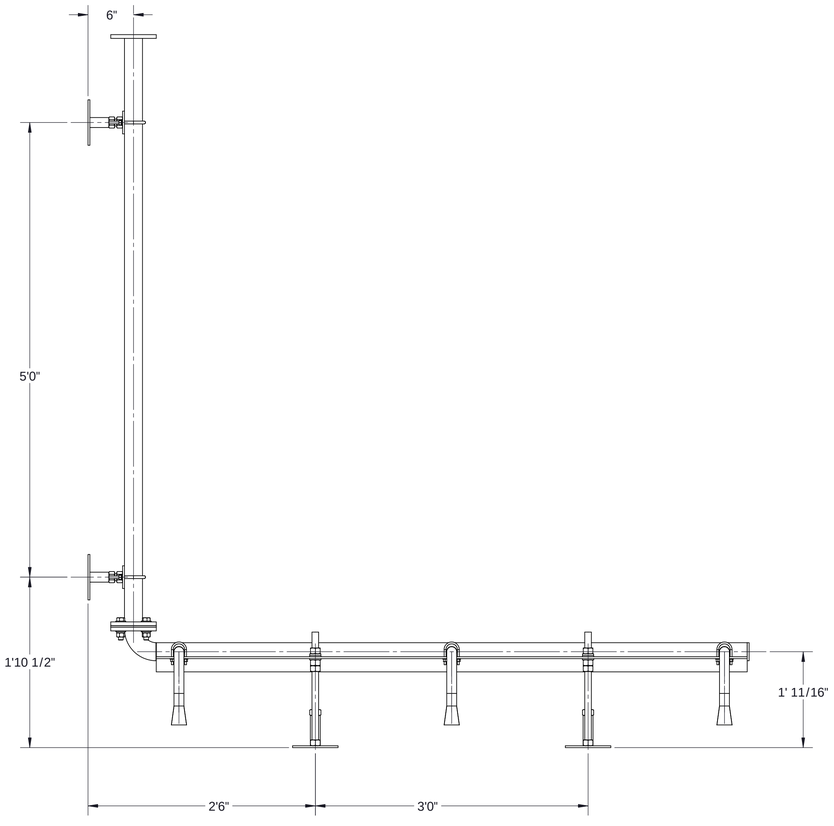
EQ ZONE AERATION GRID
QTY - 1 NO.

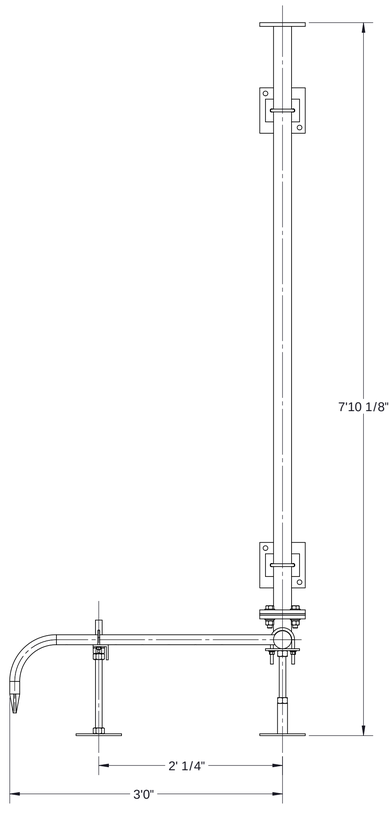
ITEM NO.	DESCRIPTION
1	AERATION GRID ASSY 2 INCH - 3 FT X 6 FT LG -36 IN SPACED - RH
2	DROP PIPE 2 INCH - 6 FT 6 IN LG
3	MANIFOLD SUPPORT ASSY 2 INCH
4	DROP PIPE SUPPORT ASSY 2 INCH
5	DIFFUSER THREADED SUPPORT

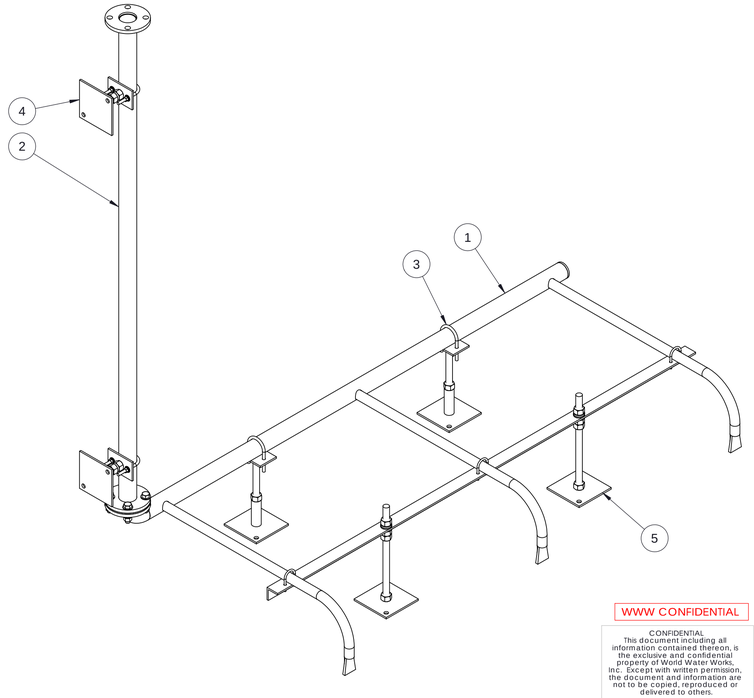
ANCHORING HOLE DETAILS
DIA 5/8" - 2NOS. PER SUPPORT
(6 NOS. PER GRID)
(TOTAL QTY - 6 NOS.)











WWW CONFIDENTIAL

REV	DATE	DESCRIPTION	BY
R00	12/06/23	INITIAL REVIEW	TA
R01	12/06/23	FOR APPROVAL	TA

World water works

CLIENT: OCEANIC COMPANIES - HEEIA KEA BOAT HARBOR
LOCATION: KAPOLEI - HI
FILE NAME: 23053-0702
DESCRIPTION: EQ ZONE AERATION GRID

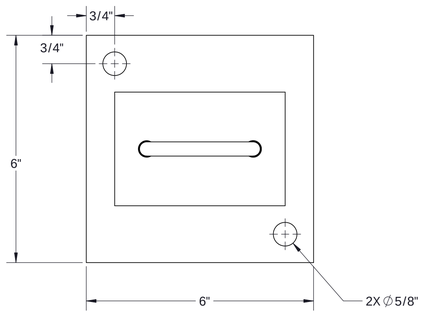
FOR APPROVAL

P.O.#: 23-880-2 R0
DRAWN BY: TA
REVIEWED BY: GH
DATE: 12/06/23
SCALE: 1:10
JOB #: 23-053
DRAWING # 0702
SHEET: 1 OF 2 SHEETS

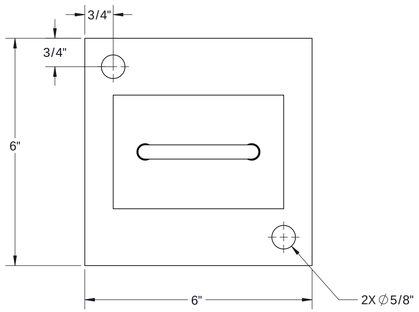
AERATION GRID SUPPORTS

ITEM NO.	MATERIAL	DESCRIPTION
1	SS316	WASH, 3/8" F/W
2	SS316	HEX NUT, 3/8"-16
3	SS316	WASHER, LOCK, SS316, 3/8"
4	SS316	HEX NUT, 7/8" HX NUT
5	SS316	LK WASH, 7/8" SPLIT L/W
6	SS316	WASH, 7/8" F/W
7	SS316	U-BOLT, SS, 3/8-16NC X 4 7/16 IN LG
8	SS316	PLATE, 1/4" X 4" X 4 1/2" LG
9	SS316	ALL THREADED ROD 7/8"-9 X 4" LG
10	SS316	PIPE, SS, SCH 10, 1" X 2 -1/2" LG
11	SS316	BASE PLATE, 1/4" X 6" X 6"
12	SS316	ALL THREADED ROD 7/8"-9 X 9" LG
13	SS316	PIPE, SS, SCH 10, 1" X 4" LG
14	SS316	ALL THREADED ROD 7/8"-9 X 15" LG

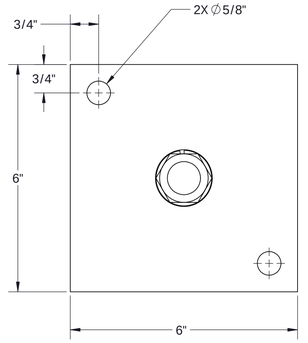
2 IN DROP PIPE SUPPORTS
QUANTITY: 2 NOS.

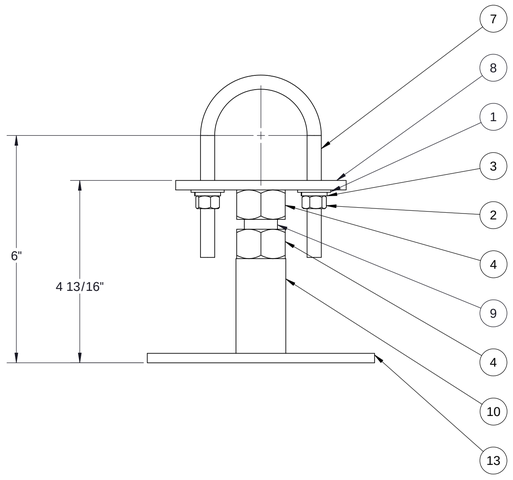


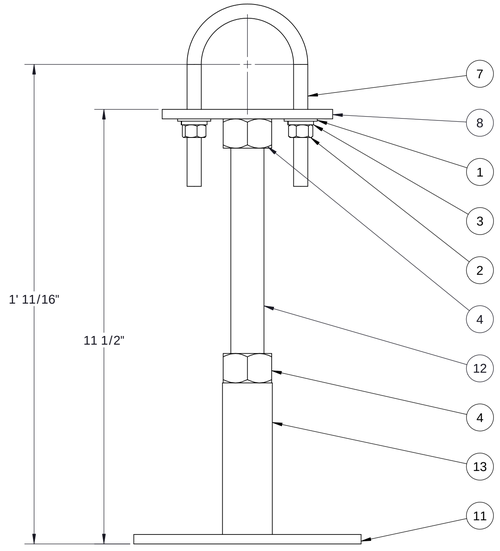
2 IN PIPE SUPPORTS
QUANTITY: 2 NOS.

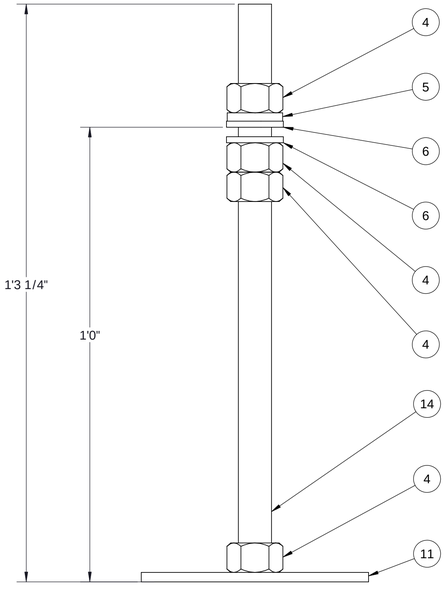


DIFFUSER SUPPORTS
QUANTITY: 2 NOS.









REV	DATE	DESCRIPTION	BY
R00	12/06/23	INITIAL REVIEW	TA
R01	12/06/23	FOR APPROVAL	TA

World water works

CLIENT: OCEANIC COMPANIES - HEEIA KEA BOAT HARBOR
LOCATION: KAPOLEI - HI
FILE NAME: 23053-0702
DESCRIPTION: EQ ZONE AERATION GRID

FOR APPROVAL

P.O.#: 23-880-2 R0

DRAWN BY: TA

REVIEWED BY: GH

DATE: 12/06/23

SCALE: 1:2

JOB #: 23-053

DRAWING # 0702

SHEET: 2 OF 2 SHEETS

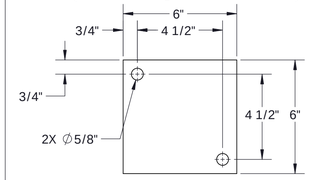
GENERAL NOTES

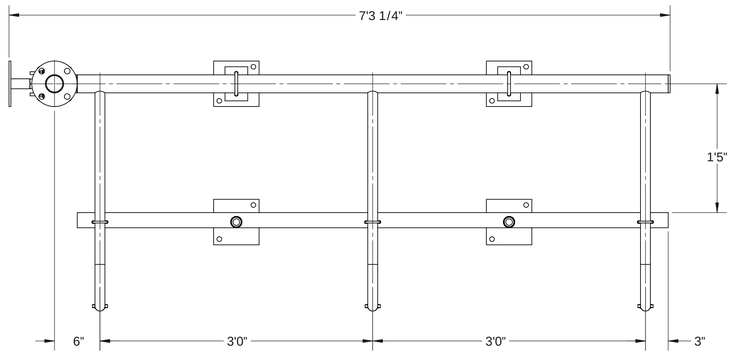
1. ALL IS TO BE CONSTRUCTED FROM 316 STAINLESS STEEL
2. SERVICE: WASTE WATER @ 40 ˚F ~ 130 ˚F
3. ALL FLANGES TWO-HOLED TO THE CENTER LINE
4. ALL DIMENSIONS SHOWN APPLY TO AMBIENT TEMPERATURE (NONEXPAND)
5. SOME HIDDEN LINES AND COMPONENTS OMITTED FOR CLARITY
6. ALL FASTENERS AND ANCHOR BOLTS SHALL TO BE 316 SS.

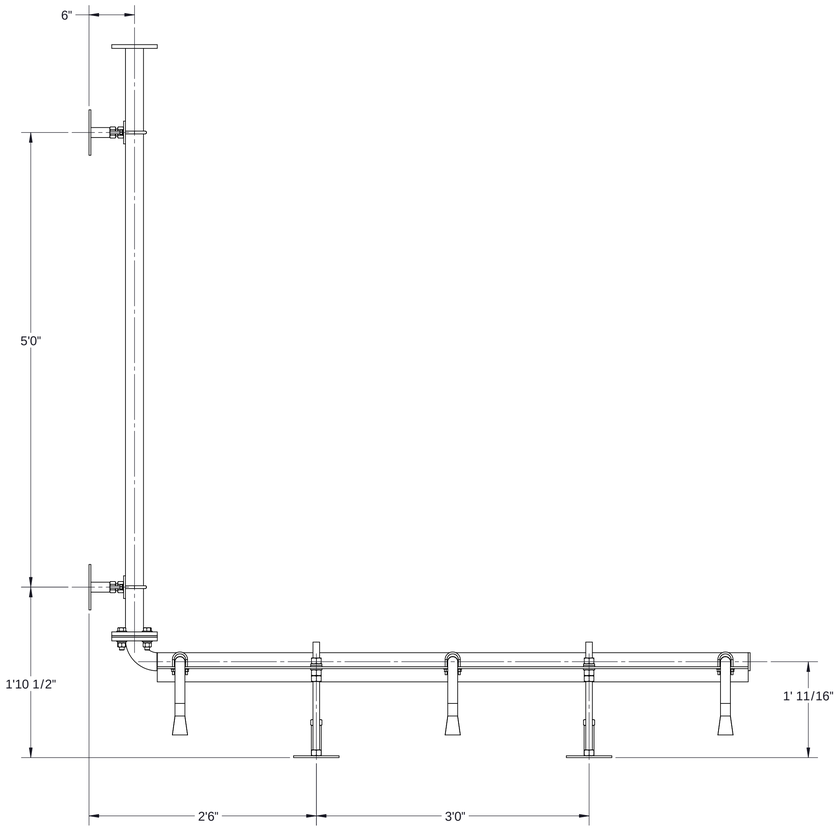
MBBR#1 AERATION GRID
QTY - 1 NO.

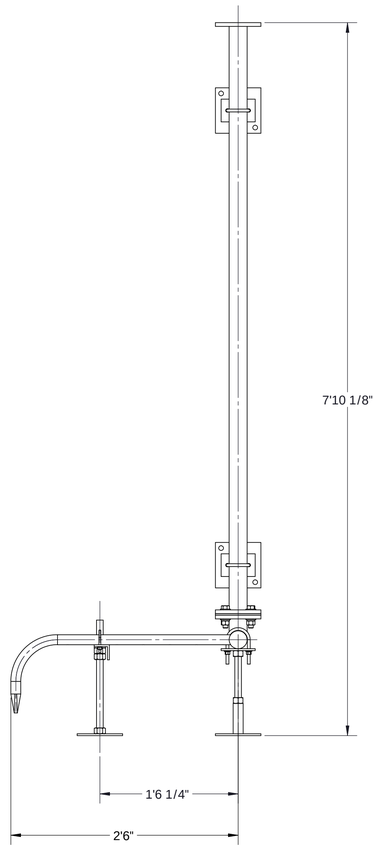
ITEM NO.	DESCRIPTION
1	AERATION GRID ASSY 2 INCH - 2 FT 6 IN X 6 FT LG -36 IN SPACED - RH
2	DROP PIPE 2 INCH - 6 FT 6 IN LG
3	MANIFOLD SUPPORT ASSY 2 INCH
4	DROP PIPE SUPPORT ASSY 2 INCH
5	DIFFUSER THREADED SUPPORT

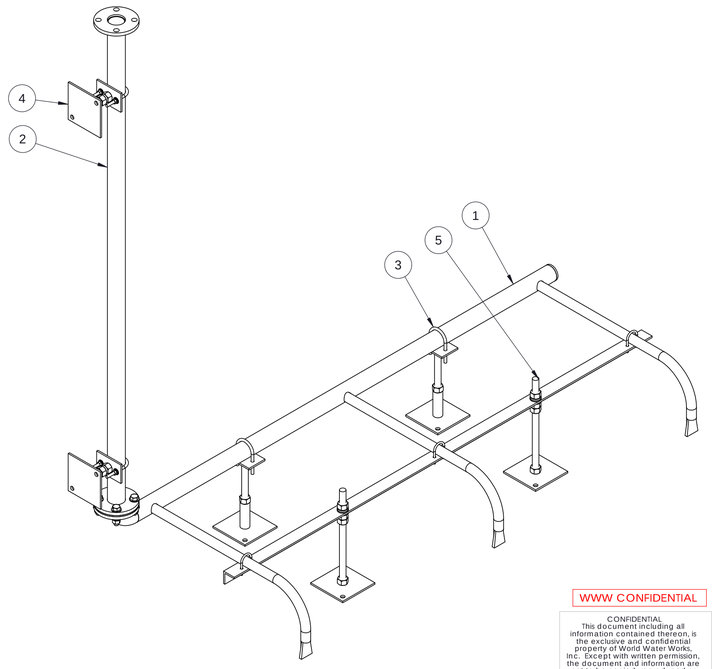
ANCHORING HOLE DETAILS
DIA 5/8" - 2NOS. PER SUPPORT
(6 NOS. PER GRID)
(TOTAL QTY - 6 NOS.)











WWW CONFIDENTIAL

REV	DATE	DESCRIPTION	BY
R00	12/06/23	INITIAL REVIEW	TA
R01	12/06/23	FOR APPROVAL	TA

World water works

CLIENT: OCEANIC COMPANIES - HEEIA KEA BOAT HARBOR
LOCATION: KAPOLEI - HI
FILE NAME: 23053-0703
DESCRIPTION: MBBR#1 AERATION GRID

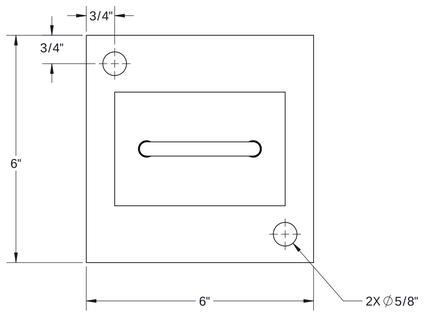
FOR APPROVAL

P.O.#: 23-880-2 R0
DRAWN BY: TA
REVIEWED BY: GH
DATE: 12/06/23
SCALE: 1:10
JOB #: 23-053
DRAWING # 0703
SHEET: 1 OF 2 SHEETS

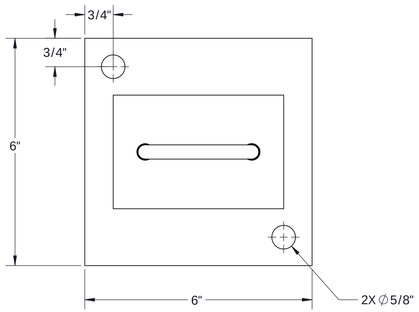
AERATION GRID SUPPORTS

ITEM NO.	MATERIAL	DESCRIPTION
1	SS316	WASH, 3/8" F/W
2	SS316	HEX NUT, 3/8"-16
3	SS316	WASHER, LOCK, SS316, 3/8"
4	SS316	HEX NUT, 7/8" HX NUT
5	SS316	LK WASH, 7/8" SPLIT L/W
6	SS316	WASH, 7/8" F/W
7	SS316	U-BOLT, SS, 3/8-16NC X 4 7/16 IN LG
8	SS316	PLATE, 1/4" X 4" X 4 1/2" LG
9	SS316	ALL THREADED ROD 7/8"-9 X 4" LG
10	SS316	PIPE, SS, SCH 10, 1" X 2 -1/2" LG
11	SS316	BASE PLATE, 1/4" X 6" X 6"
12	SS316	ALL THREADED ROD 7/8"-9 X 9" LG
13	SS316	PIPE, SS, SCH 10, 1" X 4" LG
14	SS316	ALL THREADED ROD 7/8"-9 X 15" LG

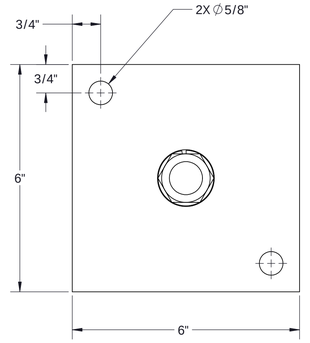
2 IN DROP PIPE SUPPORTS
QUANTITY: 2 NOS.

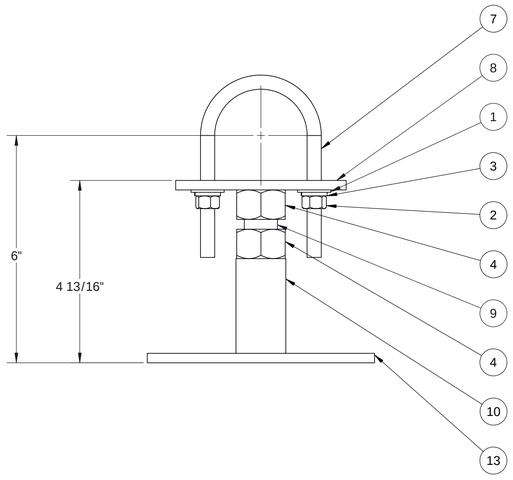


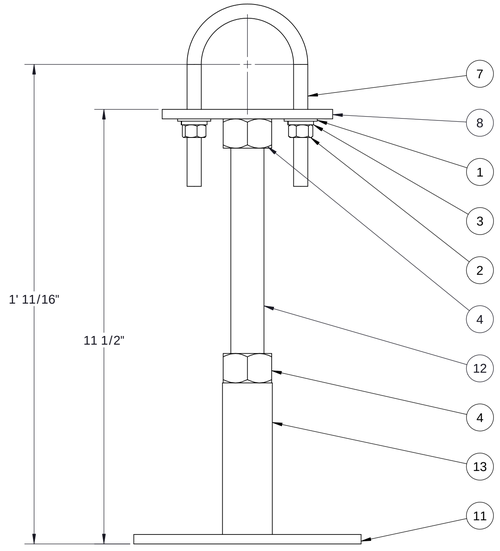
2 IN PIPE SUPPORTS
QUANTITY: 2 NOS.

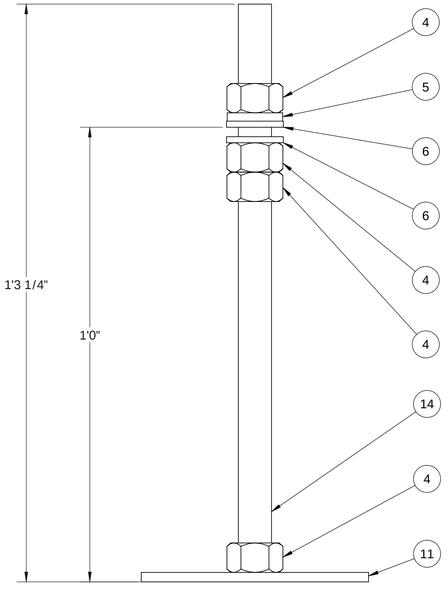


DIFFUSER SUPPORTS
QUANTITY: 2 NOS.









WWW CONFIDENTIAL

REV	DATE	DESCRIPTION	BY
R00	12/06/23	INITIAL REVIEW	TA
R01	12/06/23	FOR APPROVAL	TA

World water works

CLIENT: OCEANIC COMPANIES - HEEIA KEA BOAT HARBOR
LOCATION: KAPOLEI - HI
FILE NAME: 23053-0703
DESCRIPTION: MBBR#1 AERATION GRID

FOR APPROVAL

P.O.#: 23-880-2 R0

DRAWN BY: TA

REVIEWED BY: GH

DATE: 12/06/23

SCALE: 1:2

JOB #: 23-053

DRAWING # 0703

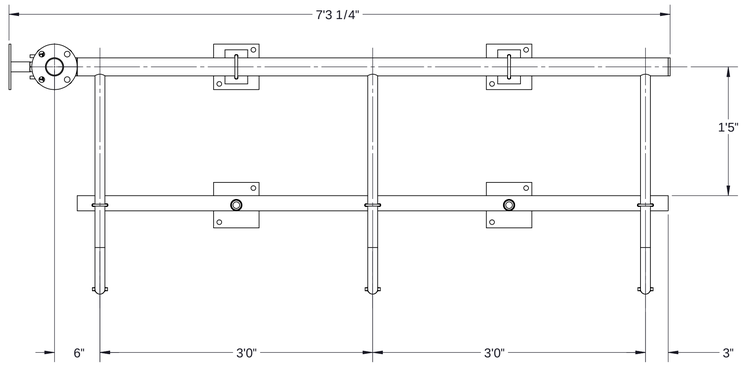
SHEET: 2 OF 2 SHEETS

GENERAL NOTES

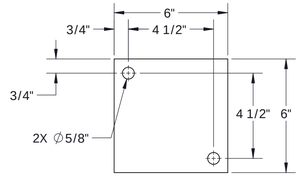
1. ALL IS TO BE CONSTRUCTED FROM 316 STAINLESS STEEL
2. SERVICE: WASTE WATER @ 40 ˚F ~ 130 ˚F
3. ALL FLANGES TWO-HOLED TO THE CENTER LINE
4. ALL DIMENSIONS SHOWN APPLY TO AMBIENT TEMPERATURE (NONEXPAND)
5. SOME HIDDEN LINES AND COMPONENTS OMITTED FOR CLARITY
6. ALL FASTENERS AND ANCHOR BOLTS SHALL TO BE 316 SS.

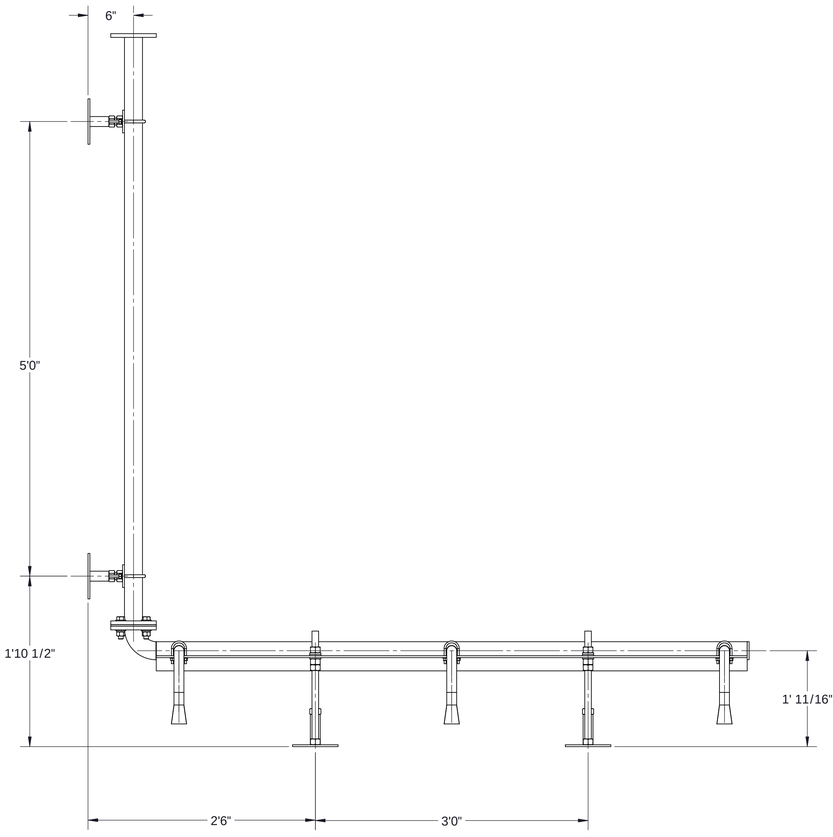
MBBR#2 AERATION GRID
QTY - 1 NO.

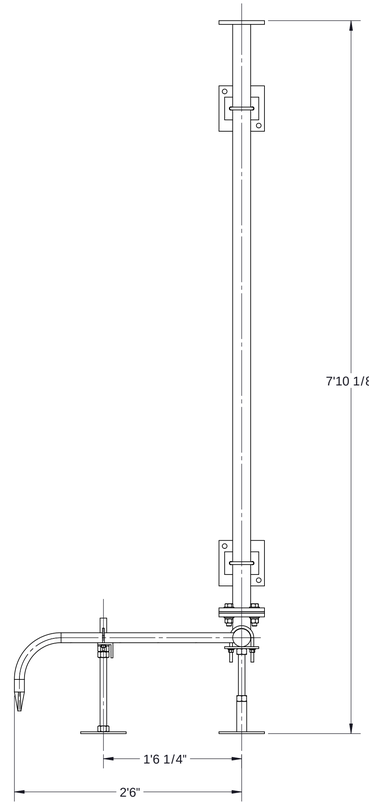
ITEM NO.	DESCRIPTION
1	AERATION GRID ASSY 2 INCH - 2 FT 6 IN X 6 FT LG -36 IN SPACED - RH
2	DROP PIPE 2 INCH - 6 FT 6 IN LG
3	MANIFOLD SUPPORT ASSY 2 INCH
4	DROP PIPE SUPPORT ASSY 2 INCH
5	DIFFUSER THREADED SUPPORT

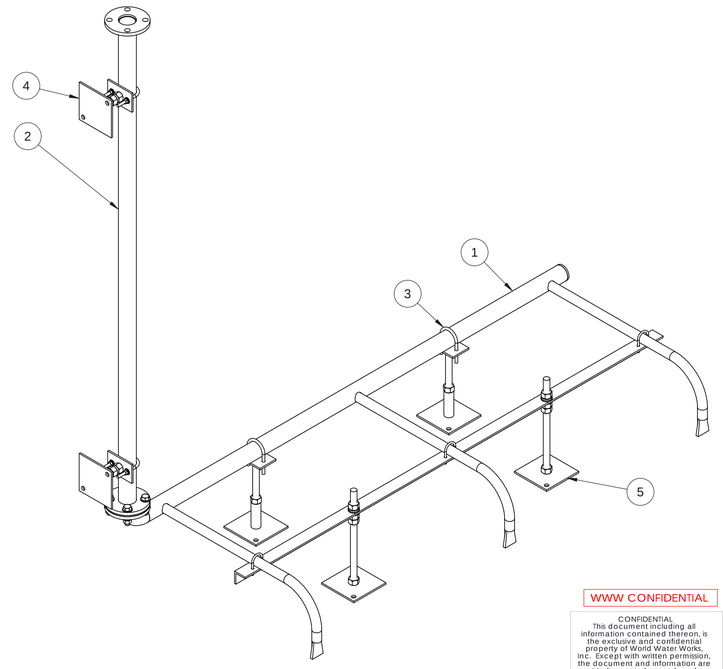


ANCHORING HOLE DETAILS
DIA 5/8" - 2NOS. PER SUPPORT
(6 NOS. PER GRID)
(TOTAL QTY - 6 NOS.)









WWW CONFIDENTIAL

REV	DATE	DESCRIPTION	BY
R00	12/06/23	INITIAL REVIEW	TA
R01	12/06/23	FOR APPROVAL	TA

World water works

CLIENT: OCEANIC COMPANIES - HEEIA KEA BOAT HARBOR
LOCATION: KAPOLEI - HI
FILE NAME: 23053-0704
DESCRIPTION: MBBR#2 AERATION GRID

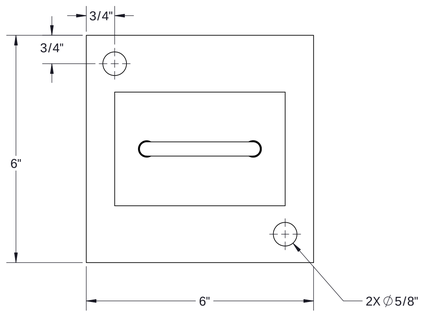
FOR APPROVAL

P.O.#: 23-880-2 R0
DRAWN BY: TA
REVIEWED BY: GH
DATE: 12/06/23
SCALE: 1:10
JOB #: 23-053
DRAWING # 0704
SHEET: 1 OF 2 SHEETS

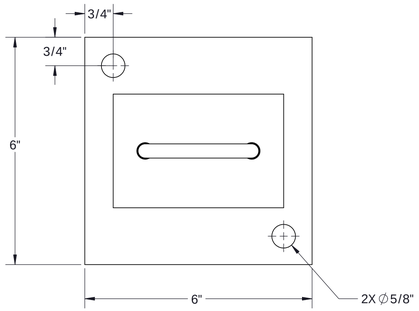
AERATION GRID SUPPORTS

ITEM NO.	MATERIAL	DESCRIPTION
1	SS316	WASH, 3/8" F/W
2	SS316	HEX NUT, 3/8"-16
3	SS316	WASHER, LOCK, SS316, 3/8"
4	SS316	HEX NUT, 7/8" HX NUT
5	SS316	LK WASH, 7/8" SPLIT L/W
6	SS316	WASH, 7/8" F/W
7	SS316	U-BOLT, SS, 3/8-16NC X 4 7/16 IN LG
8	SS316	PLATE, 1/4" X 4" X 4 1/2" LG
9	SS316	ALL THREADED ROD 7/8"-9 X 4" LG
10	SS316	PIPE, SS, SCH 10, 1" X 2 -1/2" LG
11	SS316	BASE PLATE, 1/4" X 6" X 6"
12	SS316	ALL THREADED ROD 7/8"-9 X 9" LG
13	SS316	PIPE, SS, SCH 10, 1" X 4" LG
14	SS316	ALL THREADED ROD 7/8"-9 X 15" LG

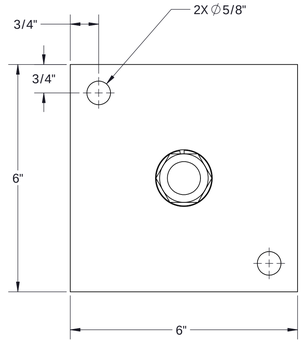
2 IN DROP PIPE SUPPORTS
QUANTITY: 2 NOS.

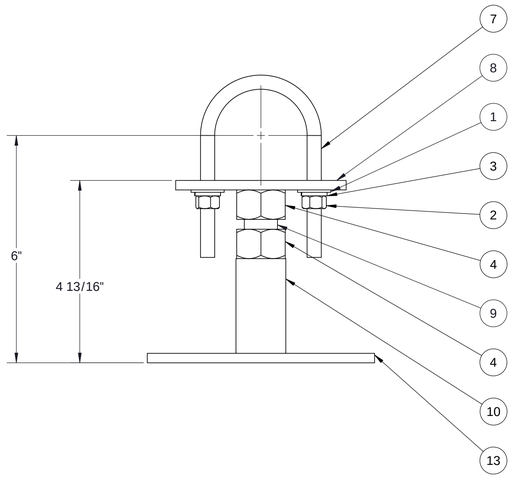


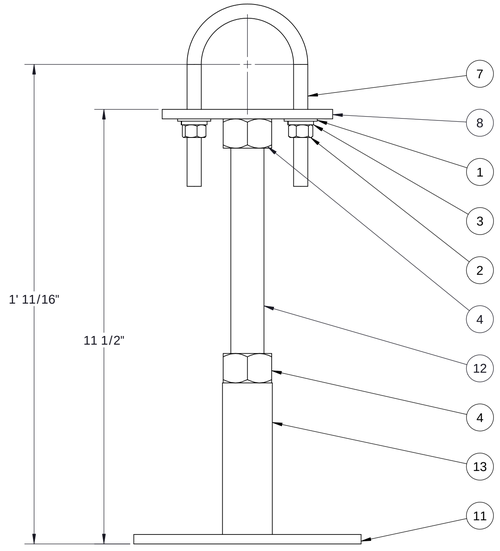
2 IN PIPE SUPPORTS
QUANTITY: 2 NOS.

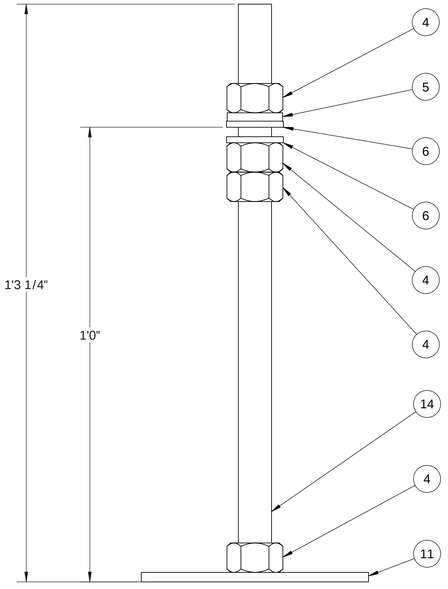


DIFFUSER SUPPORTS
QUANTITY: 2 NOS.









WWW CONFIDENTIAL

REV	DATE	DESCRIPTION	BY
R00	12/06/23	INITIAL REVIEW	TA
R01	12/06/23	FOR APPROVAL	TA

World water works

CLIENT: OCEANIC COMPANIES - HEEIA KEA BOAT HARBOR
LOCATION: KAPOLEI - HI
FILE NAME: 23053-0704
DESCRIPTION: MBBR#2 AERATION GRID

FOR APPROVAL

P.O.#: 23-880-2 R0

DRAWN BY: TA

REVIEWED BY: GH

DATE: 12/06/23

SCALE: 1:2

JOB #: 23-053

DRAWING # 0704

SHEET: 2 OF 2 SHEETS

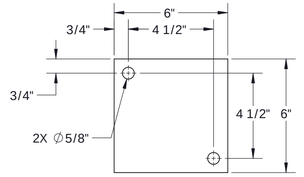
GENERAL NOTES

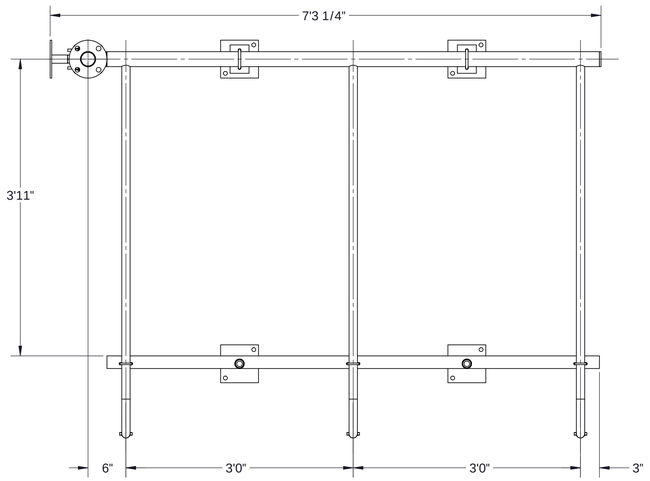
1. ALL IS TO BE CONSTRUCTED FROM 316 STAINLESS STEEL
2. SERVICE: WASTE WATER @ 40 ˚F ~ 130 ˚F
3. ALL FLANGES TWO-HOLED TO THE CENTER LINE
4. ALL DIMENSIONS SHOWN APPLY TO AMBIENT TEMPERATURE (NONEXPAND)
5. SOME HIDDEN LINES AND COMPONENTS OMITTED FOR CLARITY
6. ALL FASTENERS AND ANCHOR BOLTS SHALL TO BE 316 SS.

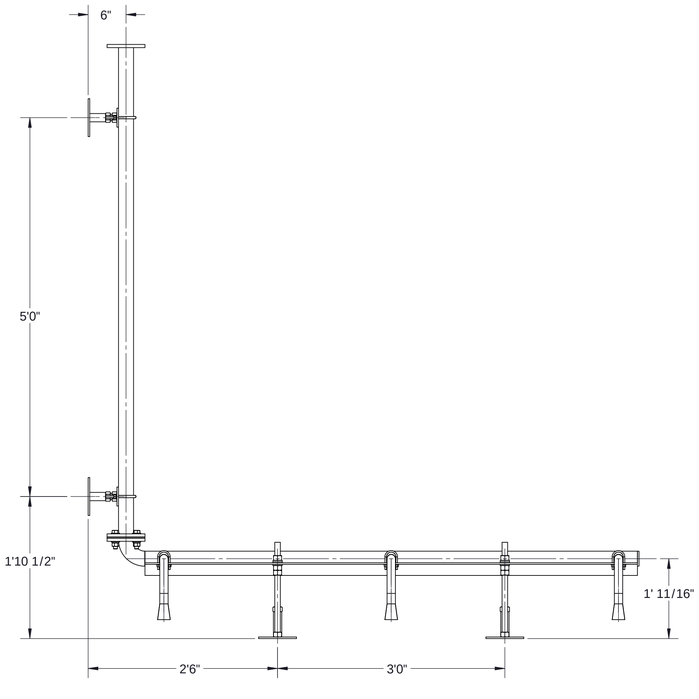
SLUDGE AERATION GRID
QTY - 1 NO.

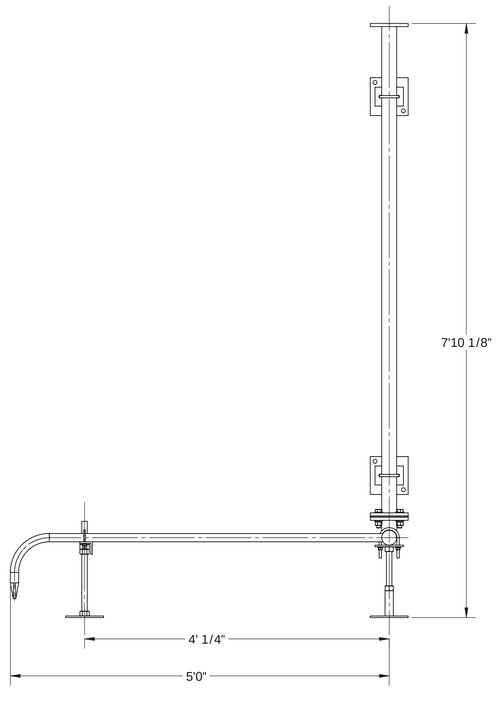
ITEM NO.	DESCRIPTION
1	AERATION GRID ASSY 2 INCH - 5 FT X 6 FT LG -36 IN SPACED - RH
2	DROP PIPE 2 INCH - 6 FT 6 IN LG
3	MANIFOLD SUPPORT ASSY 2 INCH
4	DROP PIPE SUPPORT ASSY 2 INCH
5	DIFFUSER THREADED SUPPORT

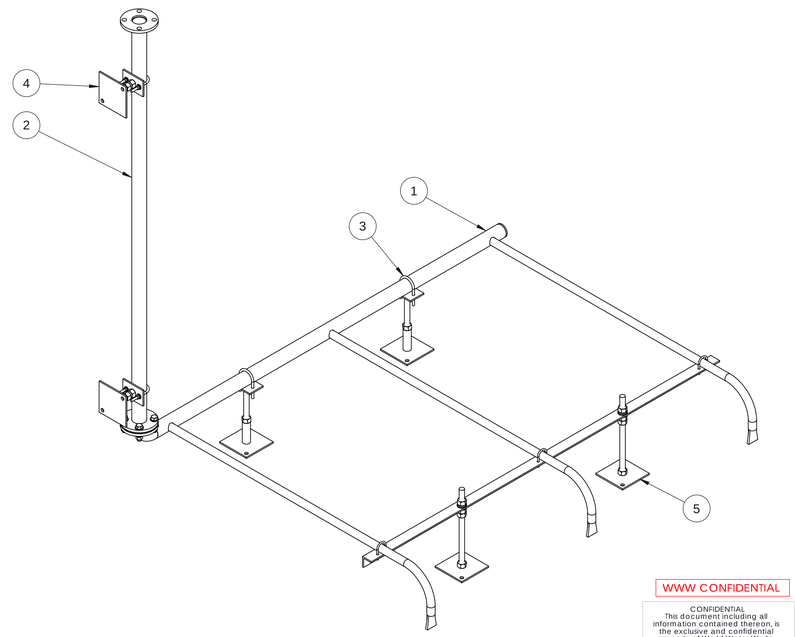
ANCHORING HOLE DETAILS
DIA 5/8" - 2NOS. PER SUPPORT
(6 NOS. PER GRID)
(TOTAL QTY - 6 NOS.)











WWW CONFIDENTIAL

REV	DATE	DESCRIPTION	BY
R00	12/06/23	INITIAL REVIEW	TA
R01	12/06/23	FOR APPROVAL	TA

World water works

CLIENT: OCEANIC COMPANIES - HEEIA KEA BOAT HARBOR
LOCATION: KAPOLEI - HI
FILE NAME: 23053-0705
DESCRIPTION: SLUDGE AERATION GRID

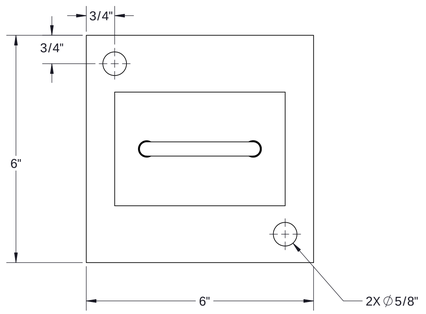
FOR APPROVAL

P.O.#: 23-880-2 R0
DRAWN BY: TA
REVIEWED BY: GH
DATE: 12/06/23
SCALE: 1:12
JOB #: 23-053
DRAWING # 0705
SHEET: 1 OF 2 SHEETS

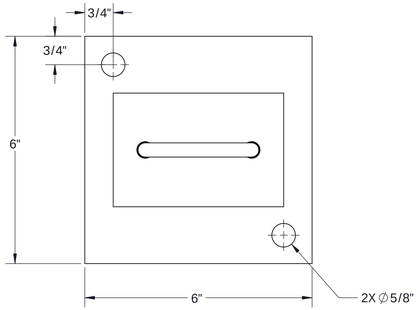
AERATION GRID SUPPORTS

ITEM NO.	MATERIAL	DESCRIPTION
1	SS316	WASH, 3/8" F/W
2	SS316	HEX NUT, 3/8"-16
3	SS316	WASHER, LOCK, SS316, 3/8"
4	SS316	HEX NUT, 7/8" HX NUT
5	SS316	LK WASH, 7/8" SPLIT L/W
6	SS316	WASH, 7/8" F/W
7	SS316	U-BOLT, SS, 3/8-16NC X 4 7/16 IN LG
8	SS316	PLATE, 1/4" X 4" X 4 1/2" LG
9	SS316	ALL THREADED ROD 7/8"-9 X 4" LG
10	SS316	PIPE, SS, SCH 10, 1" X 2 -1/2" LG
11	SS316	BASE PLATE, 1/4" X 6" X 6"
12	SS316	ALL THREADED ROD 7/8"-9 X 9" LG
13	SS316	PIPE, SS, SCH 10, 1" X 4" LG
14	SS316	ALL THREADED ROD 7/8"-9 X 15" LG

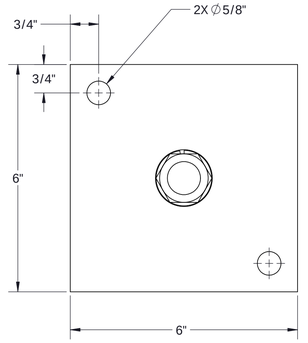
2 IN DROP PIPE SUPPORTS
QUANTITY: 2 NOS.

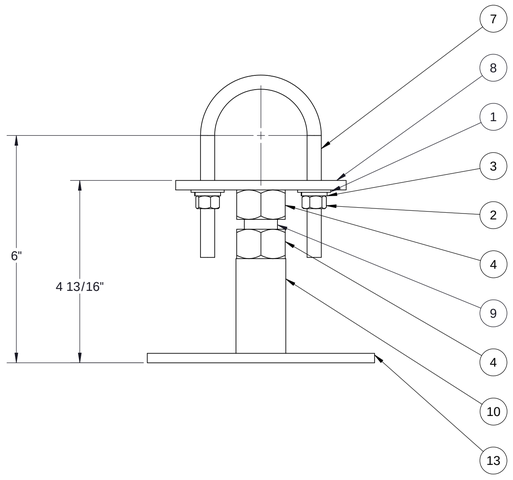


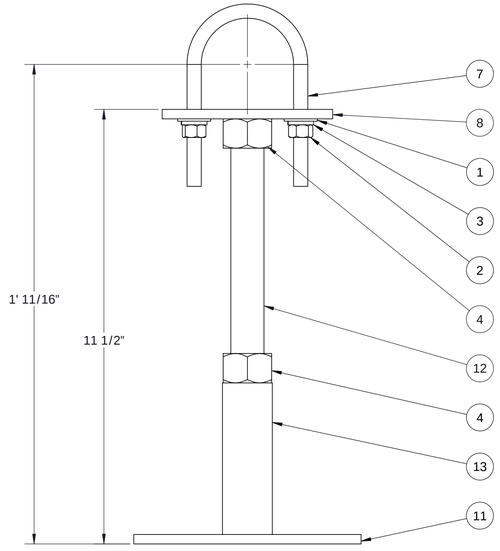
2 IN PIPE SUPPORTS
QUANTITY: 2 NOS.

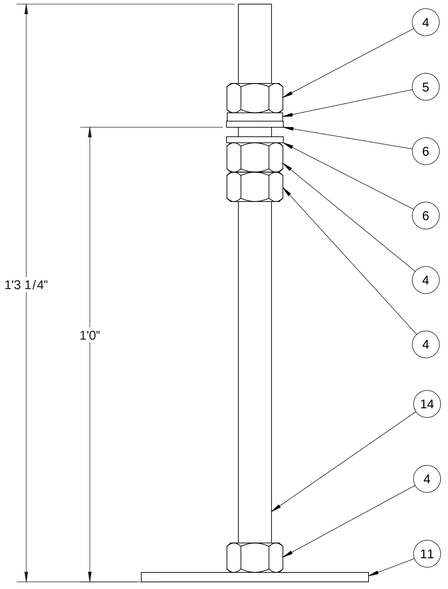


DIFFUSER SUPPORTS
QUANTITY: 2 NOS.









REV	DATE	DESCRIPTION	BY
R00	12/06/23	INITIAL REVIEW	TA
R01	12/06/23	FOR APPROVAL	TA

World water works

CLIENT: OCEANIC COMPANIES - HEEIA KEA BOAT HARBOR
LOCATION: KAPOLEI - HI
FILE NAME: 23053-0705
DESCRIPTION: SLUDGE AERATION GRID

FOR APPROVAL

P.O.#: 23-880-2 R0

DRAWN BY: TA

REVIEWED BY: GH

DATE: 12/06/23

SCALE: 1:2

JOB #: 23-053

DRAWING # 0705

SHEET: 2 OF 2 SHEETS

PUMP TAG#	PUMP MODEL#	CHEMICAL	LOCATION
CP1011-01	E711-468SI	POLYMER	MBBR CLARIFIER POLYMER

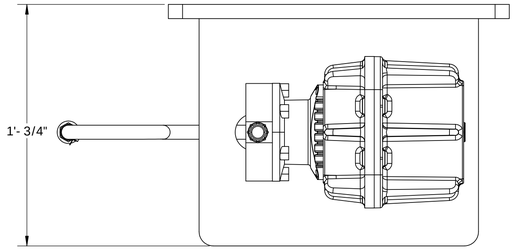
CHEMICAL SHELF POLYMER BATCH QTY - 1 NO.

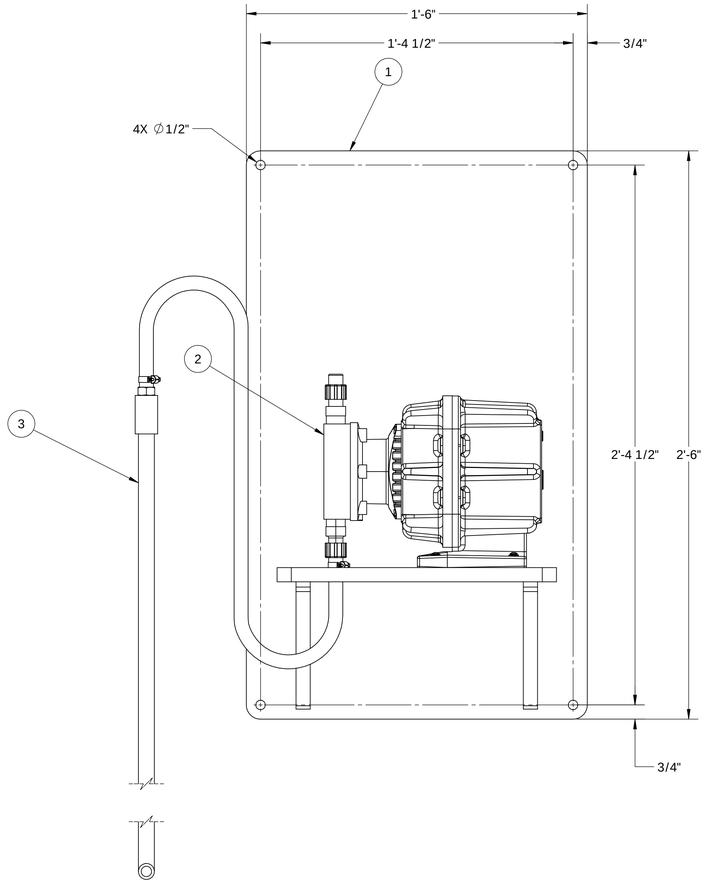
ITEM NO.	DESCRIPTION
1	CHEMICAL SHELF WELDMENT
2	POLYMER BATCH FEED PUMP - LMI
3	CHEMICAL WAND 3/8"

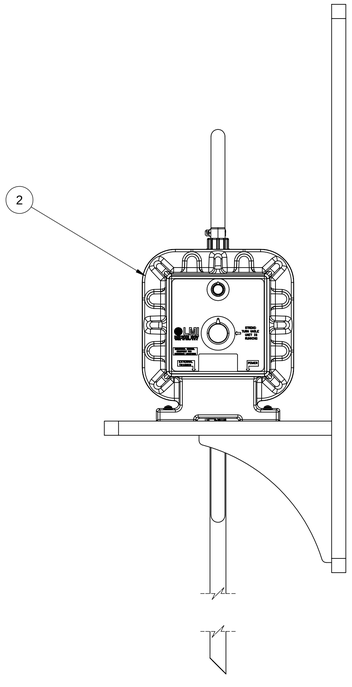
NOTE:

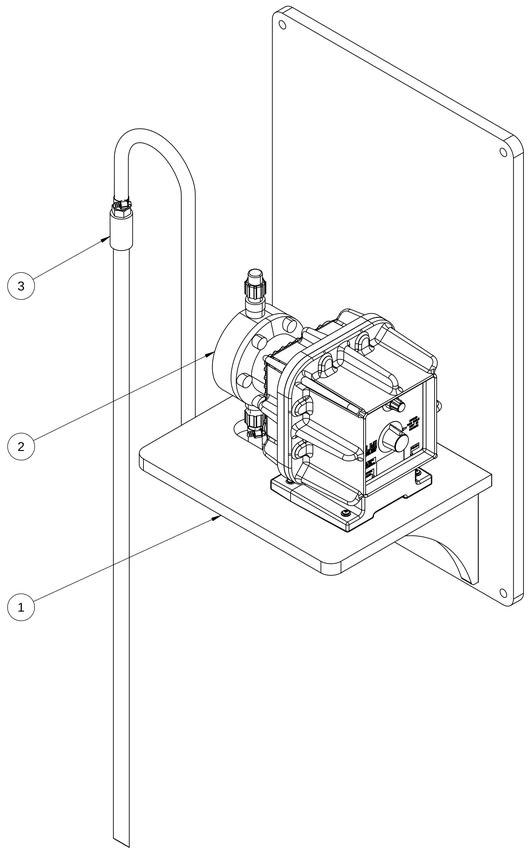
REQUIRES 110 VAC UITILITY POWER

EMPTY WEIGHT: 35 LBS









REV	DATE	DESCRIPTION	BY
R00	12/22/23	INITIAL REVIEW	TA
R01	12/22/23	FOR APPROVAL	TA

World water works

CLIENT: OCEANIC COMPANIES - HEEIA KEA BOAT HARBOR
LOCATION: KAPOLEI - HI
FILE NAME: 23053-0706
DESCRIPTION: CHEMICAL SHELF - POLYMER BATCH

FOR APPROVAL

P.O.#: 23-880-2 R0

DRAWN BY: TA

REVIEWED BY: GH

DATE: 12/22/23

SCALE: 1:4

JOB #: 23-053

DRAWING # 0706

SHEET: 1 OF 1 SHEETS

WWW CONFIDENTIAL

PUMP TAG#	PUMP MODEL#	CHEMICAL	LOCATION
CP0911-01	E711-468SI	ANTI-FOAM	MBBR ANTI-FOAM

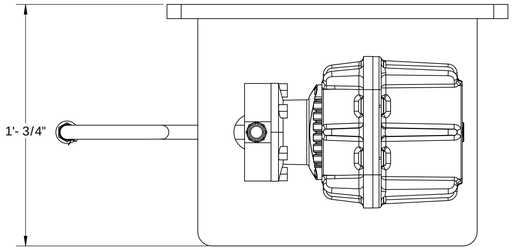
CHEMICAL SHELF ANTI-FOAM
QTY - 1 NO.

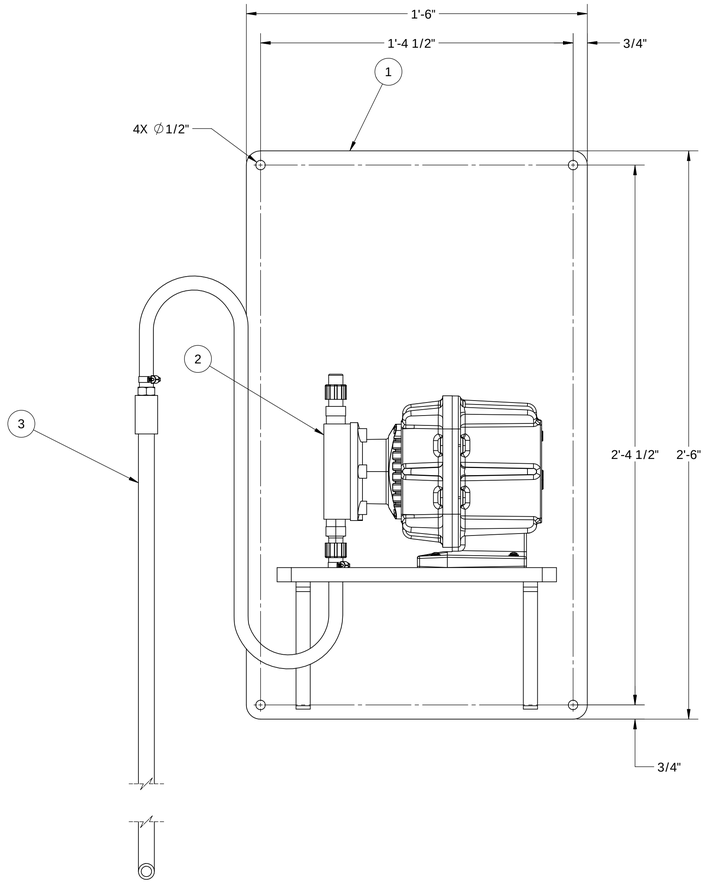
ITEM NO.	DESCRIPTION
1	CHEMICAL SHELF WELDMENT
2	ANTI-FOAM PUMP - LMI
3	CHEMICAL WAND 3/8"

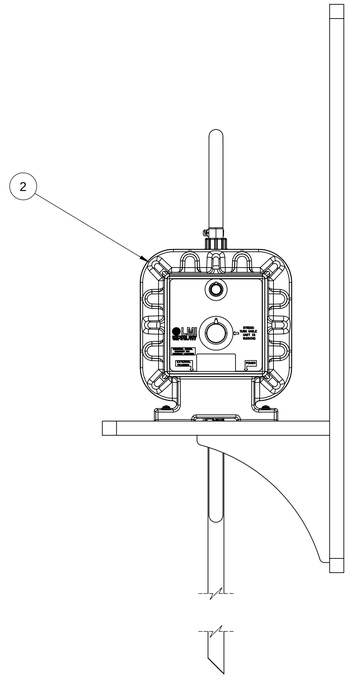
NOTE:

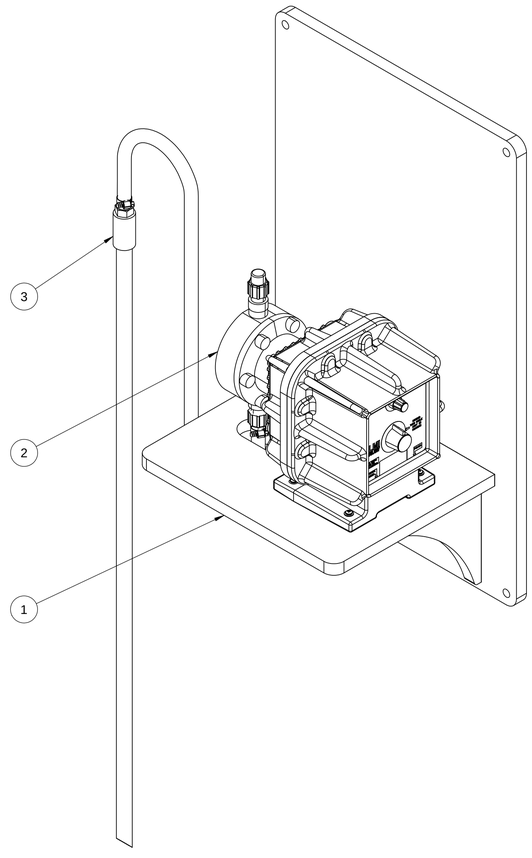
REQUIRES 110 VAC UITILITY POWER

EMPTY WEIGHT: 35 LBS









REV	DATE	DESCRIPTION	BY
R00	12/06/23	INITIAL REVIEW	TA
R01	12/06/23	FOR APPROVAL	TA

World water works

CLIENT: OCEANIC COMPANIES - HEEIA KEA BOAT HARBOR
LOCATION: KAPOLEI - HI
FILE NAME: 23053-0707
DESCRIPTION: CHEMICAL SHELF - ANTIFOAM

FOR APPROVAL

P.O.#: 23-880-2 R0

DRAWN BY: TA

REVIEWED BY: GH

DATE: 12/06/23

SCALE: 1:4

JOB #: 23-053

DRAWING # 0707

SHEET: 1 OF 1 SHEETS

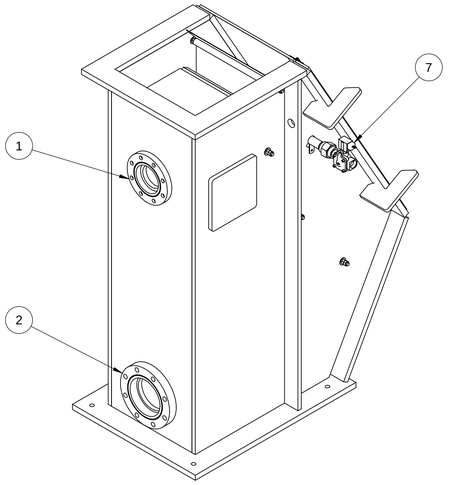
WWW CONFIDENTIAL

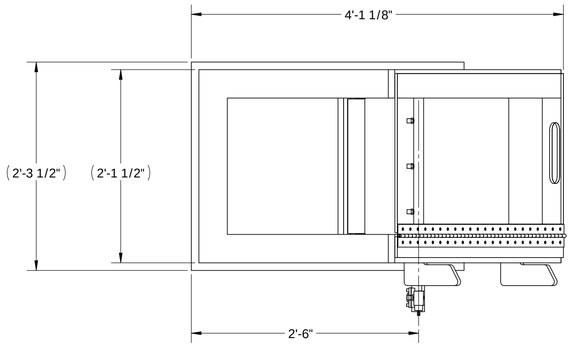
SIDEHILL SCREEN (SHS-1838)

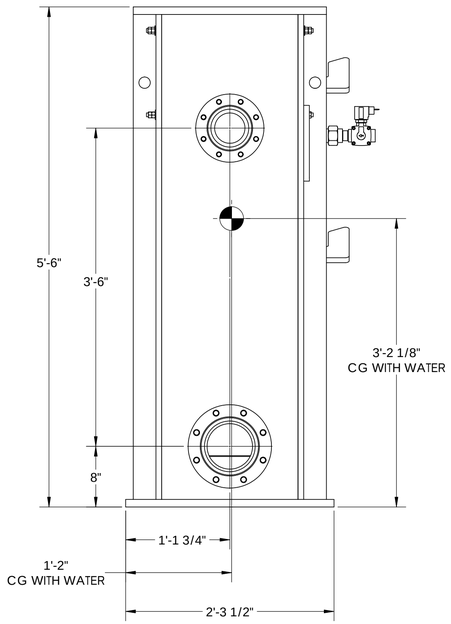
ITEM NO.	DESCRIPTION
1	INFLUENT, 4" FLANGE 150 LB
2	EFFLUENT, 6" FLANGE 150 LB
3	FRAME, POLYPROPYLENE
4	SCREEN, 0.2" WEDGEWIRE SCREEN, SS316
5	DAMPNER, SS316
6	SPRAY BAR, SS316
7	SOLENOID VALVE, BRASS, 1" NPT
8	SHS COVER-CLEAR

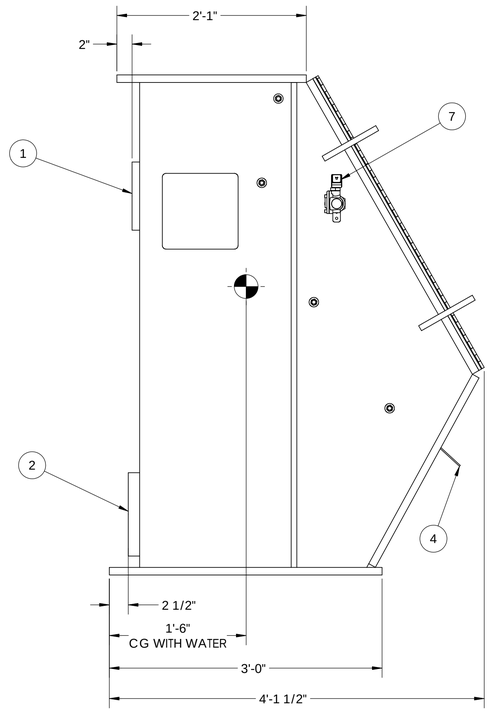
NOTE:

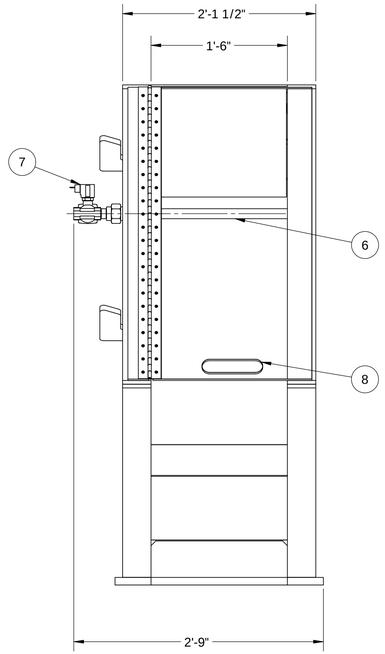
EMPTY WEIGHT: 309 LBS
OPERATION WEIGHT: 473 LBS

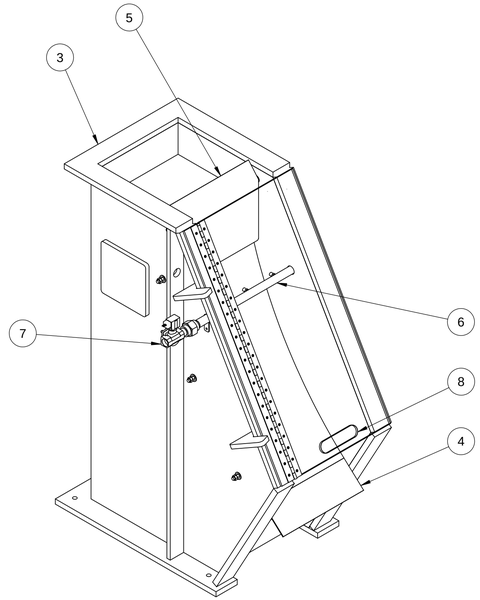


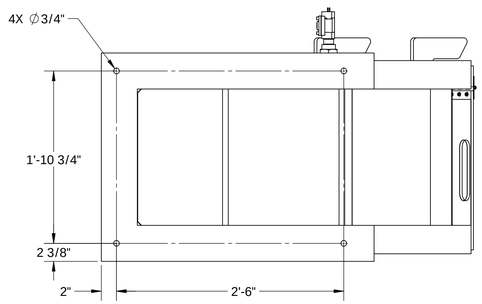












REV	DATE	DESCRIPTION	BY
R00	12/06/23	INITIAL REVIEW	TA
R01	12/06/23	FOR APPROVAL	TA

World water works

CLIENT: OCEANIC COMPANIES - HEEIA KEA BOAT HARBOR
LOCATION: KAPOLEI - HI
FILE NAME: 23053-0708
DESCRIPTION: SIDE HILL SCREEN GENERAL ARRANGEMENT

FOR APPROVAL

P.O.#: 23-880-2 R0

DRAWN BY: TA

REVIEWED BY: GH

DATE: 12/06/23

SCALE: 1:12

JOB #: 23-053

DRAWING # 0708

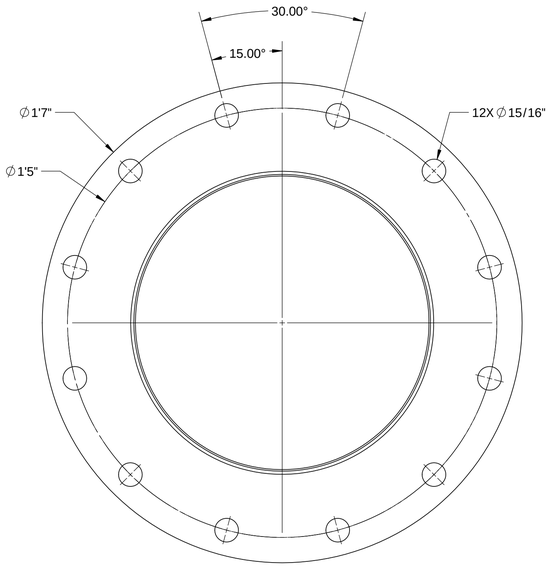
SHEET: 1 OF 1 SHEETS

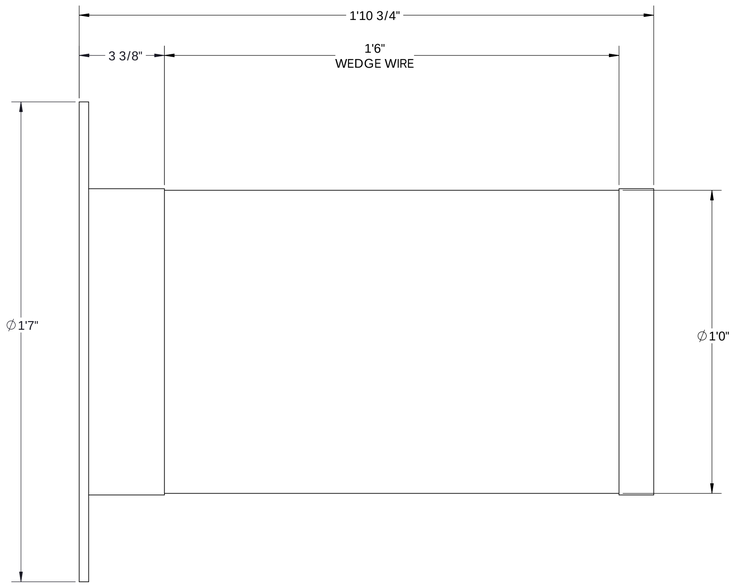
WWW CONFIDENTIAL

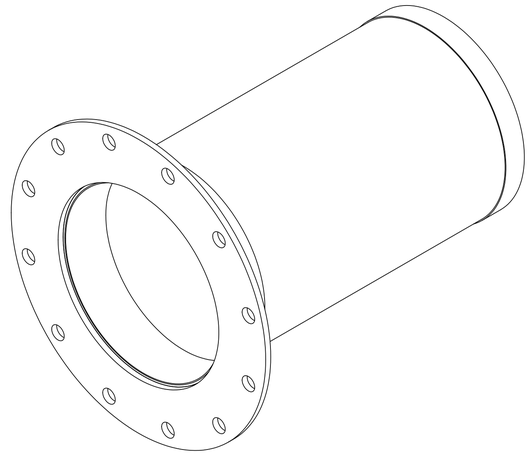
GENERAL NOTES

1. ALL IS TO BE CONSTRUCTED FROM 316 STAINLESS STEEL
2. SERVICE: WASTE WATER @ 40 °F ~ 130 °F
3. ALL FLANGES TWO-HOLED TO THE CENTER LINE
4. ALL DIMENSIONS SHOWN APPLY TO AMBIENT TEMPERATURE (NONEXPAND)
5. SOME HIDDEN LINES AND COMPONENTS OMITTED FOR CLARITY
6. ALL FASTENERS AND ANCHOR BOLTS SHALL TO BE 316 SS.
7. WEDGE WIRE SCREEN WITH NO. 90 WRAP WIRE AND NO. 177 SUPPORT RODS WITH A 5 MM SLOT OPENING, USE 90 SUPPORT RODS SPACED ON 0.619" CENTERS.

MBBR SIEVE - DIA 12" X 18" LG
QUANTITY : 2 NOS.







WWW CONFIDENTIAL

REV	DATE	DESCRIPTION	BY
R00	12/06/23	INITIAL REVIEW	SRC
R01	12/06/23	FOR APPROVAL	SRC

World water works

CLIENT: OCEANIC COMPANIES - HEEIA KEA BOAT HARBOR
LOCATION: KAPOLEI - HI
FILE NAME: 23053-0709
DESCRIPTION: MBBR SIEVE – DIA 12 IN X 18 IN LG

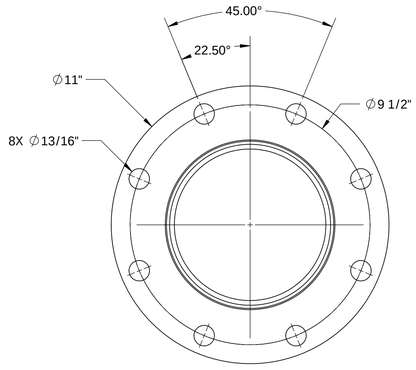
FOR APPROVAL

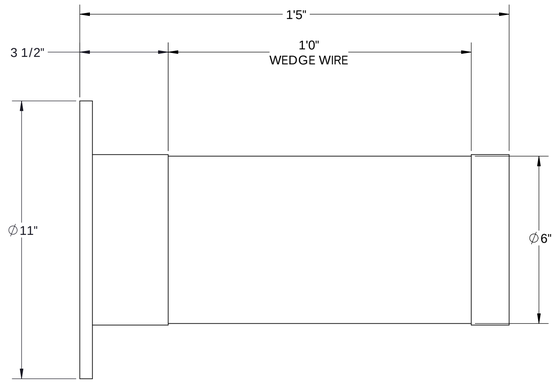
P.O.#: 23-880-2 R0
DRAWN BY: SRC
REVIEWED BY: GH
DATE: 12/06/23
SCALE: 1:10
JOB #: 23-053
DRAWING # 0709
SHEET: 1 OF 1 SHEETS

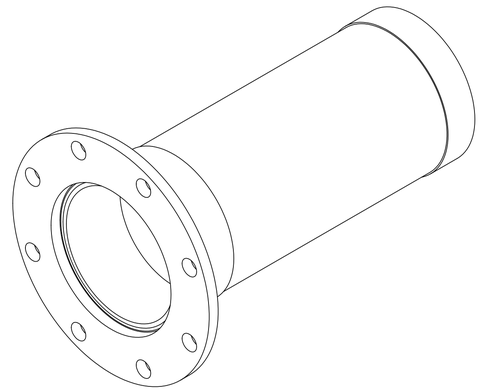
GENERAL NOTES

1. ALL IS TO BE CONSTRUCTED FROM 316 STAINLESS STEEL
2. SERVICE: WASTE WATER @ 40 °F ~ 130 °F
3. ALL FLANGES TWO-HOLED TO THE CENTER LINE
4. ALL DIMENSIONS SHOWN APPLY TO AMBIENT TEMPERATURE (NONEXPAND)
5. SOME HIDDEN LINES AND COMPONENTS OMITTED FOR CLARITY
6. ALL FASTENERS AND ANCHOR BOLTS SHALL TO BE 316 SS.
7. WEDGE WIRE SCREEN WITH NO. 90 WRAP WIRE AND NO. 177 SUPPORT RODS WITH A 5 MM SLOT OPENING, USE 90 SUPPORT RODS SPACED ON 0.619" CENTERS.

OVERFLOW SIEVE - DIA 6" X 12" LG
QUANTITY : 2 NOS.







WWW CONFIDENTIAL

REV	DATE	DESCRIPTION	BY
R00	12/06/23	INITIAL REVIEW	SRC
R01	12/06/23	FOR APPROVAL	SRC

World water works

CLIENT: OCEANIC COMPANIES - HEEIA KEA BOAT HARBOR
LOCATION: KAPOLEI - HI
FILE NAME: 23053-0710
DESCRIPTION: OVERFLOW SIEVE – DIA 6 IN X 12 IN LG

FOR APPROVAL

P.O.#: 23-880-2 R0

DRAWN BY: SRC

REVIEWED BY: GH

DATE: 12/06/23

SCALE: 1:10

JOB #: 23-053

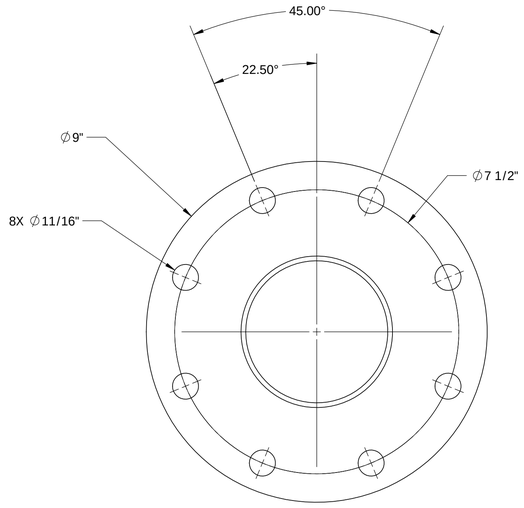
DRAWING # 0710

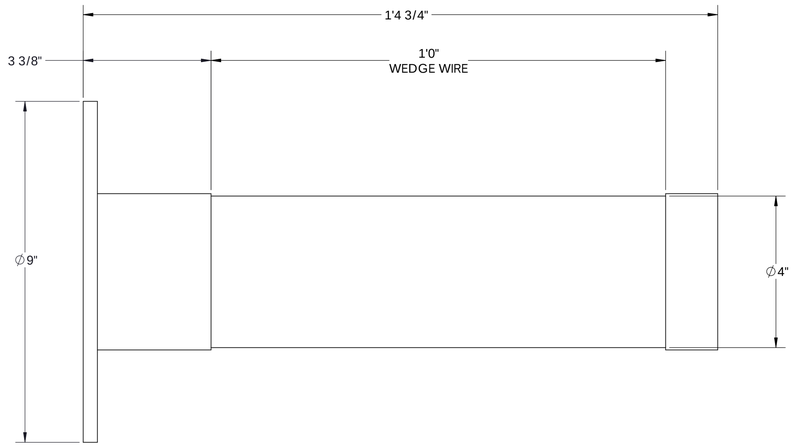
SHEET: 1 OF 1 SHEETS

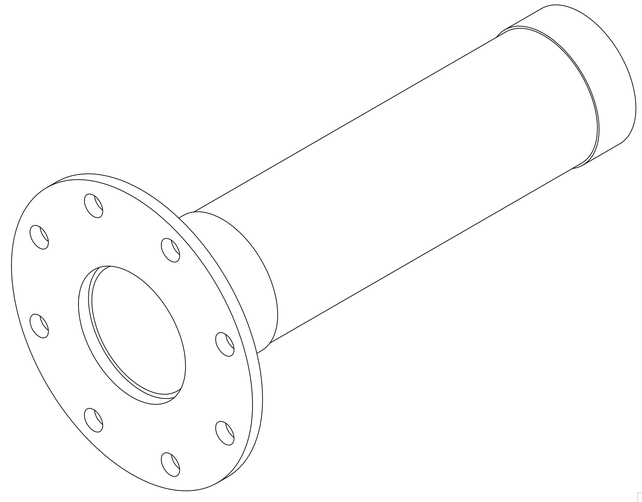
GENERAL NOTES

1. ALL IS TO BE CONSTRUCTED FROM 316 STAINLESS STEEL
2. SERVICE: WASTE WATER @ 40 °F ~ 130 °F
3. ALL FLANGES TWO-HOLED TO THE CENTER LINE
4. ALL DIMENSIONS SHOWN APPLY TO AMBIENT TEMPERATURE (NONEXPAND)
5. SOME HIDDEN LINES AND COMPONENTS OMITTED FOR CLARITY
6. ALL FASTENERS AND ANCHOR BOLTS SHALL TO BE 316 SS.
7. WEDGE WIRE SCREEN WITH NO. 90 WRAP WIRE AND NO. 177 SUPPORT RODS WITH A 5 MM SLOT OPENING, USE 90 SUPPORT RODS SPACED ON 0.619" CENTERS.

DRAIN SIEVE - DIA 4" X 12" LG
QUANTITY : 2 NOS.







WWW CONFIDENTIAL

REV	DATE	DESCRIPTION	BY
R00	12/06/23	INITIAL REVIEW	SRC
R01	12/06/23	FOR APPROVAL	SRC

World water works

CLIENT: OCEANIC COMPANIES - HEEIA KEA BOAT HARBOR
LOCATION: KAPOLEI - HI
FILE NAME: 23053-0711
DESCRIPTION: DRAIN SIEVE – D/A 4 IN X 12 IN LG

FOR APPROVAL

P.O.#: 23-880-2 R0

DRAWN BY: SRC

REVIEWED BY: GH

DATE: 12/06/23

SCALE: 1:10

JOB #: 23-053

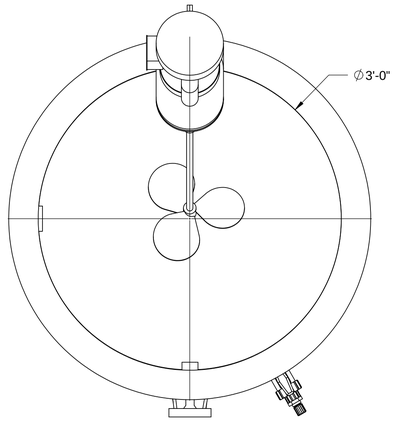
DRAWING # 0711

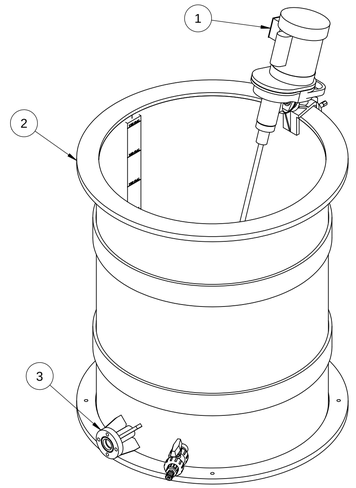
SHEET: 1 OF 1 SHEETS

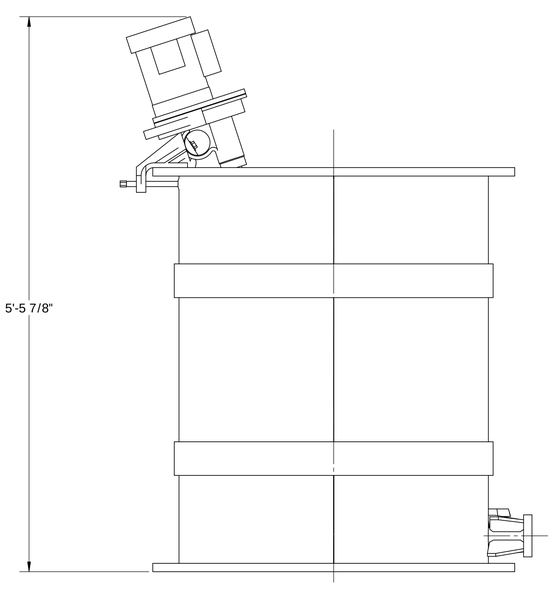
POLYMER BATCH TANK ASSY WITH MIXER

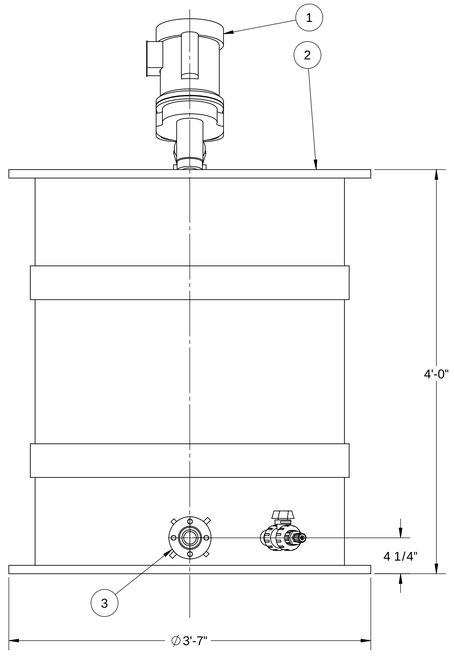
ITEM NO.	DESCRIPTION
1	TANK MIXER NEPTUNE JD 2.3 (1/3 HP, 460 VAC)
2	POLYMER BATCH TANK
3	DRAIN, 1.5" FLANGE 150 LB

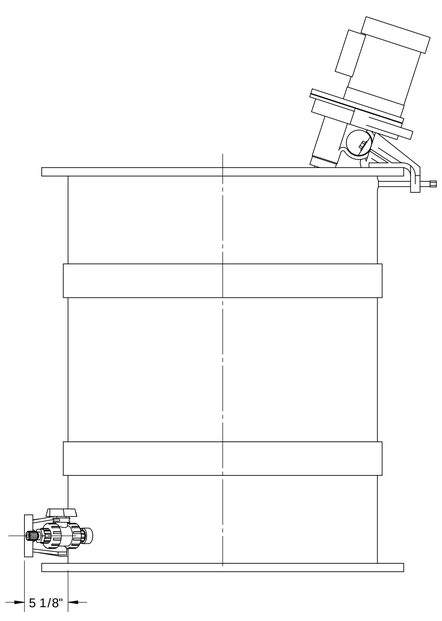
EMPTY WEIGHT: 205 LBS











WWW CONFIDENTIAL

REV	DATE	DESCRIPTION	BY
R00	12/22/23	INTERNAL REVIEW	SRC
R01	01/11/24	FOR APPROVAL	SRC

World water works

CLIENT: OCEANIC COMPANIES - HEEIA KEA BOAT HARBOR
LOCATION: KAPOLEI - HI
FILE NAME: 23053-0712
DESCRIPTION: GENERAL ARRANGEMENT

FOR APPROVAL

P.O.#: 23-880-2 R0

DRAWN BY: SRC

REVIEWED BY: GH

DATE: 12/22/23

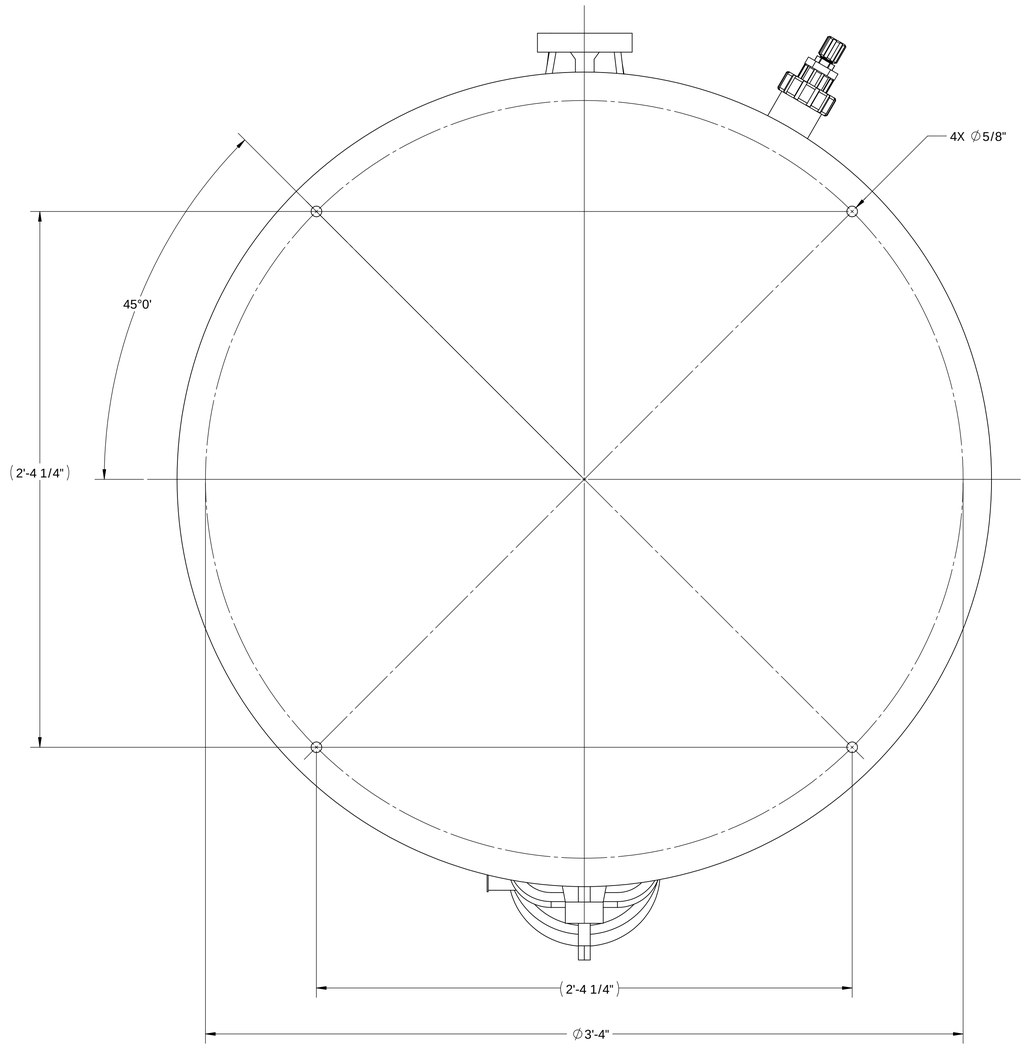
SCALE: 1:8

JOB #: 23-053

DRAWING # 0712

SHEET: 1 OF 2 SHEETS

FOUNDATION DETAILS FOR ANCHORING



REV	DATE	DESCRIPTION	BY
R00	12/22/23	INTERNAL REVIEW	SRC
R01	01/11/24	FOR APPROVAL	SRC

World water works

CLIENT: OCEANIC COMPANIES - HEEIA KEA BOAT HARBOR
LOCATION: KAPOLEI - HI
FILE NAME: 23053-0712
DESCRIPTION: GENERAL ARRANGEMENT

FOR APPROVAL

P.O.#: 23-880-2 R0

DRAWN BY: SRC

REVIEWED BY: GH

DATE: 12/22/23

SCALE: 1:12

JOB #: 23-053

DRAWING # 0712

SHEET: 2 OF 2 SHEETS

WWW CONFIDENTIAL

PART 4

Side Hill Screen Operation and Maintenance Manual

World Water Works SH Series Side Hill Screen Installation, Operation and Maintenance Manual

About this manual

Thank you for purchasing your WORLD WATER WORKS SH Series screen. Please read these instructions *before* you attempt to install and operate your screen. You can refer any questions to the WORLD WATER WORKS Service Department. This manual is divided into four sections:

Section 1	General Information
Section 2	Installation
Section 3	Operating Instructions
Section 4	**Drawings**.

TABLE OF CONTENTS

1.1 General Description

The WORLD WATER WORKS SH Series Screen is a simple device to remove suspended solids from water. The separation process consists of a flow of water by gravity over a screen surface which retains the solids. The SH screen retains and moves the solids in such a way to insure a large throughput, with minimal physical size requirement.

The WORLD WATER WORKS SH Series Screen is made up of a curved screen deck mounted in a housing. The housing includes a headbox to receive the influent and a drainage section to channel screened effluent to a single discharge pipe. The screen deck is mounted at a steeply sloped angle (to horizontal). The screening separation proceeds as the effluent moves, under gravity, from the higher chamber (headbox) to the lower chamber (drainage area).

The SH Series Screen is available in various sizes, based on screen deck width. Widths vary between one foot and six feet. The screen deck for most size screens has the consistent length of forty-two inches. Some of the smaller width screens have a deck length of thirty-eight inches.

1.2 Component Parts

1.2.1 Headbox

The headbox is a rectangular tank on the upper part of the housing. Influent enters a flanged connection on one side. Discharge from the headbox is a full width overflow weir.

1.2.2 Screen Deck

The SH Screen deck is a curved, rectangular panel constructed of wedge profile wires that run horizontally. The space between wires (0.005 - 0.200 inches) forms the opening (slot). The wires are fixed to cross member support rods spaced at 1-1/2 inches (normal construction). The wires are designed in this shape so that the flat top surface is exposed to the flow and promotes solids movement, and the beveled sides profile impedes the formation of solids bridging between wires and thereby "blinding" the screen. The screen is curved so that, with the progressively flatter slope, retained solids can achieve higher concentrations.

1.2.3 Drainage Area

The lower area of the screen housing is designed to collect the screened water and direct it to a single pipe outlet. The pan is sloped to help prevent fine solid accumulations.

1.3 Operation

Raw water enters the lower back headbox through a pipe inlet. Influent energy is dissipated by baffles so that flow of water at the weir is slow and even. As water flows over the weir onto a short ramp, it picks up speed, under gravity. As the ramp is at the same slope as the upper part of the screen deck, water is fed tangentially that creates a shearing action at the water/screen interface. Because of this, solids separation is greater than the actual slot opening. Also, the momentum of the initial water delivery will help sustain movement of solids down the deck as water tends to move vertically through the slots. Solids also slide under their own weight off the lower end of the deck into separate collection containers

2.1 Installation

2.1.1 Inspection

Before uncrating, examine packaging for any obvious damage. After uncrating, inspect for damage or unattached parts. Report any damage to your carrier and also notify WORLD WATER WORKS.

2.1.2 Moving Screen

The SH Screen can be moved with a forklift truck, with the forks placed under the base frame. If overhead lifting equipment is used, using shackles, attach cables to lifting lugs on two sides of the housing. It may be required to use spreader bars to ensure that no external forces are placed on the headbox. Always transport the SH unit in level position.

2.2 Site

2.2.1 Site

The SH Screen is designed for mounting on a level concrete or steel structure. The unit must be fully supported under the two side structural members of the housing.

2.2.2 Access

Influent and effluent piping is attached to the back of the housing. Adequate access to install and service pipe lines is required.

Three feet of access is required at the front of the screen for deck removal and maintenance.

2.2.3 Mounting

Level the unit at the assigned location. Place shims under the base at each mounting hole lug. Bolt the unit to the floor at each lug.

2.3 Piping

2.3.1 Influent Piping

Connect the influent pipe to the standard pipe flange (ANSI) or NPT Coupling on the headbox. Do not use the headbox to support the piping.

A properly designed influent piping system is essential for proper operation of the SH unit. The headbox is designed to divert an evenly distributed flow from the influent pipe to an even flow over the weirs. If reduced size influent piping is used, as is common with pump delivery, do not make the reduction immediately at the influent connection. On gravity delivery systems, ensure that the venting is sufficient and routing does not entrap large amounts of air. Entrapped air, upon release in the headbox, will cause turbulence.

2.3.2 Effluent piping (for units with pipe connection)

Connect the effluent pipe to the standard pipe flange (ANSI) on the bottom of the drain pan. Do not use unit to support the pipe. Long horizontal runs of drain pipe may not be possible to accommodate the maximum capacity of the unit. Where reduced size drain pipe is used, ensure that the size, head and venting are sufficient.

3.0 Operation and Maintenance Instructions

The SH Series Screen is a ruggedly built screen designed for long life. It is applied on simple applications where solids are clearly defined, and easily separated.

3.1 Initial Start Up

3.1.1 Ensure that the flow orientation plate at the top of the headbox weir is freely hinged and moves without binding on housing side walls.

3.1.2 Place screen deck at lowest position (On Screens 24” and Wider).

3.1.3 If possible, start influent with reduced flow or solids concentration. Influent can be gradually increased to peak design conditions.

3.2 Operation

For most applications the screen deck is maintained at the lowest position. Provided that the solids can freely slide under the weight of the accumulation that forms on the lower part of the deck, it is possible to raise the deck to achieve drier solids concentration.

3.3 Deck Cleaning

Although the SH Screen is only for applications where the solids demonstrate freely sliding deck discharge, blinding of the screen can occur over time. Usually, this is caused by certain slot size particles lodging between screen wires or by accumulations of fine solids that adhere to the underside of the deck. Manual cleaning of the deck may be required on a periodic basis. Usually a simple sprayer hose will remove build-up. On a less frequent basis, the deck may have to be removed and cleaned with a high pressure hose and/or coarse brush. Cleaning surfactants may be used. Avoid use of cleaners having a high oxidant content.

3.4 Assembly/Disassembly

Deck installation is best accomplished using three workers.

3.4.1 Holding the panel on both sides, and keeping the panel more or less horizontal, position the top part of the panel into the housing and align the lugs on the panel with the holes under the weir ramp. Slide a 1/2 inch connecting rod through the housing holes and the lug holes. Slowly lower the deck, assuring that the screen wires do not bind on housing, until deck is fully inside housing. Slide second 1/2 inch connecting rod into slot holes at the lower position on the housing. Place the rubber washer, steel washer, lock washers and hex nut on each end of connecting rods. (Note: large washers on the bottom connecting rods.) Adjust the height of lower part of deck using the position of the lower connecting rod (On larger units). Assure that deck is level, and then tighten nuts.

3.4.2 Install the orientation plate by aligning hinge with holes on side of headbox. Slide 1/2 inch hinge pin through holes. Install two 1/2 inch hex nuts on both side pins leaving the pins to rotate freely. Tighten nuts on so that each locks on its companion nut. Insure that plate swings freely.

3.4.3 To disassemble, reverse procedure for assembly.

PART 5

Trojan UV System Operation and Maintenance Manual

TrojanUVFit™

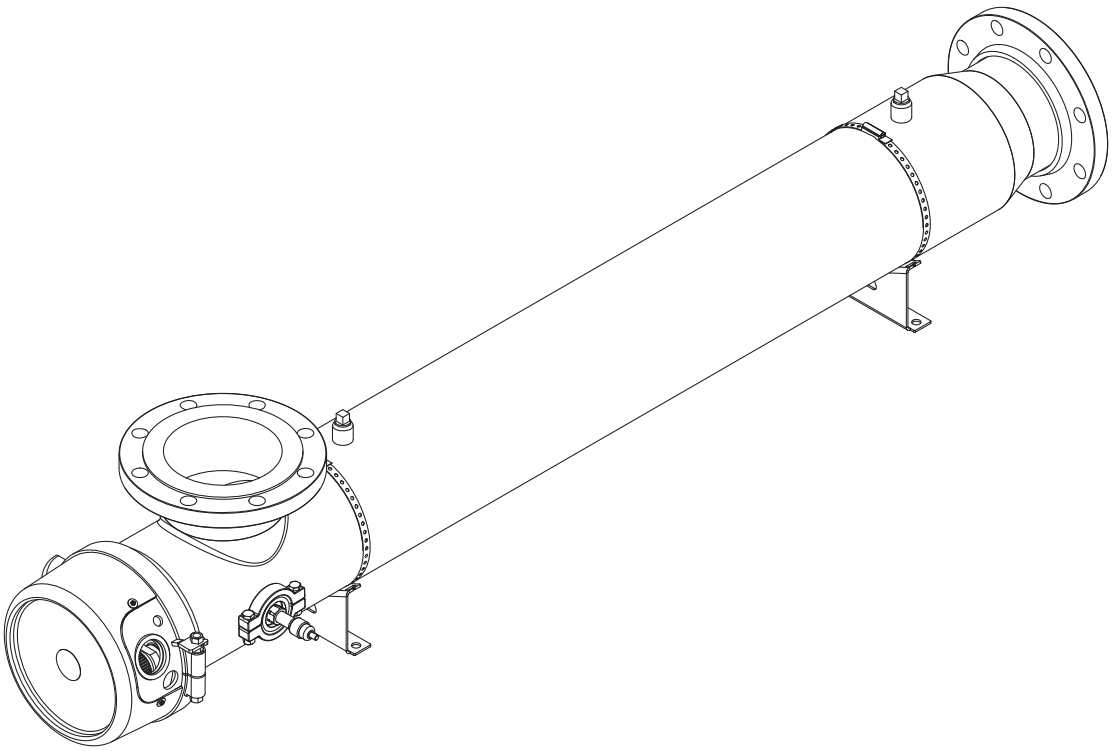
AL20 Series
Automatic and Non-Wiping Systems

Operation and Maintenance

User Manual

Original Instructions

Edition 9



If you require technical assistance, please contact your local representative. If you require additional assistance, please contact the Trojan Technologies - Technical Assistance Center (TAC) using the contact information below:

North America:	1-866-388-0488
All other areas:	1-519-457-2318
E-mail:	tac@trojanuv.com

At the time of publishing, the information within this document is current. Due to continuous improvements, we may have future changes and recommendations which will be sent via product bulletins.

Table of Contents

Section 1 Specifications

Specifications are subject to change without notice.

UV Chamber	
Material	316L stainless steel
Maximum Weight (dry)	52kgs (115 lbs)
Maximum Weight (wet)	105kgs (230 lbs)
I/O Connection	Refer to Layout Drawing
Ambient Relative Humidity	10% to 80% non-condensing
Water Temperature	1°C to 40°C (34°F to 104°F)
Ambient Operating Air Temperature	1°C to 40°C (34°F to 104°F)
Operating pressure (maximum)	10 bar (150 psi)
Hydrostatic pressure test (maximum)	1.5 times Operating pressure
UV Lamp and Lamp Sleeve	
UV Lamp body type	240W input, GA64T6 amalgam, low pressure
UV Lamp overall length	1578 mm (62.12 in.)
Lamp Sleeve bolt	Torque: 10.1 N.m (90 lbf.in)
UV Sensor	
Supply voltage power	24 VDC (12-30 VDC) from the CPP
Maximum operating temperature	50 °C (122 °F)
Control Power Panel (CPP)	
Enclosure rating and material	Refer to Component Label or System Description for enclosure rating and material
Lamp Driver	Electronic, one (1) Lamp Driver drives two (2) UV Lamps
Lamp Driver total harmonic distortion	Less than 5% in normal operation range
Weight	Refer to Component Label
Automatic Mechanical Wiping System (AMWS)	
Supply voltage power	208/220/230 VAC
Motor type	1/8 horsepower
System Certification	
UL and CE available	

Section 2 Safety Information

Please read this entire manual before operating this equipment. Pay attention to all danger, warning and caution statements in this manual. Failure to do so could result in serious personal injury 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 installation manual.

2.1 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 which, if not avoided, could result in minor or moderate injury.

NOTICE
Indicates a situation that is not related to personal injury.

2.2 Precautionary Labels

Read all labels and tags attached to the equipment. Personal injury or damage to the equipment could occur if not observed.

	Electrical equipment marked with this symbol may not be disposed of in European public disposal systems. In conformity with European local and national regulations (EU Directive 2002/96/EC), European electrical equipment users must now return old or end-of life equipment to the Producer for disposal at no charge to the user. ***Note:*** *For recycling, please contact the equipment producer or supplier for instructions on how to return end-of-life equipment, producer-supplied electrical accessories, and all auxiliary items for proper disposal. No equipment is to be returned without authorization. Local recycling programs may be used. For the manufacturer recycling UV Lamp program or producer-supplied electrical accessories and auxiliary items, contact the equipment supplier for proper disposal instructions.*
	This symbol indicates there is Mercury present.
	This is the safety alert symbol. Obey all safety messages that follow this symbol to avoid potential injury. When on the equipment, refer to the Operational and Maintenance manual for additional safety information.
	This symbol indicates a risk of electrical shock and/or electrocution exists.
	This symbol indicates the marked item has stored energy. Obey procedures to wait 5 (five) minutes after disconnecting main power, to allow stored energy to dissipate.
	This symbol indicates the marked equipment may contain a component that can eject forcibly. Obey all procedures to safely depressurize.
	This symbol indicates the components of the system have been exposed to biohazardous waste and / or bioaerosols.

	This symbol indicates a load lifting hazard.
	This symbol indicates a potential overhead crush hazard.
	This symbol indicates surfaces may be slippery and there is a potential fall hazard.
	This symbol indicates there is a potential UV hazard. Proper protection must be worn.
	This symbol indicates the marked item could be hot and should not be touched without care.
	This symbol indicates the marked item should not be touched.
	This symbol indicates a risk of electrical shock and/or electrocution exists. All appropriate lockout tag out procedures must be obeyed.
	This symbol indicates the equipment should be secured with a safety device / hook.
	This symbol indicates a safety glasses with side protection is required for protection against UV exposure.
	This symbol indicates a UV rated full face shield is required. Faces shields are to be worn with safety glasses or safety goggles.
	This symbol indicates gloves must be worn.
	This symbol indicates safety boots must be worn.
	This symbol indicates a hard hat must be worn.
	This symbol indicates the operator must read all available documentation to perform required procedures.

2.3 Safety Precautions

Read the safety precautions in this section before doing maintenance, service or repair. Obey the instructions in the safety precautions. Failure to follow the instructions in the safety precautions can result in serious injury or death.

⚠ DANGER

Arc Flash and Shock Hazard - Live Electrical Circuit Present. Hazardous Voltage.

- Failure to follow these instructions will result in electrical shock, injury or death from electrocution.
- Devices inside this equipment contain stored energy.
- NEVER work inside this equipment until at least 5 (five) minutes after disconnecting main power to allow stored energy to dissipate.
- Lockout tag out all sources of power before performing any inspection, repair, or maintenance. ***There may be more than one source of power!***

⚠ DANGER

Shock Hazard.

- Failure to use manufacturer approved parts, including UV Lamps, may result in significant thermal damage to insulation systems which may result in the exposure of live parts.

⚠ DANGER

Pressurized Device - Impalement Hazard.

- Failure to follow these instructions will result in serious injury or death due to forcible ejection of materials from UV Chamber.
- ALWAYS follow lockout tag out procedures.
- NEVER perform any physical inspection, repair, maintenance or service on UV Chamber unless UV Chamber has been isolated, depressurized and open to atmosphere. Where UV Chambers are interconnected in series and vertically stacked, only the top UV Chamber must be open to atmosphere.

  Exception: *Performing Reference Sensor check in compliance with "Install or Remove a Reference Sensor" in* ***Operation and Maintenance Manual****.*
- NEVER pressurize UV Chamber without Service End Cap properly installed.
- NEVER stand in front of UV Lamp section while UV Chamber is undergoing a hydrostatic pressure test. Stand to the side of the UV Chamber while looking for leaks.
- ***If a leak is observed, depressurize immediately, drain, repair and retest.***

⚠ WARNING

Personal Injury Hazard.

- Use of parts not approved by the manufacturer may cause personal injury, damage to the UV system or malfunction of the UV System and may void the manufacturer's warranty.
- Use of UV Lamps and Lamp Drivers, not approved by the manufacturer, will void UL and CE product safety certifications.
- The parts listed in Section 12 are approved by the manufacturer.

⚠ WARNING

Body Crush Hazard.

- Failure to follow these instructions could result in serious injury or death due to improper lifting procedures, underrated lifting equipment and, moving parts.
- ALWAYS secure with safety device.
- ALWAYS stay clear of elevated loads.

⚠ CAUTION

Slip and Fall Hazard.

- Failure to follow these instructions may result in injuries from slip and fall.
- ALWAYS ensure safe footing.
- ALWAYS clean up spills promptly.
- ALWAYS comply with site-specific safety protocols and procedures.

⚠ CAUTION

UV Light Hazard.

- Failure to follow these instructions may result in serious burns to unprotected eyes and skin.
- ALWAYS use UV protective gear, including gloves and clothing and face shield, when UV light is present.
- NEVER look directly at illuminated UV Lamp, even with protective gear.
- NEVER illuminate UV Lamp if personnel may be directly exposed to UV light.

⚠ CAUTION

Burn Hazard.

- Failure to follow these instructions may result in minor or moderate injury due to burns.
- NEVER touch hot surface
- Allow UV Lamps to cool for a minimum of 10 (ten) minutes before handling.
- If accidental exposure occurs, immediately cool affected area. Consult physician

NOTICE

Mercury Chemical.

- UV Lamps contain a small amount of mercury in either elemental or bound amalgam state, depending on lamp type. These lamps are similar to fluorescent and compact fluorescent lamps (CFL). Always comply with local regulations governing the disposal of lamps containing mercury and the waste associated with breakage.
- NEVER use a vacuum cleaner to clean up broken lamps containing mercury. Vacuuming could spread mercury-containing powder or vapour.
- Thoroughly collect broken glass and trace amounts of mercury and place into a sealable bag or container. For further reference see the U.S. EPA guidelines. http://www.epa.gov/cfl/cleaning-broken-cfl.
- If you have further questions about the safe clean-up of mercury containing lamps, contact the Trojan Technologies service support group at tac@trojanuv.com

NOTICE

Personal Protective Equipment Required.

- ALWAYS use appropriate eye, hand, and foot protection.
- ALWAYS wear UV-C safety glasses when around equipment or a UV-C faceshield with safety glasses or safety goggles when inspecting open running equipment.
- ALWAYS follow plant safety procedures and protocols.
- ALWAYS take necessary precautions when working around, operating, or working on this equipment, if contamination of components is expected within this application due to effluent biological or chemical contaminants.

NOTICE

Only competent personnel should undertake operation, repairs, maintenance, or servicing of equipment described in this manual. Maintain the continuity of the lockout tag out between shifts. If you do not understand the information or procedure explanations in this manual, STOP and contact your Service Provider for assistance.

NOTICE

The **TrojanUVFit** wastewater disinfection system has been validated through regulatory-endorsed microbial testing. Through this testing, performance data has been generated for UV dose delivery to disinfect Poliovirus, Escherichia coli (E. coli) and fecal coliform.

WARNING: This product can expose you to chemicals including phthalates, which is known to the State of California to cause cancer, and mercury, which is known to the State of California to cause birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov.

Notes: *1) Dispose of contaminated parts/components as per country requirements.*

2) Refer to the Safety Data Sheets for accidental exposure to materials.

2.4 Safety Features

The UV System has safety features that prevent personal injury:

- Service end cap - The electrical power supplied to all lamp holders is turned off when the service end cap is removed.
- Door disconnect switch - A disconnect switch removes power to the UV System.

Section 3 General Information

The information in this manual has been carefully checked and is believed to be accurate. However, the manufacturer assumes no responsibility for any inaccuracies that may be contained in this manual. 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, even if advised of the possibility of such damages. In the interest of continued product development, the manufacturer reserves the right to make improvements in this manual and the products it describes at any time, without notice or obligation.

3.1 Acceptable Noise Levels

The airborne noise emissions, A-weighted emission sound pressure level, is not more than 70 dB(A).

3.2 Patents and Permissions

The products described in this document may be protected by one or more patents in The United States of America, Canada and/or other countries. For a list of patents owned by Trojan Technologies, go to: www.trojantechnologies.com/patents.

3.3 Abbreviations and Acronyms

Table 1 describes the abbreviations and acronyms included in this manual.

Table 1 Abbreviations and Acronyms

Abbreviation/Acronym	Description
AC	Alternating Current
AMWS	Automatic Mechanical Wiping System
BPL	Lamp Driver Power Level
CCB	Communication Control Board (microprocessor)
COMM	Communications
CPP	Control Power Panel
HMI	Human Machine Interface
PSD	Particle Size Distribution
UV	Ultraviolet

3.4 System Overview

The system is a pressurized UV Chamber that uses high-output amalgam UV Lamps.

Figure 1 shows the UV Chamber components.

One Control Power Panel (CPP) provides the power distribution for one UV Chamber and controls the UV Chamber through a microprocessor user interface. Refer to Section 8.

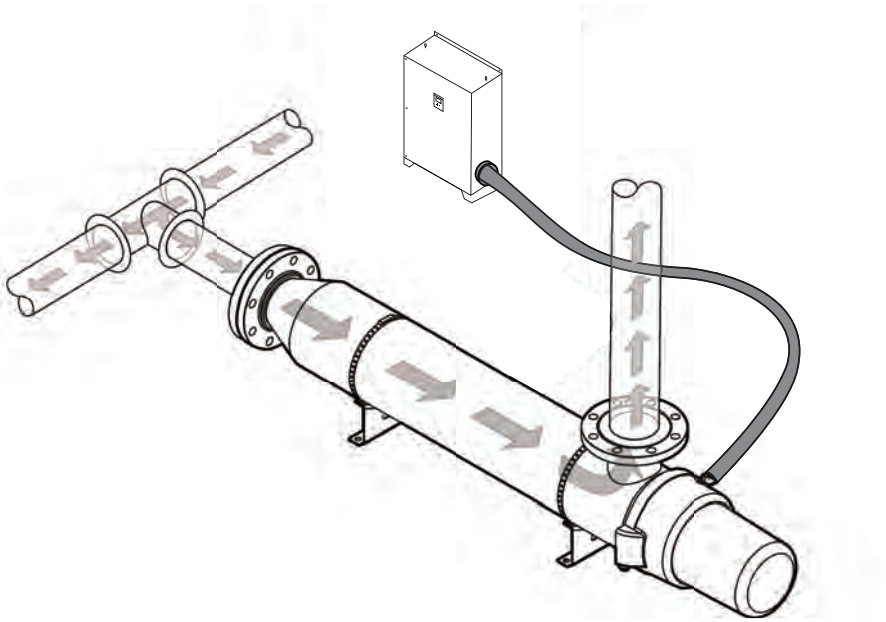


Figure 1 UV System

⚠ DANGER

Obey all warning and caution statements. Refer to Section 2.

Read and understand this manual before operating this equipment. Read all user documentation before performing operations, inspections, repair, or maintenance on this equipment.

Only competent personnel should undertake operation, repairs, maintenance, or servicing of equipment described in this section of the manual. If you do not understand the information or procedure explanations in this manual, STOP and contact your Service Provider for assistance.

The procedure in Section 4.1 is the minimum Lockout requirement. Use additional precautions, as needed. Obey all site-specific protocols.

4.1 Lockout Tag Out Procedure

4.1.1 Equipment Shutdown

Contact the plant manager or shift supervisor for help regarding equipment location and identification.

1. Ensure that no hazards will be created by equipment shutdown.
2. Shut down all equipment that will need lockout tag out.
3. Ensure that all moving parts come to a complete stop.

4.1.2 Deactivate Energy Sources

A hazardous energy source is any energy source that can cause serious personal injury or death. The potential hazardous energy sources in the system are described in this section.

1. Identify and deactivate the main isolating device of each energy source:
   -  Electrical Energy (Incoming Power)
   -  Water Pressure (Potential Energy)
   -  Thermal (Thermal Energy)
   -  UV Light (Radiation Energy)
2.  Disconnect all electrical equipment from power:
   - Unplug all electrical equipment
   - Power off and disconnect electrical power to hard-wired equipment
3.  Dissipate stored electrical energy in capacitors.
4. Close all shut-off valves.
5. Disconnect electrical power to pumps and compressors.
6. Ensure that the hydraulic lines are not pressurized.
7. Secure moving parts to avoid unintended movement.

4.1.3 Lockout Tag Out Energy Sources

1. Use a multi-lock scissor adaptor to Lockout each energy source.
2. Attach a completed Lockout tag. Include the required information:
   - Person and company applying the Lockout
   - Reason for the Lockout
   - Date of the Lockout
3. Apply a personal lock.

4.1.4 Verify the Lockout

1. Ensure that the volt meter is working correctly with a test before and after measuring the de-energized source:
   a. Test the voltmeter to a known, energized 24 VAC/120 VAC source.
   b. Use the same voltmeter to test the locked-out energy sources to verify that there is no voltage.
   c. Test the voltmeter again to a known, energized 24 VAC/120 VAC source.
2. Ensure that the stored energy sources have dissipated.
3. Ensure that the hydraulic lines are not pressurized.
4. Try to start the de-energized equipment.

4.2 Remove the Lockout Tag Out

When the work is finished, the lockout tag out can be removed.

1. Ensure that no hazards will be created by removal of the Lockout.
2. Obey manufacturer's instructions and safe work procedures to energize and start the equipment.
3. Clean up the work area.

Section 5 Shipment and Storage

5.1 Shipping Contents

The system consists of two major components, the UV Chamber and the CPP. Some components may be disconnected at the UV Chamber for shipment.

5.2 How the equipment is shipped

The system is delivered to the site by truck. System components are packed in wooden crates labeled with the component name. Other labels identify components which are fragile or breakable and components which must be kept dry.

To prepare for installation, remove only the shipping straps and bolts that secure the panel to the pallet.

5.3 Storage requirements before the install

The manufacturer recommends indoor storage of the system equipment. The equipment should be stored in a dry warehouse. Heating is not necessary during storage. However, before system start up, the equipment must be warmed to more than 15 ºC (60 ºF) for a period of 24 hours.

Storage area conditions:

- Ambient air temperature between -40 ºC to 55 ºC (-40 ºF to 130 ºF)
- Relative humidity from 10% to 90%, non-condensing
- Free from dust and dirt ingress
- Must not contain corrosive or explosive gases
- Free from salt air
- Vermin free

If indoor storage is not possible, the panel may be stored outdoors, with additional conditions:

- Equipment is stored on high ground that is not susceptible to flooding.
- Equipment is elevated a minimum of 300 mm (12 inches) above the ground or as appropriate to prevent damage from flooding.
- Equipment is completely covered with waterproof tarps to prevent exposure to the elements (e.g., rain, snow, sand, dust etc.). Tarps must be tight fitting, attached securely and examined regularly. Water and snow accumulation should be removed regularly.
- Equipment stored in crates should not be exposed to direct sunlight.
- Equipment can be stored in sea containers.

5.4 Overview of Equipment Connections

Refer to the general layout drawings provided by the manufacturer. If the supplied layout drawings do not match the site conditions, contact the manufacturer for assistance.

5.5 Startup and System Commission

After the shipment of the system, the contractor will be issued documentation for a start-up request. These documents must be completed and returned to the issuer before a commission date can be scheduled.

⚠ DANGER

Obey all warning and caution statements. Refer to Section 2.

Read and understand the Operation and Maintenance Manual before operating this equipment. Read all user documentation before performing operations, inspections, repair, or maintenance on this equipment.

Only competent personnel should undertake operation, repairs, maintenance, or servicing of equipment described in this section of the manual. If you do not understand the information or procedure explanations in this manual, STOP and contact your Service Provider for assistance.

6.1 Tools and Materials

Symbols	Description	Symbols	Description
	Lifting straps (properly sized and rated for equipment load)		Drill with bits
	Level		Tape measure
	Gasket (by others)		Adjustable wrench

All products are carefully inspected and tested before shipment from our plant. Upon delivery, check the packaging and equipment for damage that occurred during shipment.

6.2 Pre-Installation

- When preparing the site for installation, allow for valves, drain and bypass as part of your plumbing circuit.
- The Inlet/Outlet connections on the UV Chamber or manifolds are the main connection points. It is recommended that valve bypass lines be incorporated in supply lines to facilitate maintenance in the event partial or the complete unit must be taken out of service. Always follow Lockout Tag Out procedures during all partial or complete maintenance procedures.
- Connecting or attached piping to the UV System should be supported to avoid any undue load bearing strain on the UV Chamber. Limit overhead piping load to 10.9kgs (24lbs) per flange for 3inch; 23kgs (50 lbs) for 4inch; 34 kgs (75lbs) for 6inch. or above. Additional bracing and supports must be installed on any additional piping and valves to reduce the stress on the UV Chamber and manifold Inlet/Outlet connections.
- Allow sufficient air space for the air vents, a minimum of 30cm (12inches) around the sides of the panel, (or greater if required per local code) for sufficient cooling of the inner electronic components.
- Allow 183cm (72 inches) at the service end of the UV Chamber for removal of the UV Lamps and Lamp Sleeves and 23cm (9 inches) at the sensor port(s) for removal of the UV Sensor. At the opposite end, allow 92cm (36 inches) clearance for maintenance.
- If the piping system is subject to impulse pressure resulting in “water hammer” condition, a surge tank or other means must be provided to remove this condition; otherwise the extreme momentary pressure may rupture and fracture the Lamp Sleeves.
- Avoid locations that experience vibration within proximity of heavy equipment or from erratic pumps. Excessive vibration from other equipment can cause damage to UV Lamps within the UV Chamber and to the internal electrical components.
- Remove the plastic dowel placed inside the UV Chamber, used for securing the baffle during shipping.

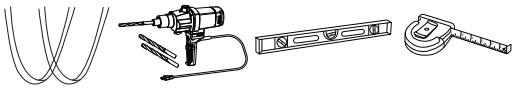
- Protect the equipment from the environment. Do not expose the equipment to direct water spray.
- The UV System does not introduce any chemical residue within the water, it is desirable to install the UV Chamber as close as possible to the point-of-use to avoid potential recontamination by discharge pipes, fitting, etc.

6.2.1 CPP

Prerequisites:

- Clear area where CPP will be installed.
- Apply Lockout tag out devices as necessary. Refer to Section 4.1.

Tools:



Materials:

- Mounting hardware (by others).

Procedure:

1. Connect lifting straps to lifting lugs on CPP and lift the CPP into position.
2. Drill holes in concrete for all the anchor bolts. Refer to anchor bolt manufacturer specifications for hole size.

Note: *CPP can be mounted on a frame if required.*

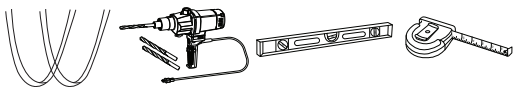
3. Install anchor bolts as specified by customer's civil engineering drawings.
4. Level the CPP top to bottom and front to back.
5. Secure the anchor bolts hardware and torque to manufacturer’s specifications. Remove lifting straps.

6.2.2 UV Chamber

Prerequisites:

- Clear area where the UV Chamber will be installed.

Tools:



Materials:

- Mounting hardware (by others)

Procedure:

1. Position a lifting strap around each of the UV Chamber mounting brackets (between the flange and the bracket). Center the lifting straps around the UV Chamber. Bring the two lifting straps above the UV Chamber and connect as required to a crane. Use a crane to lift the UV Chamber into position. The UV Chamber can be installed in either a horizontal or a vertical position. Refer to Section 6.2.5.

Note: *Avoid trapping air, ensure the outlet is oriented vertically. On vertically mounted units a venting kit is supplied.*

2. Install a flange gasket at the inlet and outlet flanges of the UV Chamber.
3. Loosely install the flange mounting hardware to the UV Chamber inlet and outlet flange to the plant piping. The provided mounting brackets on the UV Chamber can be mounted to pipe supports (by others) if available.

   Note: *The UV Chamber will not bear the load of process piping or other equipment. Make sure all piping is properly supported independent of the UV Chamber.*

4. Level the UV Chamber from front to back (horizontal), top to bottom (vertical).
5. Secure the mounting hardware and torque to manufacturer's specifications.
6. Remove the lifting straps.
7. Install Air Vent if required.
8. Connect the UV Chamber drain to plant piping as required.

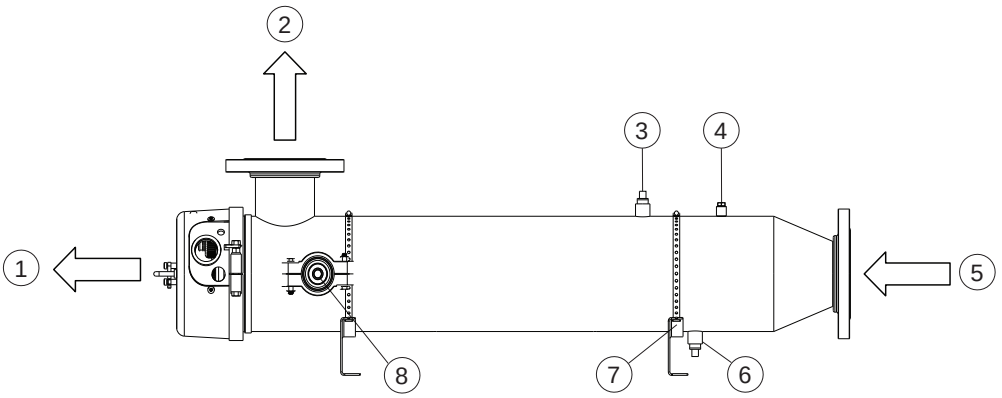


Figure 2 UV Chamber

1	Clearance for UV Lamp replacement	**5**	Inlet
2	Outlet	**6**	Drain
3	Cleaning Port	**7**	UV Chamber Mounting Bracket
4	Pressure Relief Valve Port	**8**	UV Sensor

6.2.3 Electrical Connections

Prerequisites:

- Apply lockout tag out devices as necessary. Refer to Section 4.1.
- Install the CPP. Refer to Section 6.2.1.
- Install the UV Chamber. Refer to Section 6.2.2.
- Remove the Service End Cap. Refer to Section 9.6.

Tools:

Materials:

- Electrical Drawings (supplied with the system)

Procedure:

1. Connect the CPP to the UV Chamber. The individual lamp connectors are numbered with wire tags for convenient connection; match these numbers to their corresponding number on the UV Chamber end plate.
2. Connect the lamp socket to the corresponding UV Lamp.
3. Provide AC power to the CPP matching voltage and power specifications on the serial label of the system.
4. Complete Hydrostatic Test. Refer to Section 6.2.4.

6.2.4 Hydrostatic Test.

Prerequisites:

- Complete Electrical Connections. Refer to Section 6.2.3.
- Remove UV Lamps (if installed). Refer to Section 9.7.2.
- Inspect condition of sleeves for visible cracks or damage. Replace if necessary.
- Make sure the drain valve is closed.

Materials:

Procedure:

1. Slowly fill the UV Chamber with water.
   a. Stand off to the side and make sure the area is clear of all plant personnel.
   b. Pressurize the UV Chamber.
   c. Check for leaks.
   d. Wait twenty minutes.

2. If leaks are found:
   a. Depressurize and drain the UV Chamber. Refer to Section 9.4.
   b. Fix the leaks.
   c. Fill the UV Chamber and do a pressure test. Check for leaks.
3. If there are no leaks, depressurize the UV Chamber. Refer to Section 9.4.
4. Install the UV Lamps. Refer to Section 9.7.2
5. Install the Service End Cap. Refer to Section 9.6

6.2.5 Acceptable UV Chamber Installation Orientations

Horizontal Installation:

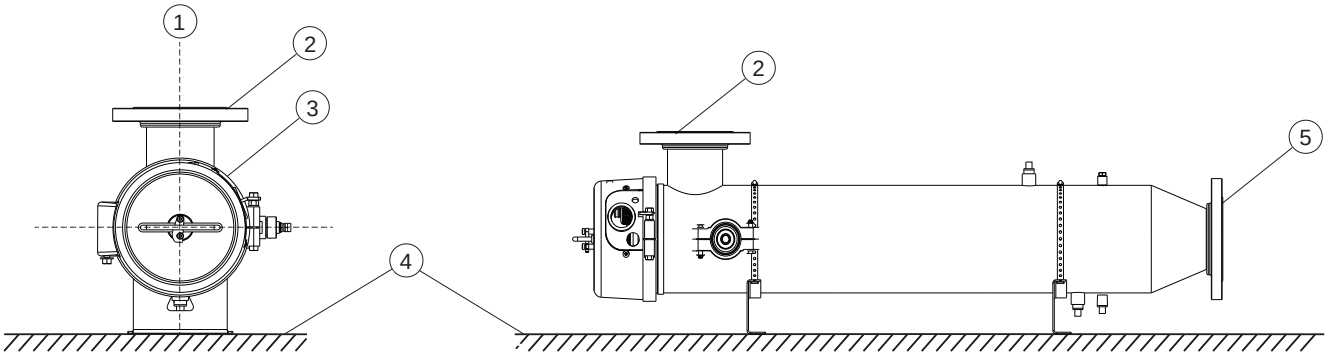


Figure 3 Horizontal Installation

1	Only Allowable Orientation 12:00	**4**	Floor
2	Outlet Flange	**5**	Inlet Flange
3	End Cap		

Note: *The only allowable outlet flange orientation is directly up (12 o'clock, from service entrance side).*

Section 7 System Startup and Shutdown

DANGER

Obey all warning and caution statements. Refer to Section 2.

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7.1 Pre-start Checklist

NOTICE

DO NOT operate the UV System until the UV Chamber is completely filled with water.

To prevent alarm conditions, overheating or equipment damage, process water level and flow in the UV Chamber must be established and maintained at all times when UV Lamps are in operation. Follow all provided site-specific instructions about automatic or manual power to operate the system.

Make sure that:

- The UV Chamber is fully assembled—all cables, UV Lamps and the UV Sensor are installed.
- The wiper motor is attached - ***applies to systems with Automatic Wiping only.***
- The service end cap is attached and fastened with supplied hardware.
- There is water in the UV Chamber.
- There are no water leaks in the UV Chamber.
- The air vent (if applicable) is operating correctly.
- The drainage or water bypass provisions are followed until UV system starts.

7.2 Startup the UV System from SCADA

Prerequisite:

Pre-start Checklist. Refer to Section 7.1.

Startup overview:

The UV System is configured to enable on/off control of the system through SCADA communications.

Startup procedure:

1. The plant SCADA:
   - Does not allow flow in the UV Chamber.
   - Ensures that there are no critical alarms present in the UV System.
   - Sets the Turn On UV Chamber bit.
2. The UV System control logic (Microprocessor Board):
   - Sets the UV Chamber to Warming state.
   - Sets the UV System Warming bit.
   - Sets the power level at 100%.
   - Does not register any alarm until a 20-second startup timer has expired. This prevents false alarms during system startup. In addition, most alarms have individual delay timers associated with them.

3. When warming is complete, and no major or critical alarms are present, the UV System:
   - Sets the UV System Online bit.
   - Clears the UV System Warming bit.
4. The plant:
   - Resolves any active alarms.
   - Allows flow through the UV Chamber.
5. For Pacing systems, the UV System will adjust the UV lamp power.

7.3 Startup the UV System from Local

Prerequisite:

Pre-start Checklist. Refer to Section 7.1.

Startup Overview:

The UV System is configured to enable on/off control of the system through the local CPP interface.

Startup Procedure:

1. The plant:
   - Ensures there are no Critical Alarms present on the UV System.
   - Does not allow flow during startup.
   - Changes the UV System Operation Mode from REMOTE to LOCAL. Refer to Section 8.2.6.
2. The UV System control logic (Microprocessor Board):
   - Sets the UV Chamber to Warming state.
   - Displays the warm up status with countdown timer display on microprocessor interface.
   - Sets the power level at 100%.
   - Does not register any alarm until a 20-second startup timer has expired. This prevents false alarms during system startup. In addition, most alarms have individual delay timers associated with them.
3. When warming is complete, and no major or critical alarms are present, the UV System:
   - Shows “System On-Line” on the microprocessor user interface.
4. The plant:
   - Resolves any active alarms.
   - Allows flow through the UV Chamber.
5. For Pacing systems, the UV System will adjust the UV lamp power.

7.4 Startup the UV System from Remote

Prerequisite:

Pre-start Checklist. Refer to Section 7.1.

Startup overview:

The UV System is configured to enable on/off control of the system through Digital Inputs or Digital Outputs.

Startup procedure:

1. The plant:
   - Ensures there are no Critical Alarms present on the UV System.
   - Does not allow flow during startup.
   - Energizes the Remote On/Off digital input signal.

2. The UV System control logic (Microprocessor Board):
   - Sets the UV Chamber to the Warming state.
   - Energizes the UV System Warming digital output signal (configuration optional).
   - Sets the power level at 100%.
   - Does not register any alarm until a 20-second startup timer has expired. This prevents false alarms during system startup. In addition, most alarms have individual delay timers associated with them.
3. When warming is complete and no major or critical alarms are present, the UV System:
   - Energizes the UV System Online digital output signal (configuration optional).
   - De-energizes the UV System Warming digital output signal (configuration optional).
4. The plant:
   - Resolves any active alarms.
   - Allows flow through the UV Chamber.
5. For Pacing systems, the UV System will adjust the UV lamp power.

7.5 Shutdown the UV System from SCADA

Prerequisite:

Pre-start Checklist. Refer to Section 7.1.

Shutdown procedure:

1. The plant:
   - Stops process flow through UV Chamber.
   - Clears the “Turn On UV Chamber” bit.
2. The UV System:
   - Clears the UV System Online bit.

7.6 Shutdown the UV System from Local

Prerequisite:

Pre-start Checklist. Refer to Section 7.1.

Shutdown procedure:

1. The plant:
   - Stops process flow through the UV Chamber.
2. The Operator changes the UV System Operation Mode from LOCAL to REMOTE. Refer to Section 8.2.6.
3. The UV System:
   - Changes the status from Online to Shutdown.

7.7 Shutdown the UV System from Remote

Prerequisite:

Pre-start Checklist. Refer to Section 7.1.

Shutdown procedure:

1. The plant:
   - Stops process flow through the UV Chamber
   - De-energizes the Remote On/Off digital input signal.
2. The UV System:
   - Changes the status from Online to Shutdown.

DANGER

Obey all warning and caution statements. Refer to Section 2.

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NOTICE

The HMI user interface screens on the CPP vary with the system configuration. The screens described in this section of the manual may not be the same as the screens shown on the CPP.

A Communication Control Board (CCB) and HMI user interface is located on the door of the Control Power Panel (CPP). The CCB monitors the UV Chamber and the HMI user interface provides system status, alarms and control for the UV Chamber.

If the CPP loses power, the control program is retained in memory.

The HMI user interface has a rechargeable battery that takes approximately 48 hours to charge fully and when fully charged will retain the time and date for up to 30 days when powered down. If the system has been powered down for longer than 30 days the time and date will need to be set again on startup. See Section 8.7 for instructions on setting the time and date.

8.1 HMI User Interface

The HMI user interface on the CPP is a touchscreen HMI that is programmed with custom screens. To go through the different screens, push the buttons on the screen. Refer to Figure 4.

Figure 4 HMI User interface

The HMI user interface has two levels of user access: operator-level and technician-level. A user with operator-level access cannot view all the screens that a user with technician-level access can. Operator level requires no log in or password and is the default level.

8.2 Home Screen

The Home Screen is the main system overview screen and is designed to provide all necessary information.

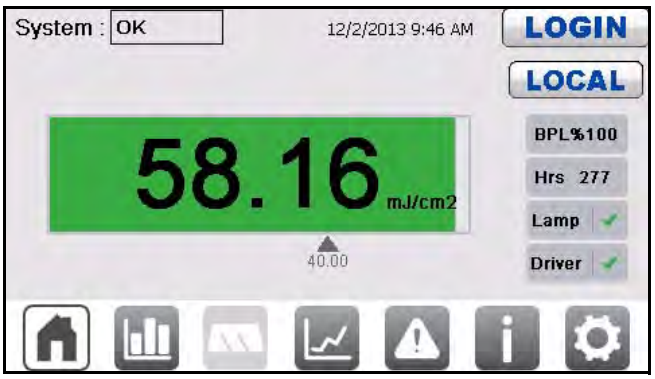


Figure 5 Home Screen

8.2.1 Navigation Bar

Figure 6 Navigation Bar

The navigation bar allows the user to navigate between the different sections of the HMI application and is available on most screens.

The currently active screen will be indicated by the grey on white icon. All others will be white on grey.

NOTICE

If Automatic Wiping is not available, the navigation icon for the wiper screen will be greyed out as shown in the above picture.

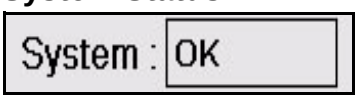
If an alarm is present, the Alarms Screen icon will change color to indicate the severity of the currently active alarms.


No Alarms.


Minor Alarm(s) active.


Major Alarm(s) active.

8.2.2 System Status



The System Status indicator tells the operator what system conditions are currently present and is available on most screens.

The different System Status are:

- **OK** - Lamps are ON, warm-up is complete, no Major or Critical alarms are present. Will display as grey.

- **STANDBY** - Lamps are OFF and no Critical alarms are present. System is ready to start. Will display as green.
- **WARMING** - Lamps are ON, System is not yet ready to treat water. Will display as yellow.
- **ALARM** - An alarm is present. Will display as red.
- **REFERENCE CHECK** - Low UV Intensity Alarms and Low Dose/RED Alarms are currently masked to allow a reference sensor check procedure. Will display as yellow.

8.2.3 Bar Graph

The Bar Graph shows the current:

- RED for NWRI Systems or Dose for Theoretical Systems

The pointer shows the current Major Alarm setpoint for the bar graph.

NOTICE

If an alarm is present, the bar graph will change color to indicate the severity of the currently active alarms.

No Alarms.

Minor Alarm(s) active.

Major Alarm(s) active.

8.2.4 System Clock

The system clock shows the current time and date and is available on most screens.

8.2.5 LOGIN Button

The LOGIN button allows the user to change the user access level and is available on most screens. Touching the button will bring up the login dialog pop-up where users can select the desired user access level and enter the required password for that level. The user access will automatically log back out after 5 minutes of inactivity.

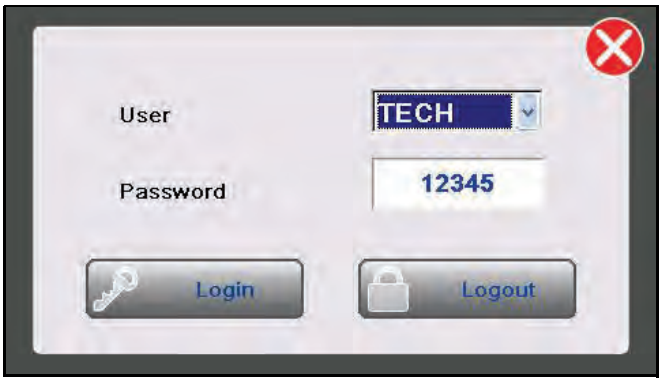


Figure 7 Login Screen

8.2.6 Operation Mode Button

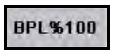
The Operation Mode button allows the user to change the Operation Mode of the system. Touching the button will bring up the Operation Mode pop-up screen.

Touching the desired Operation Mode button will close the pop-up screen and set the system to that Operation Mode if possible. To close the pop-up screen touch the red “X” in the top right of the screen.

Figure 8 Operation Mode Screen

8.2.7 System Information

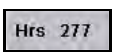
8.2.7.1 Current Lamp Driver Power



The current Lamp Driver power level. If the UV Lamp power is currently in the latched Run 100% Power override mode, the indicator will show yellow.

In this case, touching the indicator will navigate to the General Settings screen where the Run 100% Power can be switched to OFF if the conditions that caused the override have been remedied.

8.2.7.2 Current Lamp Hours



The current system lamp hours. If the current lamp hours exceed the End Of Lamp Life Hours set point, the indicator will show yellow.

In this case, touching the indicator will navigate to the Counters Settings screen where the hours can be reset once new UV Lamps have been installed.

8.2.7.3 Current Lamp Alarm Status

Lamp Alarm status indicator. If there are UV Lamp faults active, the green check mark will be replaced with a red alarm symbol.

In this case, touching the indicator will open a pop-up dialog with the current active lamp alarms.

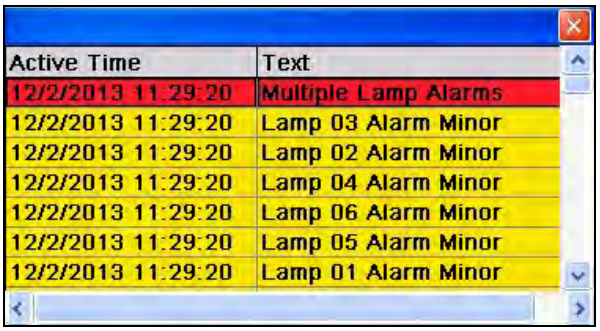


Figure 9 Current Lamp Alarm Status

8.2.7.4 Current Lamp Driver Alarm Status

Lamp Driver Alarm status indicator. If there are Lamp Driver faults active, the green check mark will be replaced with a red alarm symbol.

In this case, touching the indicator will open a pop-up dialog with the current active Lamp Driver alarms.

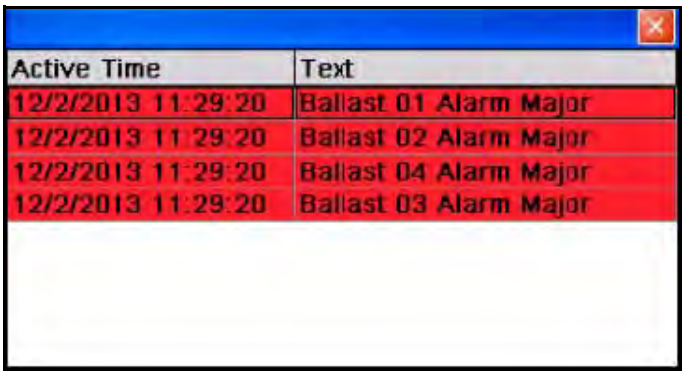


Figure 10 Current Lamp Driver Alarm Status

8.3 Analog Graphs Screen

The Analog Graphs Screen shows the current values of all input signals. This includes signals from Analog Inputs, signals from SCADA and entered signals. Only the signals that are configured for the system will be shown.

The arrows to the side of the graphs show the current alarm set points. The graph will change color based on the alarm level of each signal.

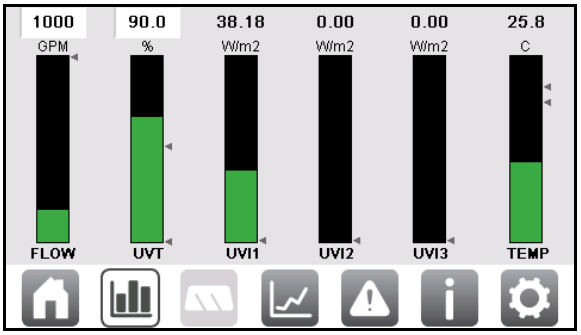


Figure 11 Analog Graphs Screen

NOTICE

If the source for Flow or UVT is set to Entered, the value shown at the top of the graph will be white and the Entered value can be adjusted from this screen.

8.4 Wiper Status Screen

Note: Applies to Automatic Wiping Systems only.

The Wiper Status Screen provides some information and control of the Automatic Wiping System.

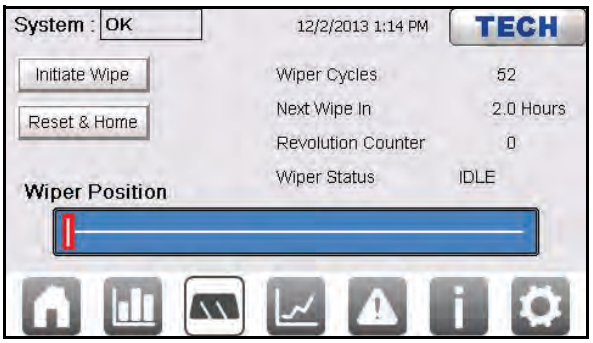


Figure 12 Wiper Status Screen

Initiate Wipe	Initiates a wipe if there are no wiper related alarms regardless of the remaining time until the next automatic wipe
Reset & Home	Resets any wiper related alarms and attempts to move the wiper to the home position.
Wiper Position	Shows a graphic representation of the position of the wiper based on the Revolution Counter.
Wiper Cycles	Shows the number of cycles the wiper has completed since installation. ***Note:*** *Reset the counter at the Counter Settings Screen (Section 8.8.4)*
Next Wipe In	Shows the remaining time until the next scheduled automatic wipe. ***Note:*** *Set the time interval at the Wiper Settings Screen (Section 8.8.3)*
Revolution Counter	Shows the current number of revolutions the wiper has travelled from the park position.
Wiper Status	Shows the current status of the wiper. • IDLE – Wiper is stationary at home position. • EXTENDING – Wiper is currently traveling away from home position. • RETRACTING – Wiper is currently traveling towards home position. • FAULT – Wiper is stationary and has a currently active alarm.

8.5 Trend Screens

The trending screens show a 12 hour history of the UVI, BPL, Flow, UVT and RED or Dose. Only signals that are configured in the system will be available as trend screens.

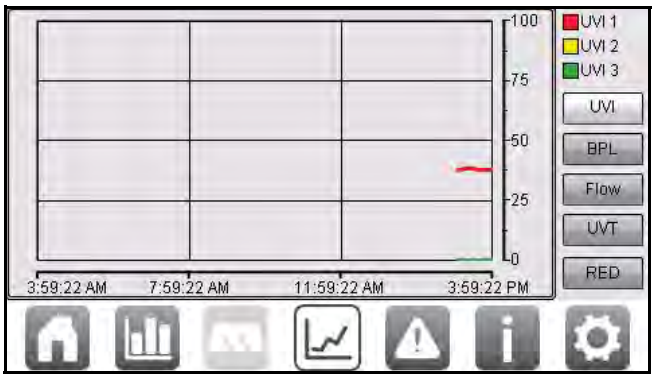


Figure 13 Trend Screen

For Flow and UVI the Y-Axis will be scaled to the 20 mA Full Scale value.

For RED or Dose the Y-Axis will be scaled to 1.5 times the RED or Dose Target.

For UVI, only the number of sensors available will be shown.

8.6 Alarm Screens

8.6.1 Active Alarm Screen

The Active Alarm screen shows only the currently active alarms in the order they occurred.

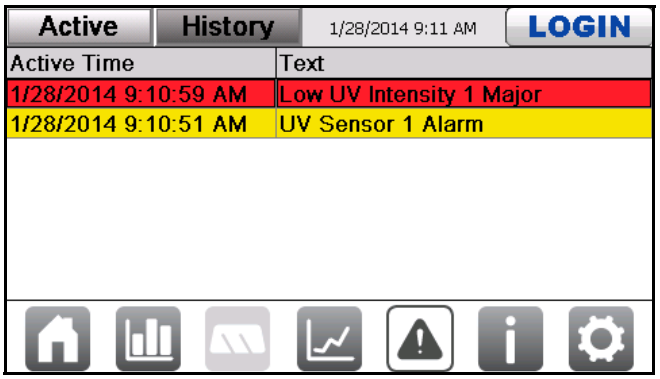


Figure 14 Active Alarm Screen

The alarms are color coded by severity.

Yellow	Minor Alarms	Action should be taken to correct the problem.
Red	Major Alarms	Immediate action is required.
	Critical Alarms	Automatic shutdown of the UV Chamber to prevent possible damage to the equipment.

8.6.2 Alarm History Screen

The Alarm History screen shows the last 100 alarms that are no longer active in the order they were cleared.

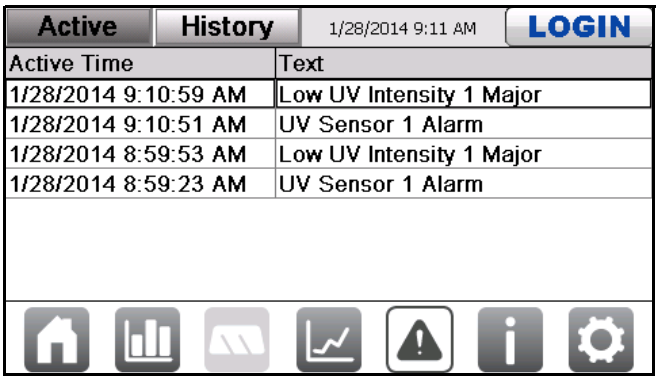
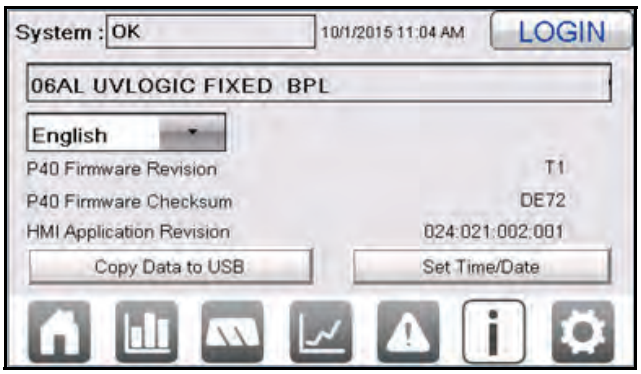


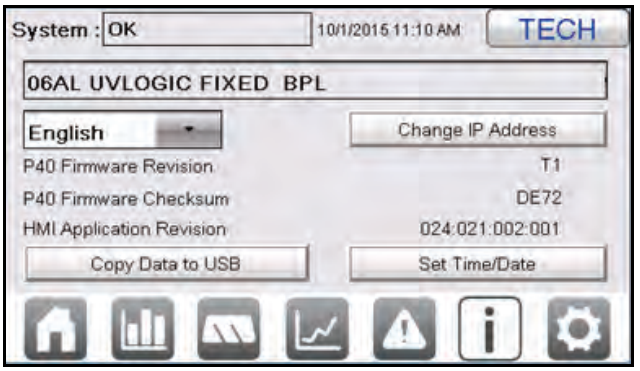
Figure 15 Alarm History Screen

8.7 Information Screen

The Information Screen shows the information about the system and application version that Trojan's Technical Assistance Center (TAC) will need in order to help troubleshoot issues.



Information Screen with General Access



Information Screen with Technician Access

Figure 16 Information Screen

System Type	Describes the UV Chamber size, product line and control methodology.
Language	Allows the user to change the display language for the HMI user interface.
P40 Firmware Revision	Is the application revision of the CCB. Major Revision (Letter). Minor Revision (Number).
P40 Firmware Checksum	Is a verification value for the CCB application.
HMI Application Revision	Is the revision of the HMI user interface application.
Copy Data to USB	Selecting this, pops up the Select Logs to Export screen. This allows the operator to select the range of data logging.
Set Time/Date*	Allows the operator to set the HMI user interface time and date.
Change IP Address	Allows the Operator to set the HMI IP address.

8.7.1 Data Logging

Materials:

- USB Stick

Procedure:

1. Install USB stick into HMI.
2. Navigate to the Information Screen.
3. Select “Copy Data to USB” to show the “Select Data to Export” screen.Refer to Section 8.7.1.1.
4. Select the range of data logging.
5. A completion notification window will pop-up when finished.
6. Remove the USB.

NOTICE

The data is logged every 5 seconds to a 24 hour internal database. Every day at 23:59:30 the internal 24 hour database will be exported to an Excel spreadsheet on an inserted USB memory stick or SD card. The USB stick or SD card must remain inserted in the HMI when this occurs or the previous days data will be lost.

*The HMI user interface has a rechargeable battery that takes approximately 48 hours to charge fully and when fully charged will retain the time and date for up to 30 days when powered down. If the system has been powered down for longer than 30 days the time and date will need to be set again on startup.

8.7.1.1 Export Log Files

Figure 17 Select Logs to Export Screen

1. To Export:
   a. A preset date range → Select either, 1 week, 1 month, 3 months or 1 year.
   b. A custom date range → Select the End Date → Export Range

8.8 Settings Screens

The Settings Screens are divided into two levels of access. General Access screens are available at any time without the need to log in. Technician Access screens require the user to log in using the “TECH” username and password. Refer to Section 8.8.2. Some settings on the General Access screens are not available or are not adjustable without Technician Access.

8.8.1 Settings Menu

The settings menu allows access to the various settings screens. Depending on the level of access some screens may not be available.

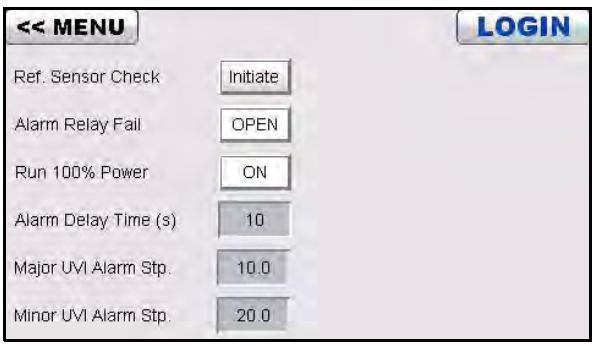
Settings Menu with General Access

Settings Menu with Technician Access

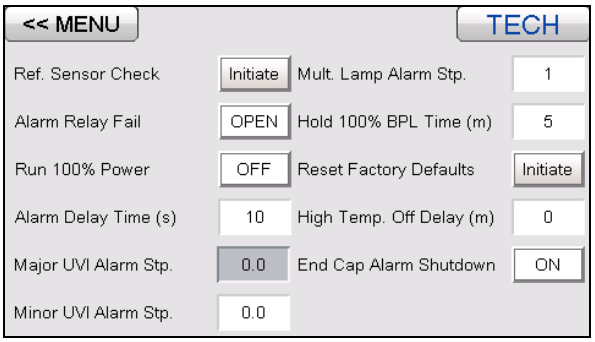
Figure 18 Settings Menu

8.8.2 General Settings Screen

The General Settings screen has settings and buttons that do not fall under one of the other settings categories.



General Settings with General Access



General Settings with Technician Access

Figure 19 General Settings Menu

Reference Sensor Check	Masks UVI Intensity Alarms and Low Dose/RED alarms for 2 minutes to allow a reference sensor check procedure to be performed.
Alarm Relay Fail	Sets the digital alarm output relays active state to open or closed.
Run 100% Power	Overrides BPL to 100%, also used to unlatch BPL override in the event of a Low Dose/RED Major or UV Lamp Fault Major.
Alarm Delay Time	Sets the delay for UV Lamp, Lamp Driver, flow, UVT and valve alarms. (10 to 999 seconds).
Major UVI Alarm Setpoint	A Low UV Major Alarm is triggered when the UVI reading goes below the Low UVI Major alarm setpoint.
Minor UVI Alarm Setpoint	A Low UV Minor Alarm is triggered when the UVI reading goes below the low UVI Minor alarm setpoint. (DVGW only).
End Cap Alarm Shutdown	Enables and disables shutdown the UV System when the End Cap Off Alarm occurs.
Multiple Lamp Alarm Setpoint	Sets the number of UV Lamp faults that must occur before a Multiple UV Lamp Fault Major Alarm alarm occurs (default=1).
Hold 100% BPL Time	Sets the time that the Lamp Driver power level (BPL) stays at 100% power after all Major Alarms are cleared (default=0 minutes). ***Note:*** *This setting does not affect latching 100% BPL when a dose or UV intensity alarm occurs.*

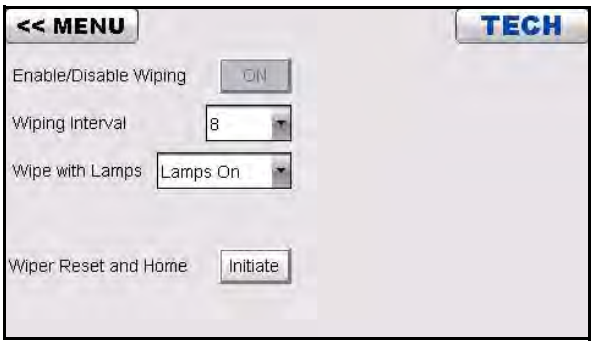
Reset Factory Defaults	Resets the microprocessor user interface settings back to the original factory settings. ***Note:*** *DO NOT reset without authorization from Trojan Technologies.*
High Temperature Off Delay	Sets the High Temperature Off alarm delay—0 to 15 minutes. If set to 0, the UV Lamps turn off immediately when a Hi Temp Critical alarm occurs.

8.8.3 Wiper Settings Screen

Note: *Applies to Automatic Wiping Systems only.*

The Wiper Settings Screen has settings relevant to the Automatic Wiping System.

Wiper Settings with General Access



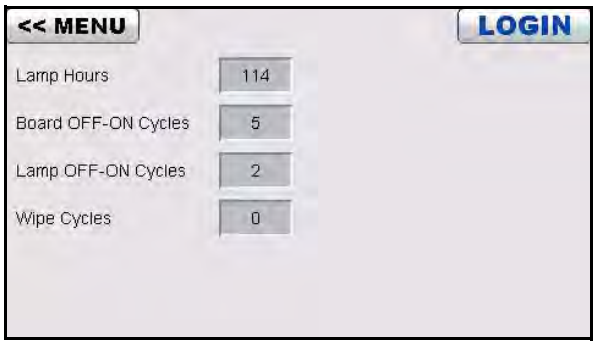
Wiper Settings with Technician Access

Figure 20 Wiper Settings Screen

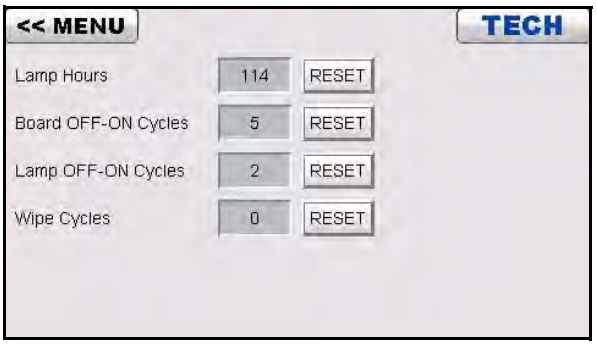
Enable/Disable Wiping	This option is read only and shows if automatic wiping is configured for the unit.
Wiping Interval	Sets the automatic wiper cleaning frequency.
Wipe with Lamps	Selects when wiping is acceptable: • Lamps ON - Wipe only when the UV Lamps are on. • Lamps ON/OFF - Wipe if the UV Lamps are on or off. • Disabled - Disables wiping.
Wiper Reset and Home	Resets any wiper related alarms and attempts to move the wiper to the home position.

8.8.4 Counter Settings Screen

The Counters Settings screen shows various system counters and allows users with Technician access to reset those counters.



Counter Settings with General Access



Counter Settings with Technician Access

Figure 21 Counter Settings Screen

Lamp Hours	The UV Lamp run-time hours for all UV Lamps in the UV Chamber. **RESET** - Resets this counter to zero. ***Note:*** *Do this only after all the UV Lamps in the UV Chamber have been changed. Refer to Section 9.7.2.*
Board OFF-ON Cycles	The counter for the number of times the power to the board has transitioned from OFF to ON. **RESET** - Resets this counter to zero.
Lamp OFF-ON Cycles	The counter for the number of times power to the UV Lamps in the UV Chamber has transitioned from OFF to ON. **RESET** - Resets this counter to zero.
Wipe Cycles*	The counter for the number of successfully completed wipe cycles. **RESET** - Resets this counter to zero. ***Note:*** *Reset if the wiper motor, drive screw and wiper plate are replaced together.* ***For systems with Automatic Wiping System only.**

8.8.5 Analog Input Settings Screen

The Analog Input settings screen allow users with Technician access to configure which analog signals are configured for the 5 available analog input connections.

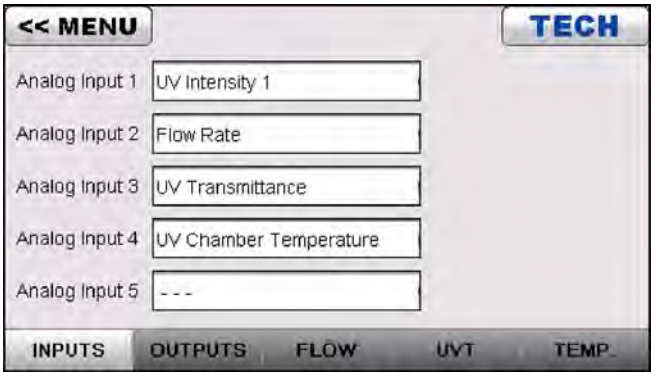


Figure 22 Analog Input Settings Screen

Available Analog Input Signals

- UV Intensity 1
- UV Transmittance
- UV Chamber Temperature
- Valve Position

8.8.6 Analog Output Settings Screen

The Analog Output settings screen allow users with Technician access to configure which analog signals are configured for the available analog output connections.

NOTICE

Analog output signals require the addition of plug in Analog Output Modules. Only 1 Analog Output Module is supplied by default. Up to 3 additional Analog Output Modules can be purchased for a total of 4 Analog Output signals.

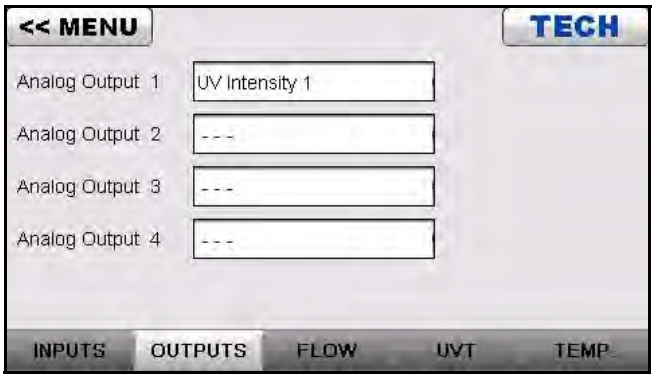


Figure 23 Analog Output Settings Screen

Available Analog Output Signals

- UV Intensity 1
- UV Chamber Temperature
- UV Transmittance
- Valve Position
- Dose Achieved - Theoretical Systems Only
- RED Value - NWRI Systems only
- UV Intensity Lowest

8.8.7 Analog Flow Settings Screen

The Analog Flow Settings screen allows users with Technician access to customize the Flow signal used for pacing and control of the UV System.

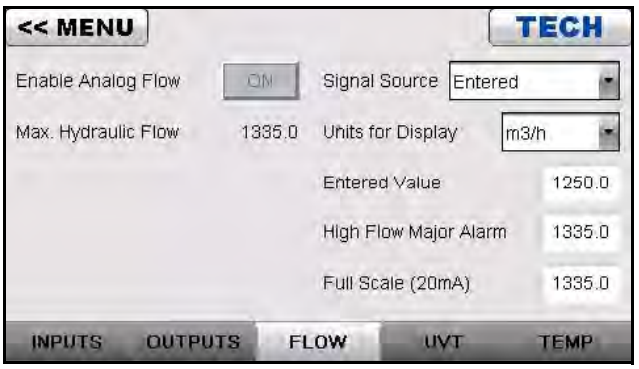


Figure 24 Analog Flow Settings Screen

Enable Analog Flow	This option is read only and shows if a Flow Signal is configured for the system.
Max. Hydraulic Flow	This option is read only and shows the maximum hydraulic flow the UV System has been validated for.
Signal Source	This option sets where the value used for control comes from. The available sources are: • Off -No Flow signal. • Entered - Uses the Entered Value for control. • Live 4-20 mA - Uses the configured Analog Input 4-20 mA signal for Flow Value. • SCADA 4-20 mA - Uses a value sent over SCADA from the Plant SCADA network.
Units for Display	The Flow units that the Flow signal is measured in. Options are: • m^3/h – Cubic Meters per Hour. • m^3/d – Cubic Meters per Day. • USGPM – US Gallons per Minute. • Live 4-20 mA - Uses the configured Analog Input 4-20 mA signal for Flow Value. • USMGD – US Million Gallons per Day. • L/s – Liters per Second.

Entered Value	The static Flow value to be used when Signal Source is configured for Entered. ***Note:*** *This value has no effect when Signal Source is other than "Entered".*
High Flow Major Alarm	The Flow value at which the system will trigger a High Flow Major Alarm.
Full Scale (20 mA)	The 20 mA scaling value to be used when the Signal Source is configured for Live 4-20 mA. This value is determined by the scale of the connected Flow Meter.

8.8.8 Analog UVT Settings Screen

The Analog UVT Settings screen allows users with Technician access to customize the UV Transmittance signal used for pacing and control of the UV System.

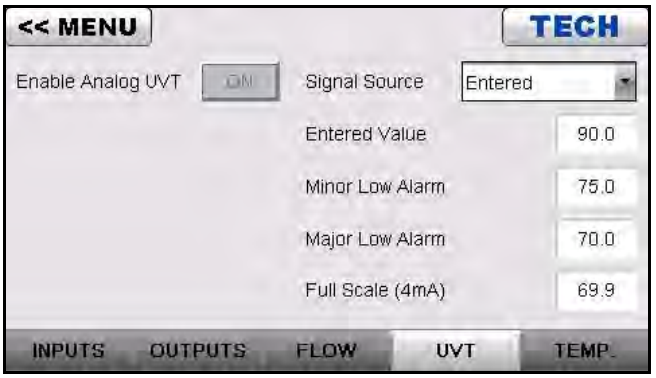


Figure 25 Analog UVT Settings Screen

Enable Analog UVT	This option is read only and shows if a UV Transmittance Signal is configured for the system.
Signal Source	This option sets where the value used for control comes from. The available sources are: • Off -No UVT signal. • Entered - Uses the Entered Value for control. • Live 4-20 mA - Uses the configured Analog Input 4-20 mA signal for UVT Value. • SCADA 4-20 mA - Uses a value sent over SCADA from the Plant SCADA network. • Live Pass Through - Is used to show the value and alarm based on the value but not to use it in control and pacing.
Entered Value	The static UV Transmittance value to be used when Signal Source is configured for Entered. ***Note:*** *This value has no effect when Signal Source is anything other than "Entered".*
Minor Low Alarm	The UVT value at which the system will trigger a Minor Low UVT Alarm.
Major Low Alarm	The UVT value at which the system will trigger a Major Low UVT Alarm.
Full Scale (4 mA)	The 4 mA scaling value to be used when the Signal Source is configured for Live 4-20 mA. This value is determined by the scale of the connected UV Transmittance meter.

8.8.9 UV Chamber Analog Temperature Settings Screen

The Analog Temperature Settings screen allows users with Technician access to customize the UV Chamber Analog Temperature signal used for control of the UV System.

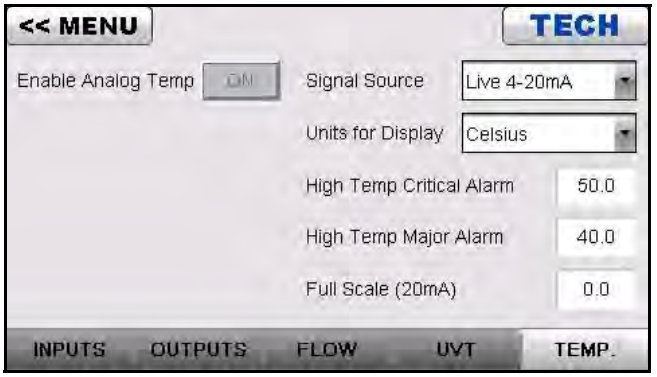


Figure 26 UV Chamber Analog Temperature Settings Screen

Enable Analog Temp.	This option is read only and shows if an Analog Temperature Signal is configured for the system.
Signal Source	This option sets where the value used for control comes from. The available sources are: • Off -No Temperature signal. • Live 4-20 mA - Uses the configured Analog Input 4-20 mA signal for Analog Temperature Value.
Units for Display	Enable temperature units to display in either Celsius and Fahrenheit.
High Temp. Critical Alarm	The Temperature value at which the system will trigger a Critical High Temperature Alarm.
High Temp. Major Alarm	The Temperature value at which the system will trigger a Major High Temperature Alarm.
Full Scale (20 mA)	The 20 mA scaling value to be used when the Signal Source is configured for Live 4-20 mA. This value is determined by the scale of the connected Temperature meter.

8.8.10 Digital Input Settings Screen

The Digital Input settings screen allow users with Technician access to configure which digital signals are configured for the 4 available digital input connections and to Enable/Disable the optional Digital Inputs 1 and 2.

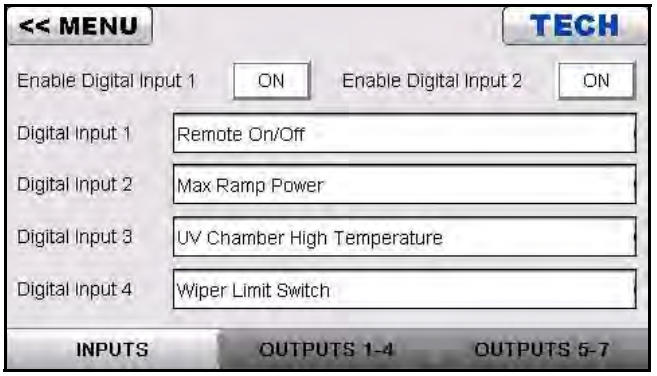


Figure 27 Digital Input Settings Screen

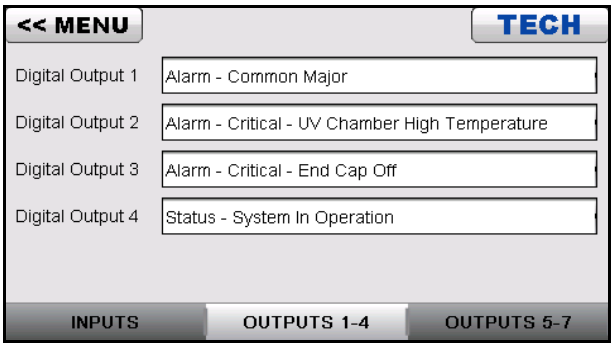
Available Digital Input Signals

- Remote On/Off
- Max (Maximum) Ramp Power
- Wiper Limit Switch*
- UV Chamber High Temperature
- End Cap Limit SW (Switch) SW
- Wipe Now Remote*

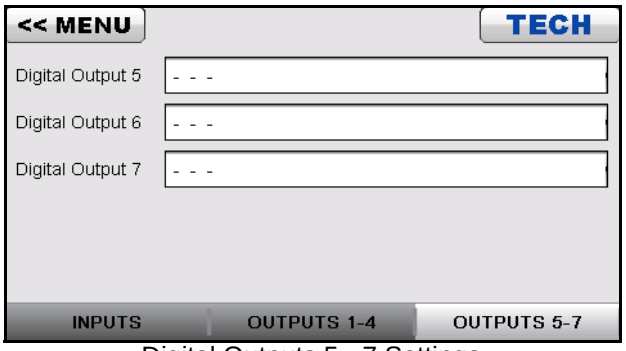
**For systems with Automatic Wiping System only.*

8.8.11 Digital Output Settings Screens (1 – 4 and 5 – 7)

The two Digital Output settings screens allow users with Technician access to configure which digital signals are configured for the 7 available digital output connections.



Digital Outputs 1 - 4 Settings



Digital Outputs 5 - 7 Settings

Figure 28 Digital Output Settings Screens

8.8.12 Communications Settings Screen

The Communications Settings screen allows a user with Technician access to configure SCADA communications.

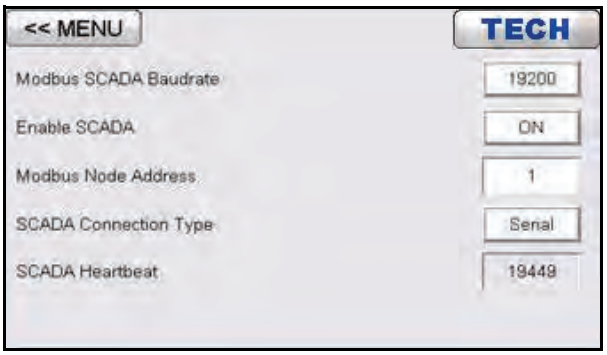


Figure 29 Communications Settings Screen

Modbus SCADA Baudrate	The serial baudrate to be used by SCADA (9600 or 19200).
Enable SCADA	Enables/Disables SCADA.
Modbus Node Address	Modbus Node Address for SCADA.
SCADA Connection Type	Choose from Serial or Ethernet. This setting is dependent on which SCADA add-on card for the P40 is installed.
SCADA Heartbeat	Shows the value of the SCADA Heartbeat register.

Section 9 Maintenance

DANGER

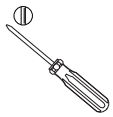
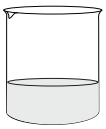
Obey all warning and caution statements. Refer to Section 2.

Read and understand this manual before operating this equipment. Read all user documentation before performing operations, inspections, repair, or maintenance on this equipment.

Only competent personnel should undertake operation, repairs, maintenance, or servicing of equipment described in this section of the manual. If you do not understand the information or procedure explanations in this manual, STOP and contact your Service Provider for assistance.

The tasks and safety information described in this section of the manual are external to the UV Chamber. Tasks that require UV Chamber disassembly are described in Section 11.2.2. Refer to Section 12 for replacement part numbers.

9.1 Tools and Materials

Symbols	Description	Symbols	Description
	Screwdriver - Slotted		Screwdriver - Phillips
	Nut Driver		Lint Free Cloth
	Wrench - Adjustable		Hex Key
	Cotton Swab		Wrench - Open Ended
	Clean Water		Wrench - Socket
	Isopropyl Alcohol		Mild acidic solution (for example, ActiClean Gel™) or approved by Trojan Service, food grade cleaner

9.2 Maintenance Schedule

Scheduled maintenance and inspections can extend the life of the system and prevent problems. Routine maintenance may include partial disassembly to access components for cleaning and visual evaluation. Table 2 shows the maintenance schedule. During any maintenance activity, the manufacturer recommends inspection of all components that can be seen. Some of the preventative maintenance tasks may also need to be done to remove a condition that caused a system alarm.

Table 2 Preventive Maintenance Schedule

System component	Maintenance requirement	Monthly	Semi-Annually	Annually	12,000 hours	As needed
Lamp Sleeves	Inspect a representative sample (i.e. 10%) of lamp sleeves (Section 9.8.1). • Check the Lamp Sleeve O-Rings for UV decay and brittle parts. Replace the Lamp Sleeve O-Rings as needed. • Remove any condensation inside the Lamp Sleeves. • Inspect the Lamp Sleeves for physical damage. • Inspect for build-up on the Lamp Sleeves.	X				
	If there is physical damage to a lamp sleeve, replace the lamp sleeve (Section 9.8.1).					X
	If there is build-up on any of the lamp sleeves inspected, clean all the lamp sleeves (Section 9.8.3). While the lamp sleeve are removed, inspect all the lamp sleeve O-rings. Replace the lamp sleeve O-rings as needed.					X
Lamp Sleeve O-rings	Inspect all Lamp Sleeve O-Rings for wear or when the Lamp Sleeves are removed (Section 9.8.2).			X		
	Replace Lamp Sleeve O-Rings if worn (Section 9.8.1).					X
UV Lamps	Inspect the UV Lamps and UV Lamp pins (Section 9.7.2).			X		
	Replace all the UV Lamps when an End of Lamp Life alarm occurs (Section 9.7.2).				X	
	If a UV Lamp fails inspection or burns out, replace the UV Lamp (Section 9.7.2).					X
UV Sensor	Clean the UV Sensor (Section 9.9.1).	X				
	Replace the UV Sensor (Section 9.9.1).					X
CPP	Replace the air filter (Section 9.11.3).	X				
	Replace a Lamp Driver (Section 9.11.2).					X
Gear Motor	Replace the gear motor (Section 9.10.2).					X
Wiper Revolution Proximity Sensor	Replace the wiper revolution proximity sensor (Section 9.10.3).					X
Wiper Seals and Wiper Seal Holders	Replace the wiper seals and wiper seal holders(Section 10.3.6) * Applies to Wiping Systems only			X		

9.3 Legend

The symbols in the following table will be used in this Section to define the wiping option provided. Follow the instructions that correspond to the supplied system.

Symbol	Description
A	Automatic Wiping Option
N	Non-wiping Option

9.4 Depressurize and Drain a UV Chamber

The manufacturer recommends that the UV Chamber be depressurized and drained before any maintenance, service or repair task is done. Failure to depressurize and drain the UV Chamber can result in serious injury or death. Always follow all site-specific safety protocols and procedures. Refer to Section 2.

Prerequisites:

- Shutdown the UV System. Refer to Section 7.5 and Section 7.6.
- Apply lockout tag out devices as necessary. Refer to Section 4.1.
- The drainage or water bypass provisions are followed until UV system starts.

Materials:

Procedure:

1. Stand off to the side of the end plate. Open the drain valve, as the water level drops, the UV System will depressurize.
2. To verify that the UV Chamber has been depressurized, open the pressure relief valve on the UV Chamber.
   a. If water is discharging from the pressure relief valve then pressure has not been removed from the UV Chamber.
   b. If water is not discharging from the pressure relief valve, the pressure has been removed from the UV Chamber.
3. To Depressurize only, close the drain valve.
4. To Depressurize and drain, keep drain valve open until the UV Chamber is empty.
5. When service is complete, assemble the prerequisites in the reverse order of disassembly.

9.5 Pressurize a UV Chamber

Prerequisites:

- Shutdown the UV System. Refer to Section 7.5 and Section 7.6.
- Apply lockout tag out devices as necessary. Refer to Section 4.1.

- The drainage or water bypass provisions are followed until UV system starts.
- Remove the UV Lamps. Refer to Section 9.7.2.
- Inspect condition of the lamp sleeves, ensure no visible cracks or damage. Replace if necessary.
- Make sure the drain valve is closed.

Materials:

Procedure:

1. Slowly fill the UV Chamber with water.
   a. Stand off to the side of the end plate and make sure the area is clear of all plant personnel.
   b. Pressurize the UV Chamber.
   c. Check for leaks.
   d. Wait twenty minutes.
2. If leaks are found:
   a. Depressurize and drain the UV Chamber. Refer to Section 9.4.
   b. Fix the leaks.
   c. Fill the UV Chamber and do a pressure test. Check for leaks.
3. If leaks are not found, depressurize the UV Chamber. Refer to Section 9.4.
4. Install the UV Lamps. Refer to Section 9.7.2.

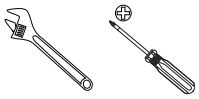
9.6 Remove and Install the Service End Cap

The service end cap must be removed before any maintenance, service or repair task can be done.

Prerequisites:

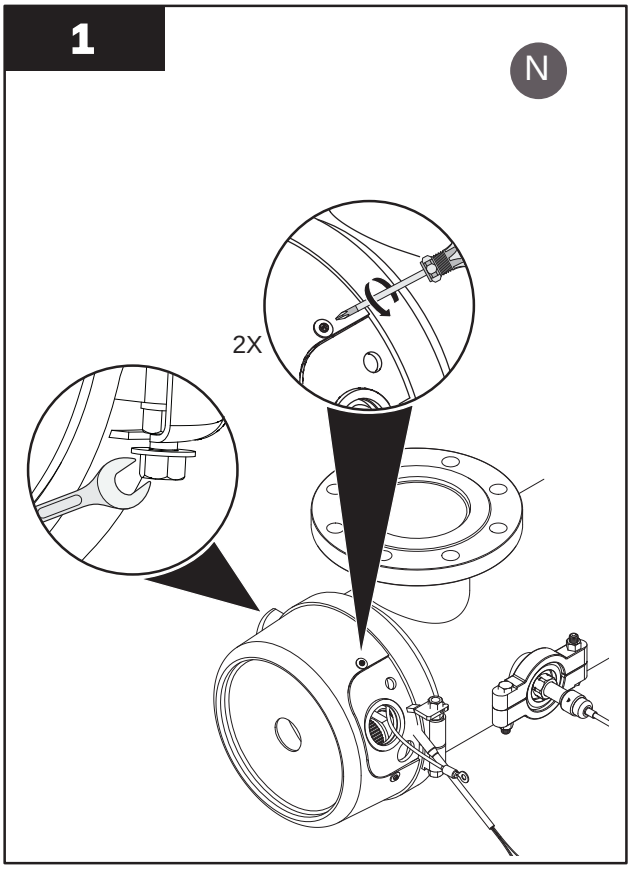
- Shutdown the UV System. Refer to Section 7.5 and Section 7.7.
- Apply lockout tag out devices as necessary. Refer to Section 4.1.
- Depressurize the UV Chamber. Refer to Section 9.4.

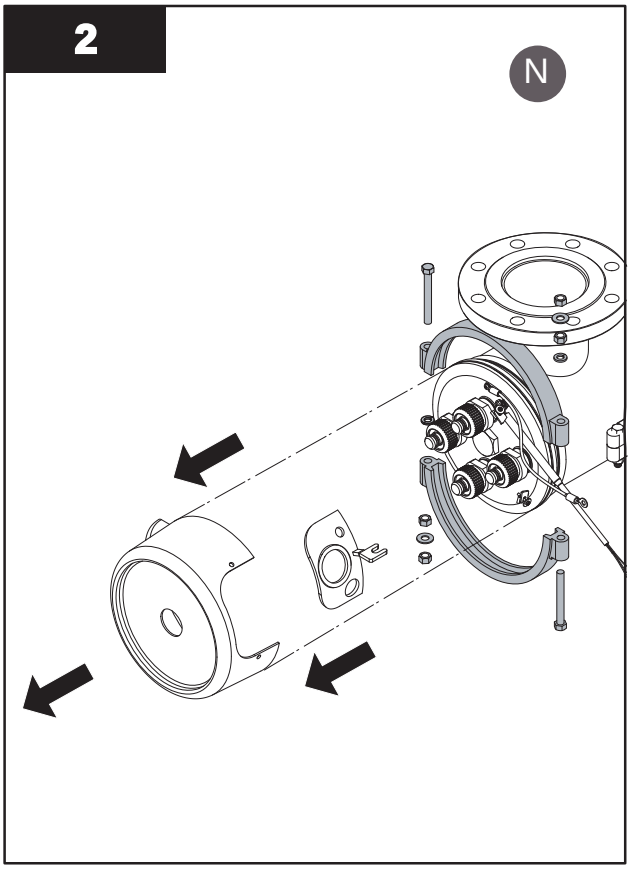
Tools:

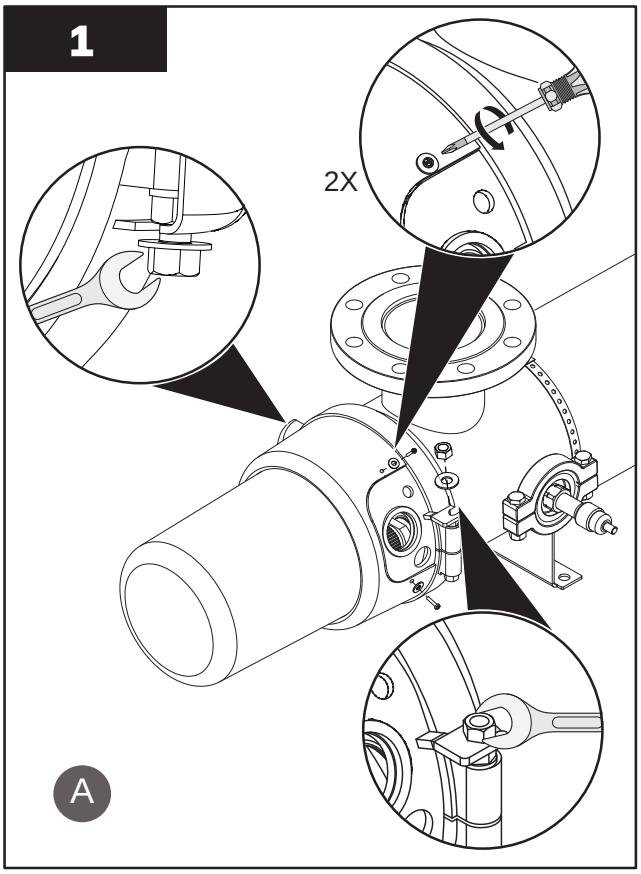


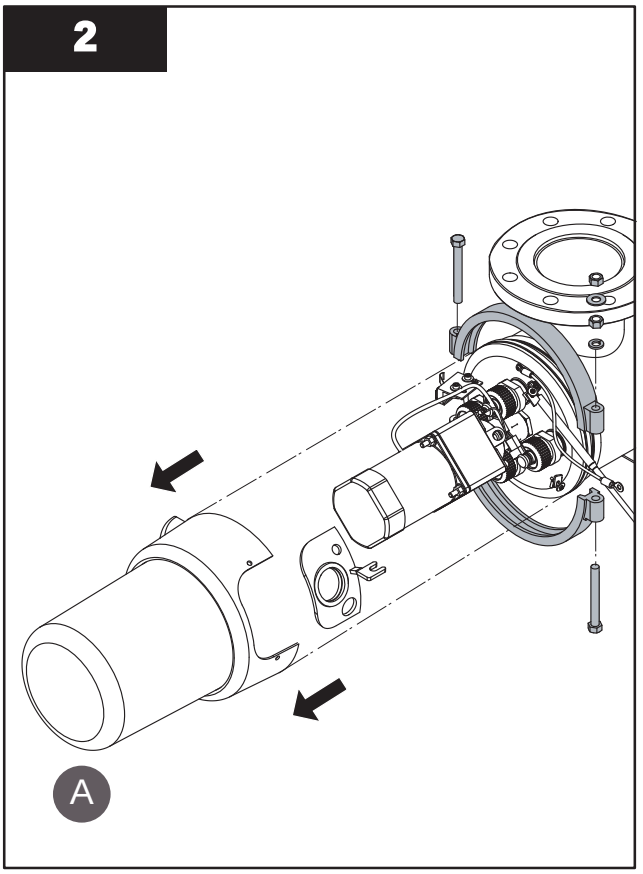
Materials:

Remove:









3. To install a service end cap, do the illustrated steps in the opposite direction.
4. When service is complete, assembly the prerequisites in the reverse order of disassembly.

9.7 UV Lamps

UV lamps contain mercury (Section 2).

9.7.1 Storage Requirements for Used UV lamps

Put used UV lamps into the replacement UV lamp shipping container, or a similar container. It is preferable that the original packing materials be used where possible, or materials adequate to prevent breakage during storage and transportation.

Boxes of used UV lamps should be labeled as such and stored in a location where the potential for accidental breakage is minimized.

A UV lamp re-cycler may have specific procedures and UV lamp storage requirements. Consult with a UV lamp re-cycler to determine all applicable policies.

This component contains Mercury. Dispose according to Local, State, or Federal Laws.

9.7.2 Remove and Replace the UV Lamp

Remove and inspect UV Lamps as a part of scheduled maintenance and when a UV Lamp status alarm occurs. Replace a UV Lamp for every 12,000 hours (an End of Lamp Life alarm occurs) or when the UV Lamp fails inspection.

Prerequisites:

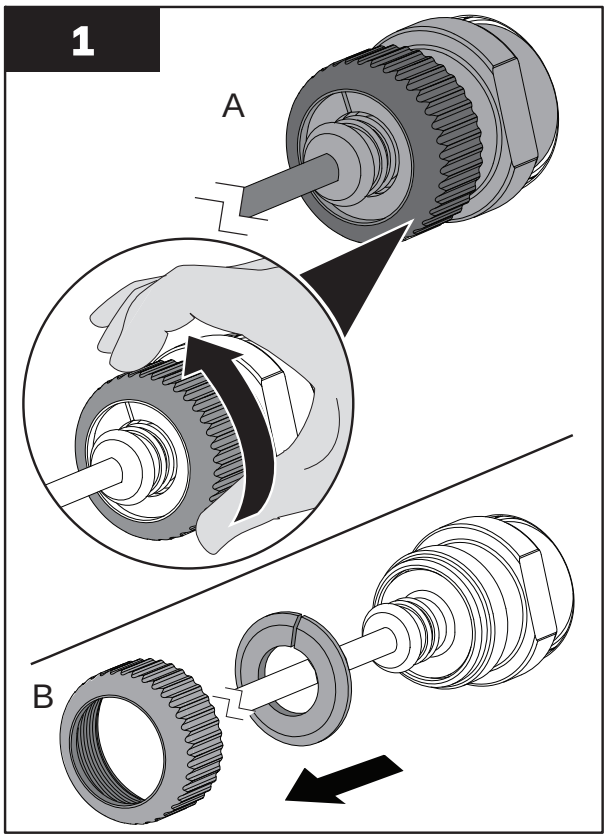
- Shutdown the UV System. Refer to Section 7.5 and Section 7.6.
- Apply lockout tag out devices as necessary. Refer to Section 4.1.
- Depressurize the UV Chamber. Refer to Section 9.4.
- Wait ten minutes to allow UV lamps to cool.
- Remove the Service End Cap. Refer to Section 9.6.
- If necessary, remove the gear motor assembly. Refer to Section 9.10.1.- ***Applies to Automatic Wiping Systems only.***

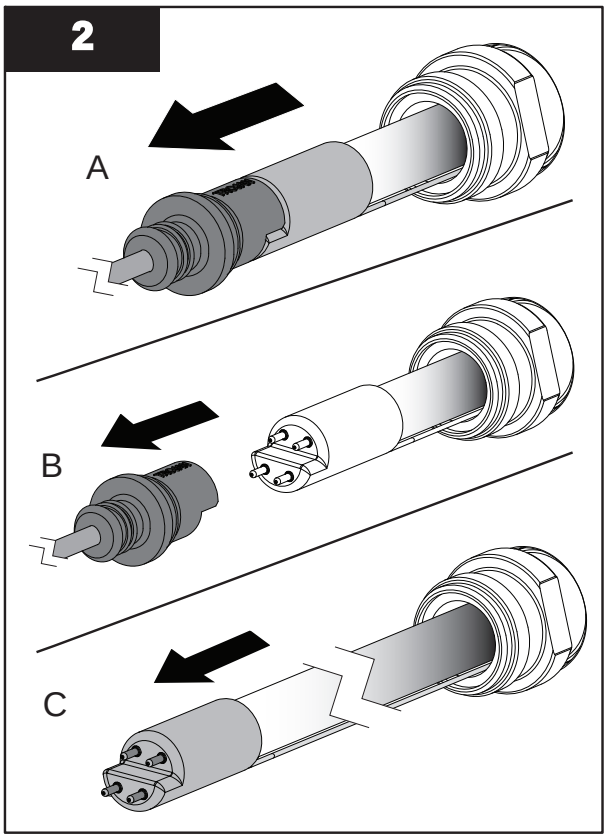
Materials:

- UV lamp

Procedure:

Remove:

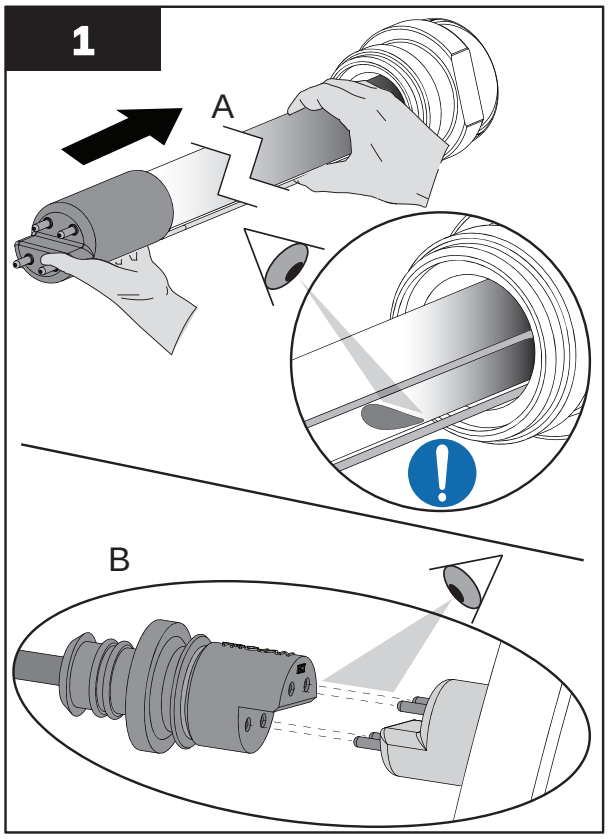


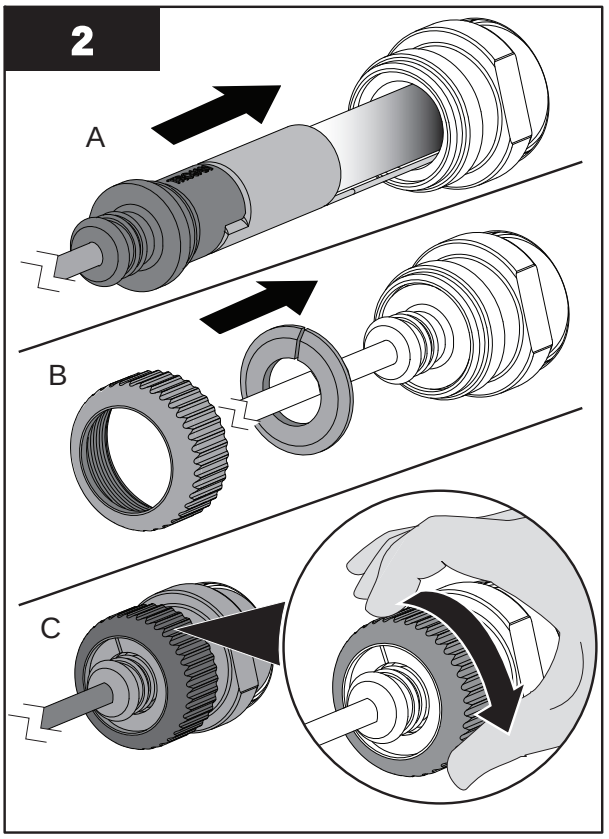


Note: *Ensure that the spring remains inside the Lamp Sleeve.*

3. Inspect the UV Lamp pins for:
   - Evidence of overheating
   - Moisture
   - Displaced or bent pins
4. Inspect the UV Lamp for:
   - Cracks or breaks, loose ceramic ends.
5. If the conditions listed are:
   - Present, replace the UV Lamp.
   - Not present, reinstall the UV Lamp.

Install:





Notes: *1) Always support the UV Lamp with clean, cotton gloved hands.*
2) Align the UV Lamp so that the amalgam spot is on the bottom.

Note: *Hand tighten the cap compression nut.*

3. Dispose of the old UV lamp, as per local regulations.
4. Reset Lamp Hours. Refer to Section 8.8.4.
5. When service is complete, assemble the prerequisites in the reverse order of the disassembly.

9.8 Lamp Sleeves

UV Lamps and Lamp Sleeves are made of fragile quartz tubing and easily fractured. Do not strike, bend or apply pressure or it will break. Discard UV Lamps and Lamp Sleeves appropriately. Follow all local regulations.

NOTICE

Use caution and apply only 10.1 N.m (90 lbf.in) of torque to the lamp sleeve bolt. Excessive torque will crack the lamp sleeve. Low torque may result in water leakage into the service end cap. Use only the provided lamp Sleeve Bolt Tool.

9.8.1 Remove and Replace the Lamp Sleeves and Lamp Sleeve O-rings

Prerequisites:

- Remove a UV Lamp. Refer to Section 9.7.2.

Tools:

- Lamp Sleeve Removal Tool
- Sleeve Bolt Socket
- 3/8-in. drive torque wrench, 10.1 N.m (90 lbf.in)

Materials:

- Lamp Sleeve - if required
- Lamp Sleeve O-Ring(s)
- Sleeve Bolt cushion ring(s)

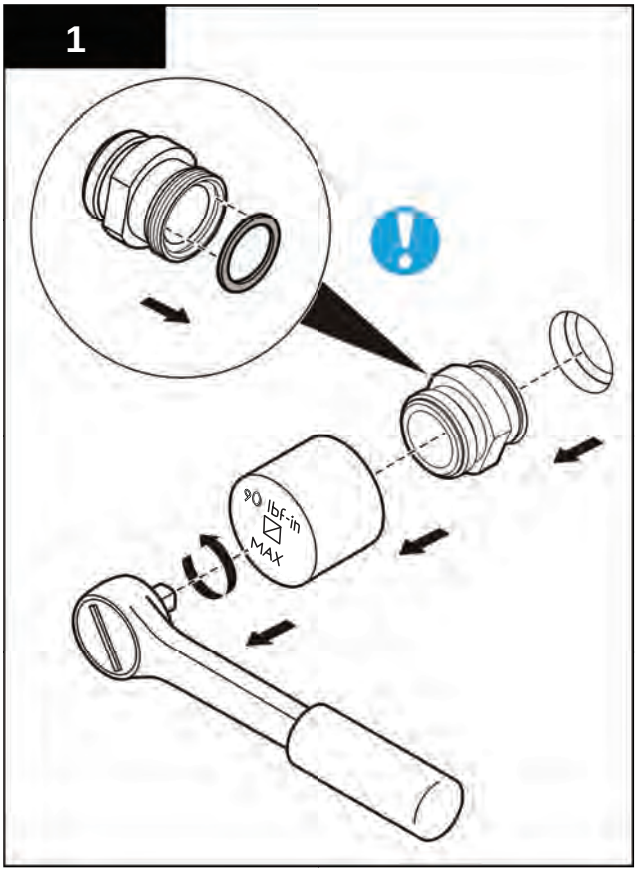
Procedure:

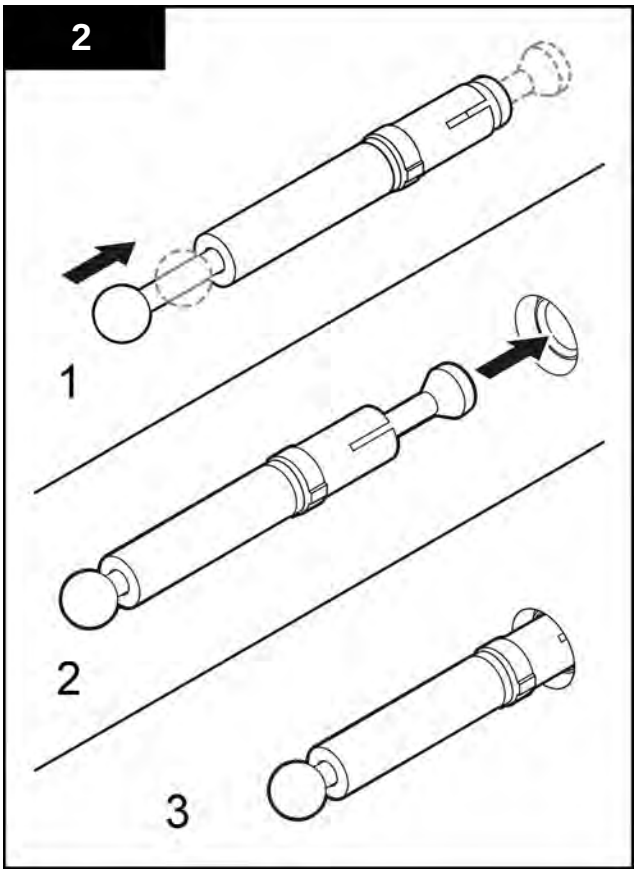
NOTICE

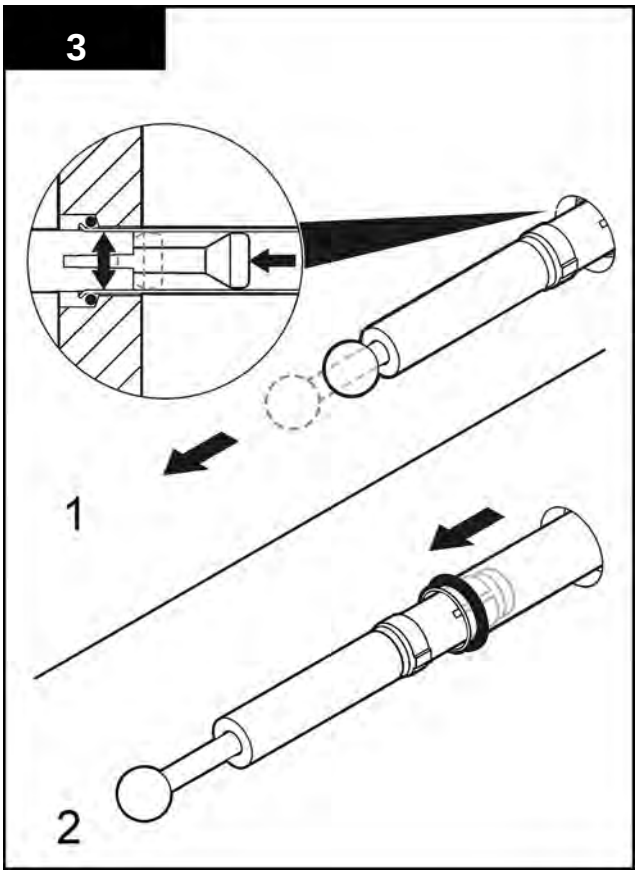
To prevent Lamp Sleeve damage during removal, be sure to keep the Lamp Sleeve level and perpendicular to the end plate. Physical damage to Lamp Sleeves indicates a possible serious condition in the UV Chamber. Full service of the UV Chamber may be needed.

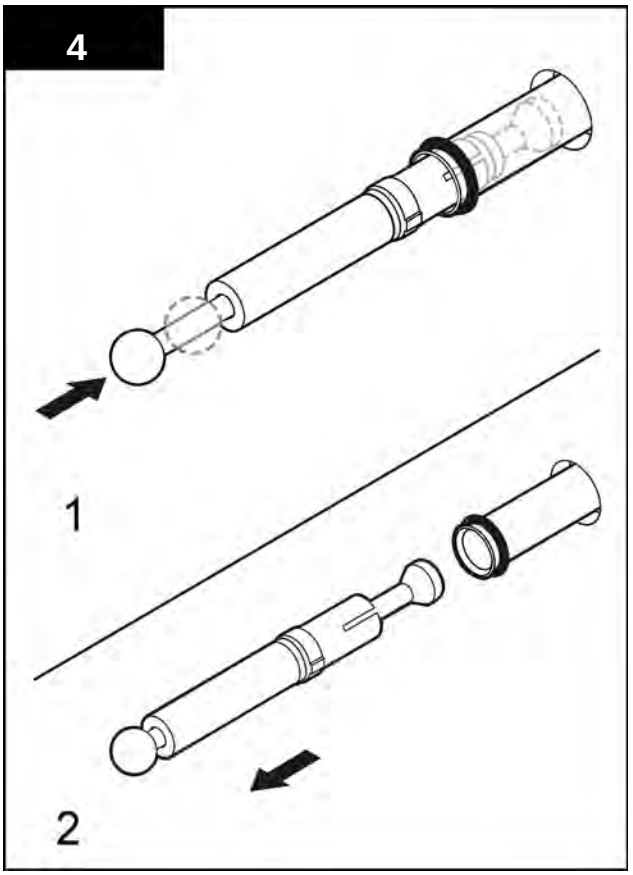
Replace the Sleeve Bolt cushion ring whenever the Sleeve Bolt is removed or the pressure seal is broken.

Remove:



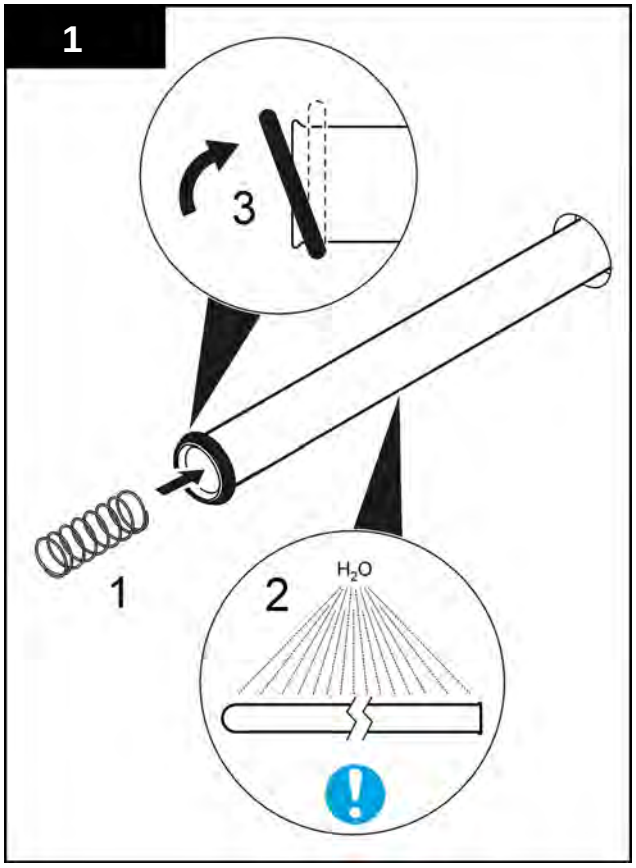


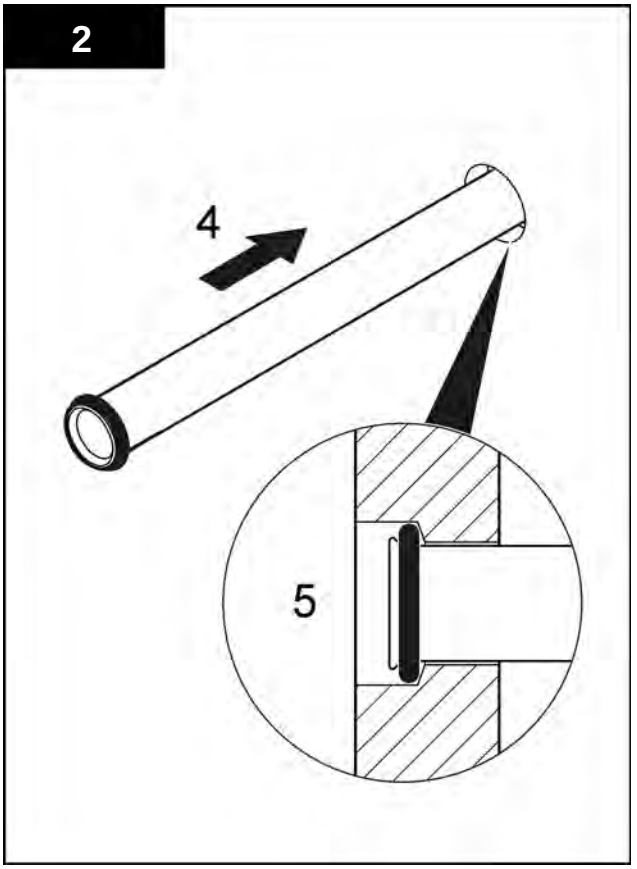


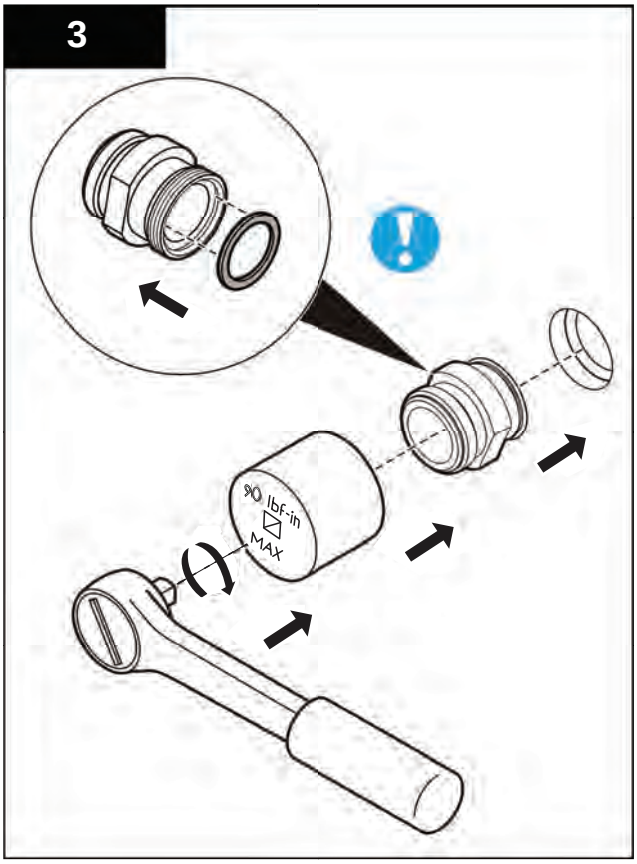


Note: *Inspect the Lamp Sleeve, Lamp Sleeve O-Ring (Section 9.8.2).*

Install:







9.8.2 Inspect the Lamp Sleeves and Lamp Sleeve O-rings

Inspect the Lamp Sleeves and Lamp Sleeve O-Rings as a part of scheduled maintenance, when a UV Intensity Low alarm occurs or a Dose/RED Low alarm occurs.

Prerequisites:

- Remove Lamp Sleeves and Lamp Sleeve O-Rings. Refer to Section 9.8.1.

Tools:

- Lamp Sleeve Removal Tool
- Sleeve Bolt Socket
- 3/8-in. drive torque wrench, 10.1 N.m (90 lbf.in)

Materials:

- Lamp Sleeve - if required
- Lamp Sleeve O-Ring(s)
- Sleeve Bolt cushion ring(s)

Procedure:

1. Inspect the Lamp Sleeves for:
   - Scratches, fractures or other physical damage. If there is physical damage to the lamp sleeves, remove all the lamp sleeves for inspection and replace the lamp sleeves with physical damage. Refer to Section 9.8.2.
   - Excessive build-up. If the inspection sample shows excessive build-up, remove all of the lamp sleeves for manual cleaning. Refer to Section 9.8.3.
   - Excessive build-up, service the Automatic Wiping System. Refer to Section 9.10.
2. Replace any Lamp Sleeve O-Rings that are worn.
3. If the Lamp Sleeves do not have excessive buildup or physical damage, go to the next step.
4. Install the Lamp Sleeve. Refer to Section 9.8.1.

   Note: *Replace the lamp sleeve bolt cushion ring (placed inside the lamp sleeve bolt groove) whenever the lamp sleeve bolt is removed or the pressure seal is broken.*
5. Do a pressure test to check for leaks. Refer to Section 9.5
6. If there are no leaks, depressurize the UV Chamber. Refer to Section 9.4.

   Note: *Draining the UV Chamber is not necessary.*
7. When service is complete, assemble the prerequisites in the reverse order of the disassembly.

9.8.3 Clean the Lamp Sleeves Manually

NOTICE

Do not use abrasive materials to clean a Lamp Sleeve. Abrasive materials will scratch and cause damage to the Lamp Sleeve.

Keep water and debris out of the Lamp Sleeves. Moisture can cause build-up in the Lamp Sleeves and corrosion of the lamp shunt and pins, which results in shorter UV Lamp life. Use a lint-free cloth to remove water or debris.

Build-up on the Lamp Sleeves decreases the amount of UV light, and can result in higher UV Lamp temperatures and decreased UV Lamp efficiency.

Only use Trojan Technologies approved cleaning solutions on the Lamp and Sensor Sleeves. Use of unapproved chemicals may result in damage to the equipment. For a list of approved cleaning solutions refer to Table 3.

Table 3 Approved Cleaning Solutions and Dilutions Ratio's

Solution	Dilution
ActiClean Gel	Not Required
20% Phosphoric Acid	2 parts ActiClean Gel to 1 part acid
40% Phosphoric Acid	5 parts ActiClean Gel to 1 part acid
75% Phosphoric Acid	10 parts ActiClean Gel to 1 part acid
80% Phosphoric Acid	12 parts ActiClean Gel to 1 part acid

Prerequisites:

- Remove Lamp Sleeves. Refer to Section 9.8.1.

Materials:

Procedure:

1. Clean the Lamp Sleeve with a mild acidic solution and a lint-free cloth. Move the cloth up and down the Lamp Sleeve.

   Note: *Clean up spills to avoid slipping and dispose ActiClean Gel as per site and country protocol.*

2. Rinse the Lamp Sleeve with clean water.
3. When service is complete, assemble the prerequisites in the reverse order of disassembly.

9.9 UV Sensor

9.9.1 Remove and Replace the UV Sensor and Sensor Window

Replace a UV Sensor when the UV Sensor is damaged or when UVI alarms occur that are not caused by UV lamp failure . Clean the UV Sensor as part of scheduled monthly maintenance or when a low UV alarm occurs.

Prerequisites:

- Depressurize and drain the UV Chamber. Refer to Section 9.4.

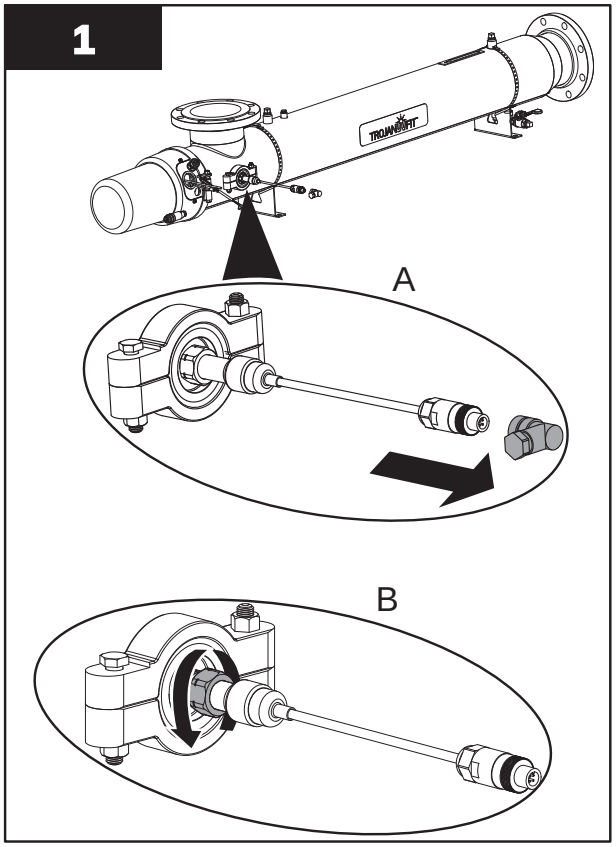
Tools:

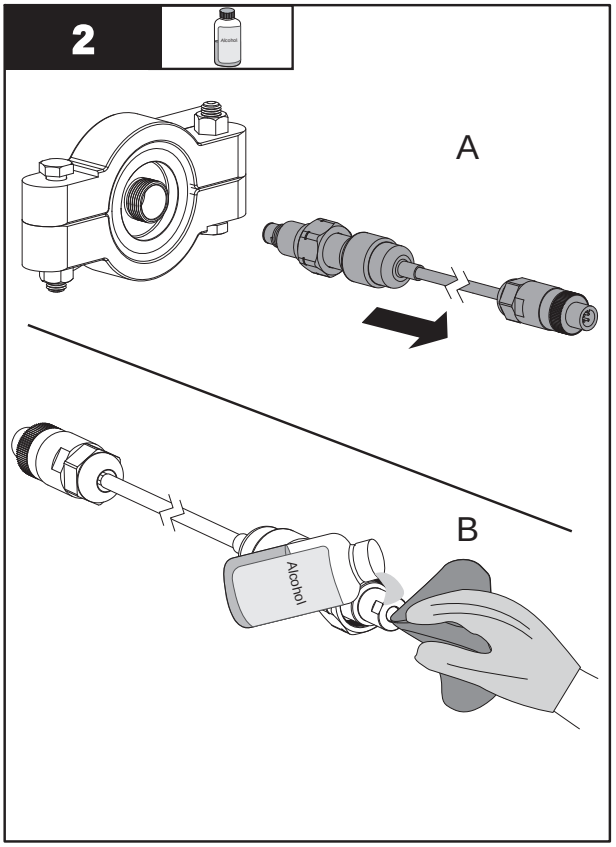
Materials:

- UV Sensor O-ring
- UV Sensor

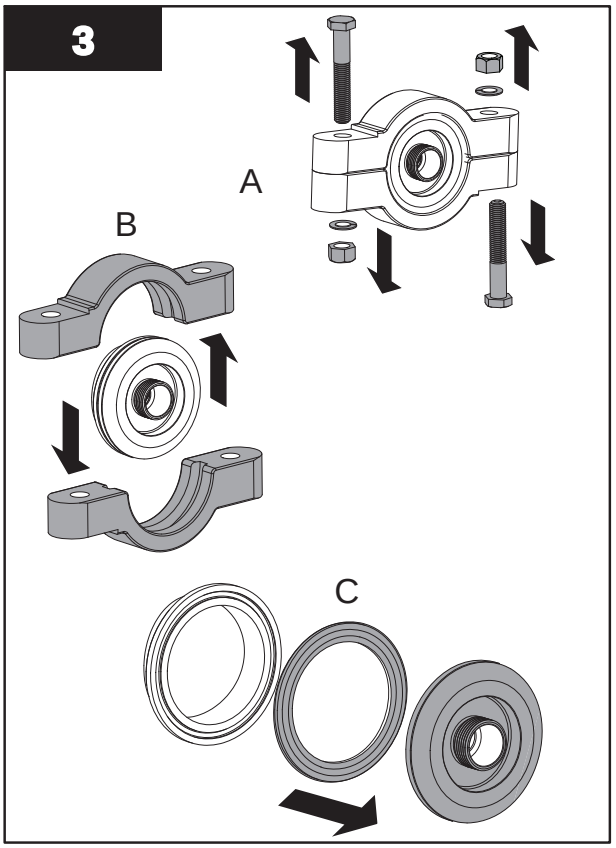
Procedure:

Remove and Clean the UV Sensor:





Note: *If water is draining at a high rate from the sensor port the UV Chamber is not fully drained. Drain UV Chamber completely before continuing.*



4. When service is complete, assemble the prerequisites in the reverse order of disassembly.

9.10 Automatic Mechanical Wiper System (AMWS)

Note: *Applies to Automatic Wiping Systems only.*

9.10.1 Remove the Gear Motor Assembly

Remove the gear motor assembly as necessary to access UV lamps and lamp sleeves that are located behind the gear motor assembly.

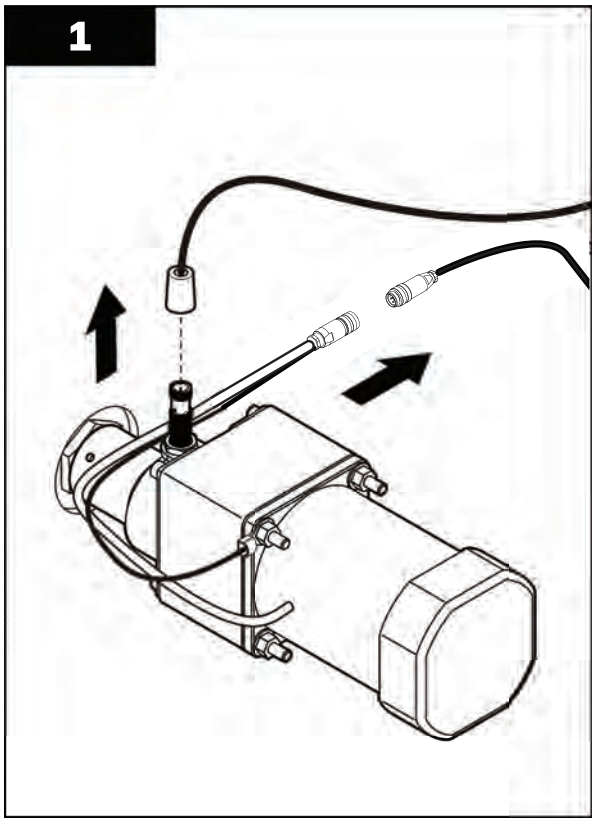
Prerequisites:

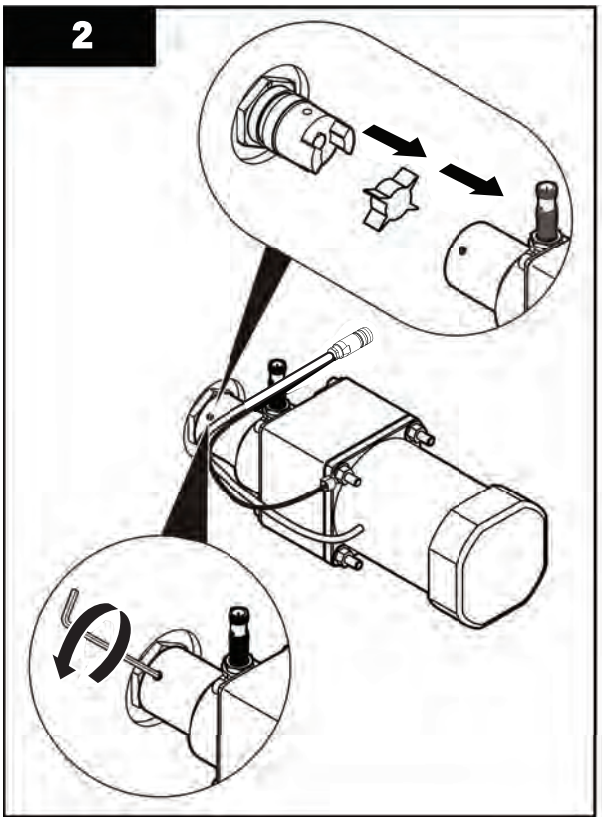
- Remove the Service End Cap. Refer to Section 9.6.

Tools:

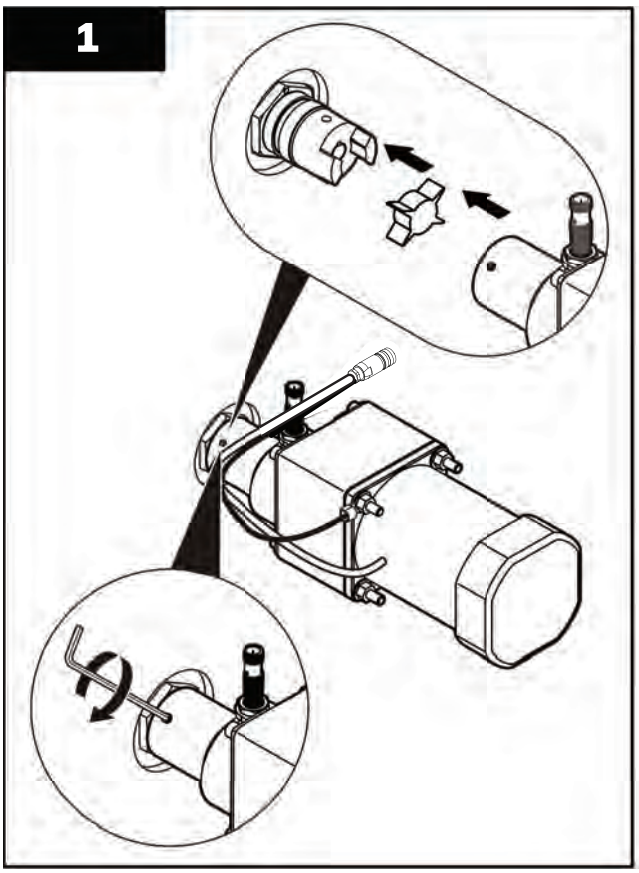
Materials:

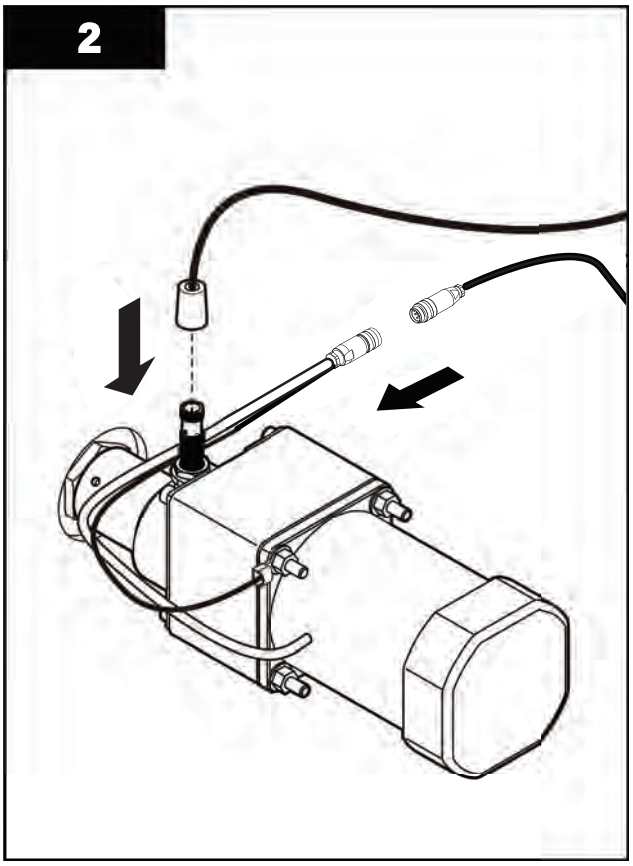
Remove:





Install:





Post-requisites:

- When service is complete, assemble the prerequisites in the reverse order of disassembly.

9.10.2 Replace the Gear Motor

Replace the gear motor when it can no longer turn the drive shaft to move the wiper plates.

Prerequisites:

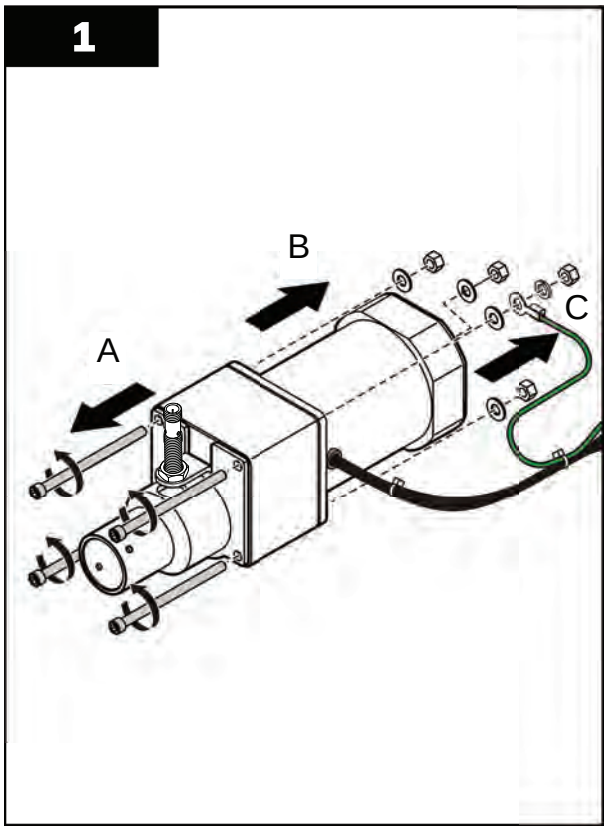
- Remove the gear motor assembly. Refer to Section 9.10.1.

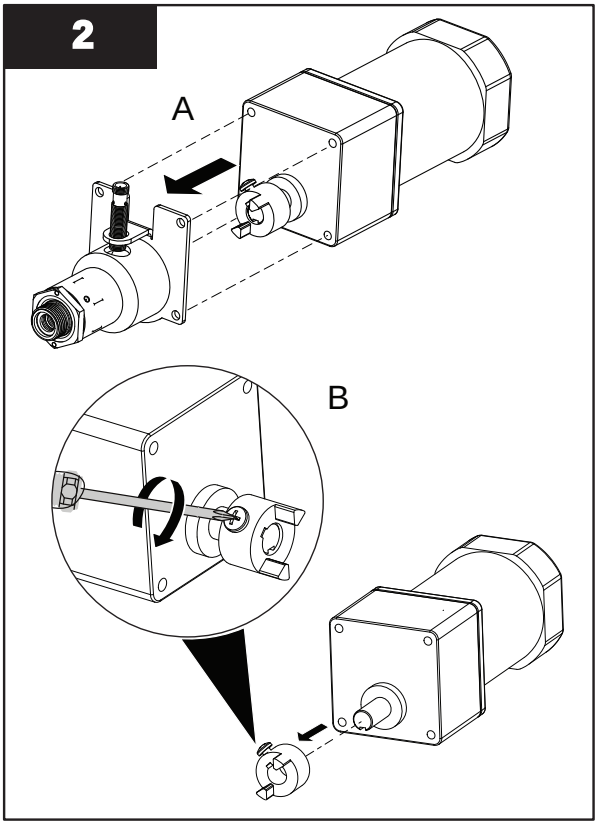
Tools:

Materials:

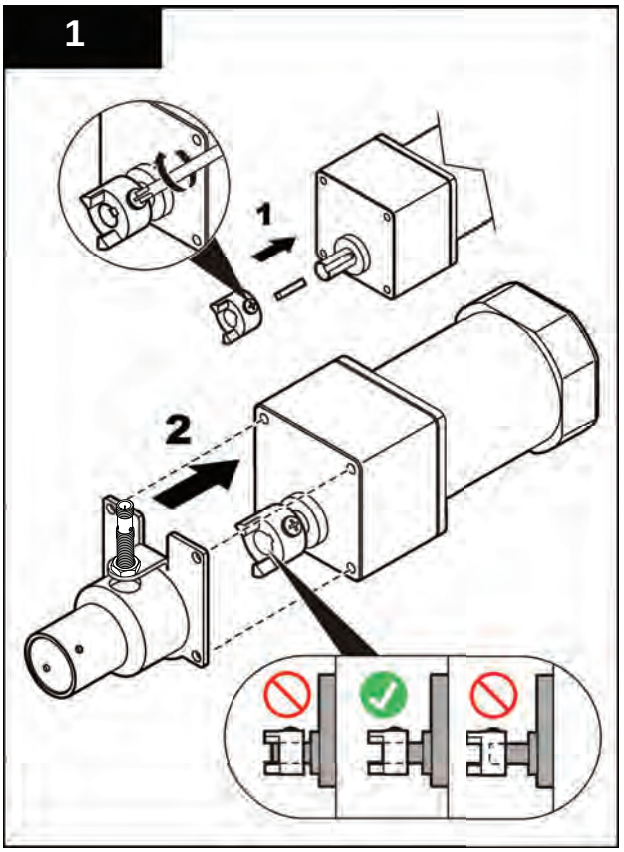
- Gear motor

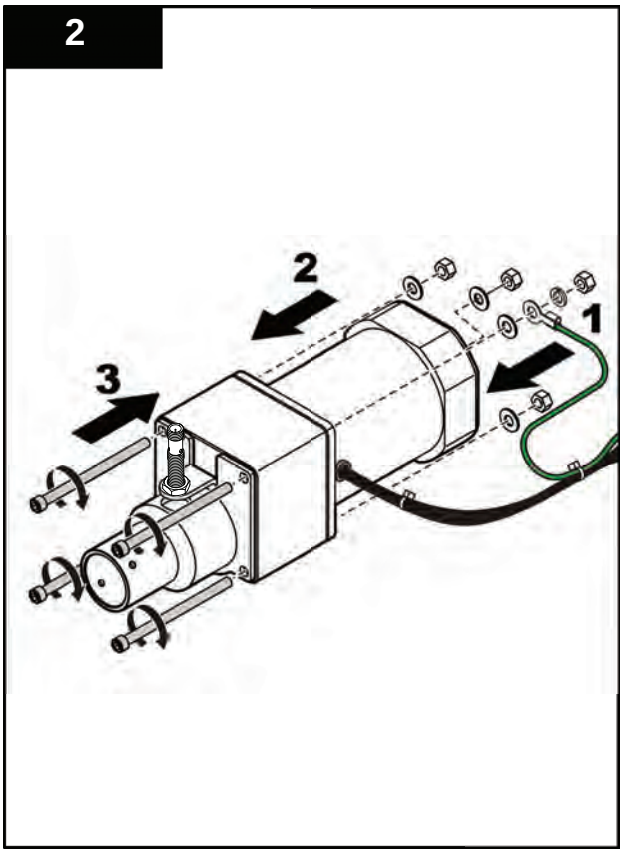
Remove:





Install:





- Turn the drive shaft coupler so that the wiper revolution proximity UV Sensor has enough clearance to rotate freely (approximately 0.050" or 1.25mm).
- When service is complete, assemble the prerequisites in the reverse order of the disassembly.

9.10.3 Replace the Wiper Revolution Proximity Sensor

Replace the wiper revolution proximity sensor when a wiper home alarm occurs and the wiper revolution proximity sensor has failed.

Prerequisites:

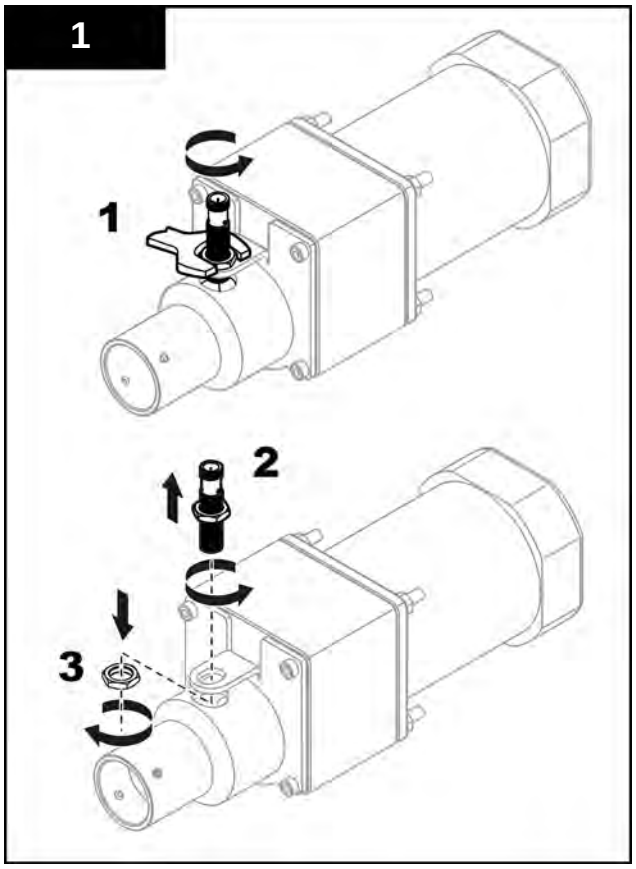
- Remove the gear motor assembly. Refer to Section 9.10.1.

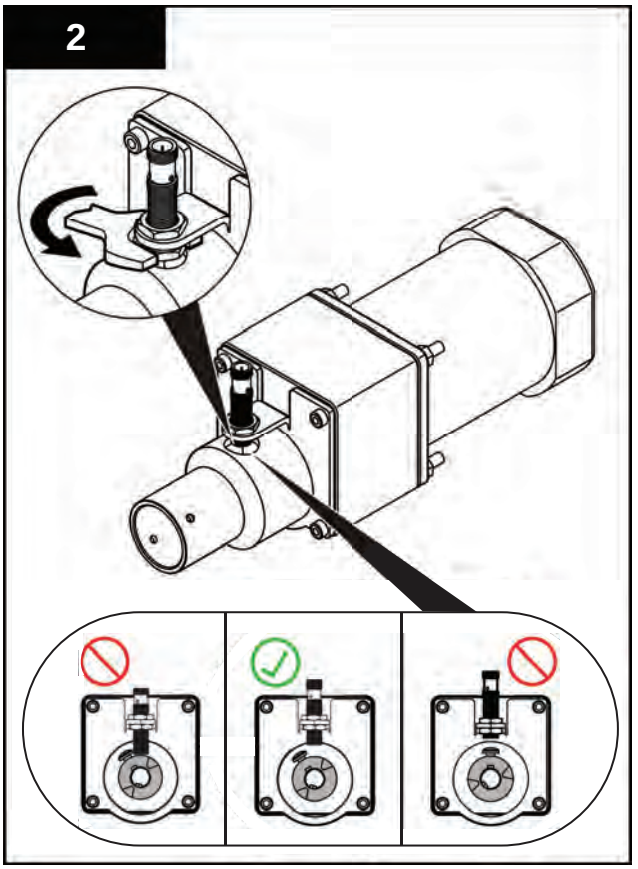
Tools:

Materials:

- Revolution proximity sensor

Replace:





- Turn the drive shaft coupler so that the wiper revolution proximity sensor has enough clearance to rotate freely.
- When service is complete, assemble the prerequisites in the reverse order of the disassembly.

9.11 Control Power Panel (CPP)

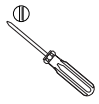
9.11.1 Open the CPP Enclosure

Open the CPP enclosure to replace lamp drivers or the air filter.

Prerequisites:

- Shutdown the UV System. Refer to Section 7.5 or Section 7.6 as needed.
- Apply lockout tag out devices as necessary. Refer to Section 4.1.
- Wait five minutes to allow stored energy to dissipate.

Tools:



Materials:

Procedure:

1. Turn the CPP disconnect switch to off (horizontal) to turn power off to the CPP. Refer to Figure 5. Apply lockout tag out as necessary to prevent unexpected exposure to high voltage.
2. Use a screwdriver on 1/4 turn to open the CPP door.

9.11.2 Replace a Lamp Driver

Replace a lamp driver when a lamp driver failure alarm occurs.

Prerequisites:

- Open the CPP enclosure. Refer to Section 9.11.1.

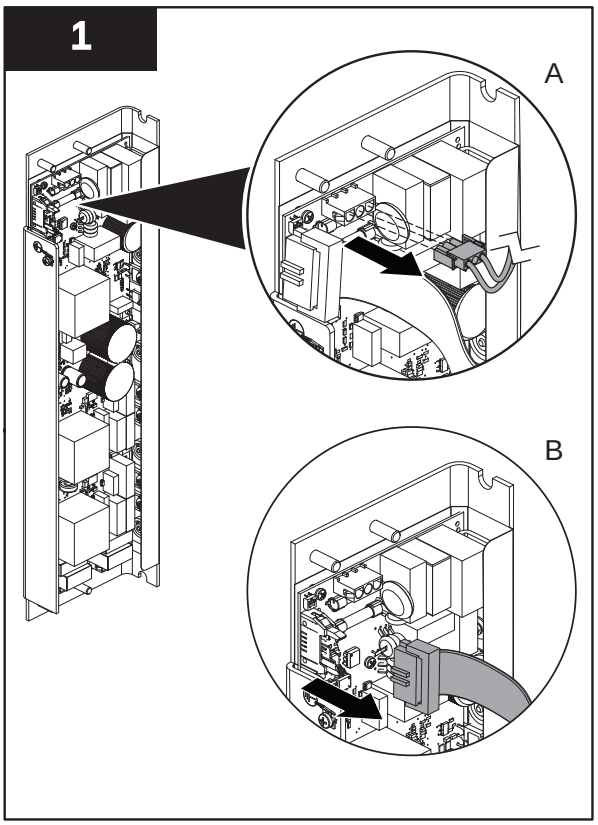
Tools:

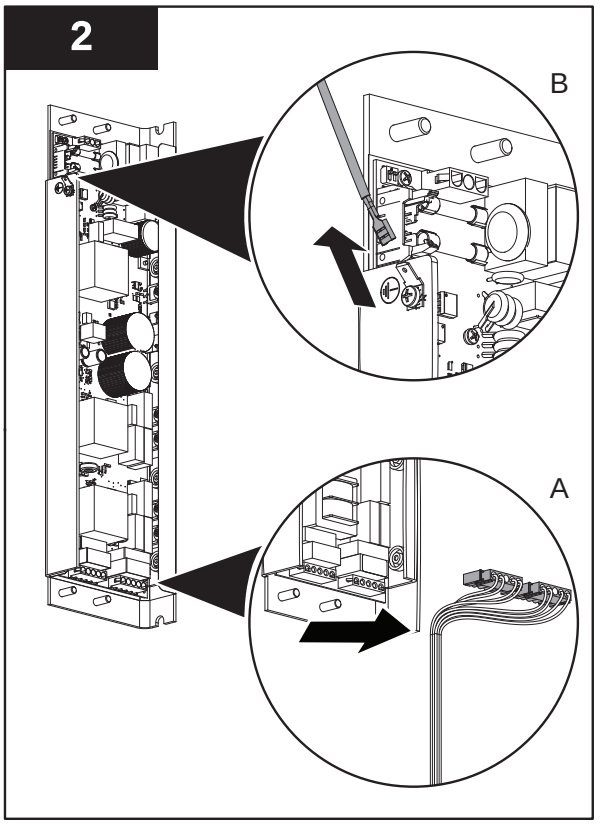
Materials:

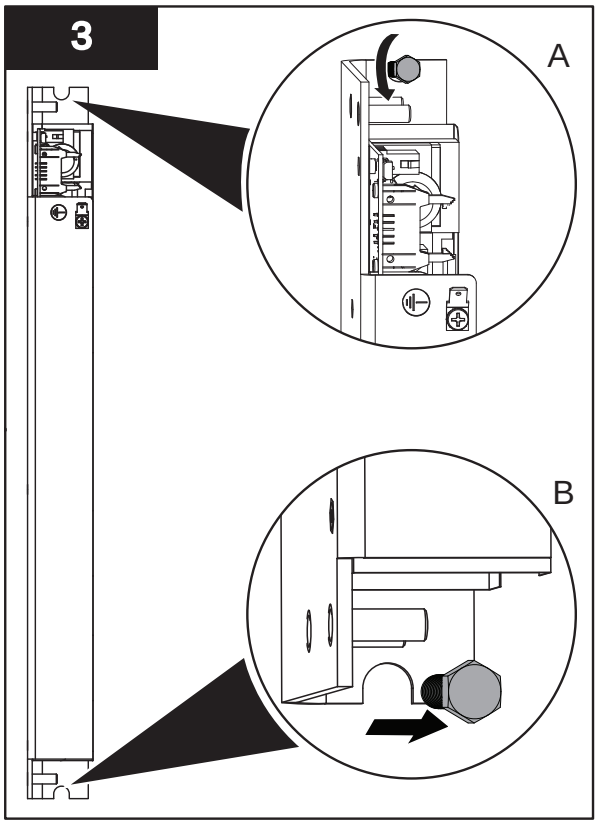
- Lamp driver

Procedure:

Remove:

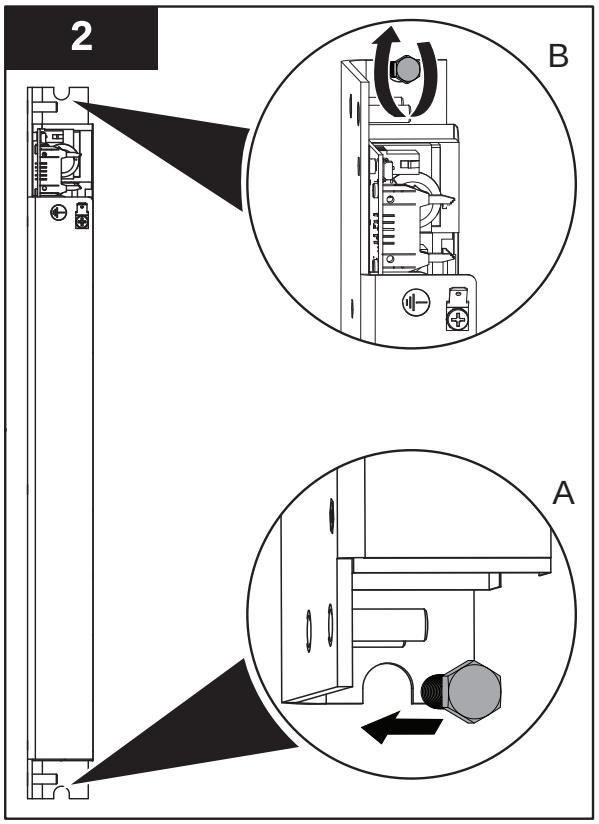


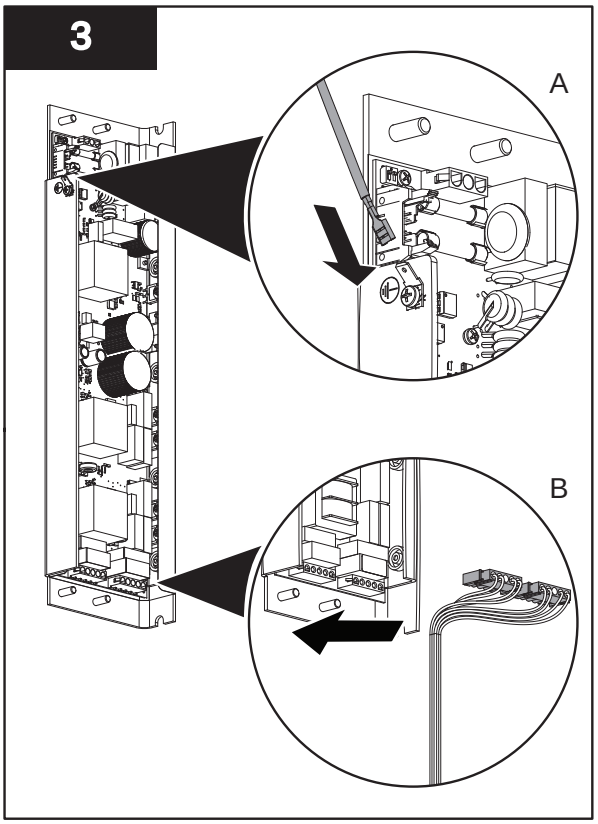


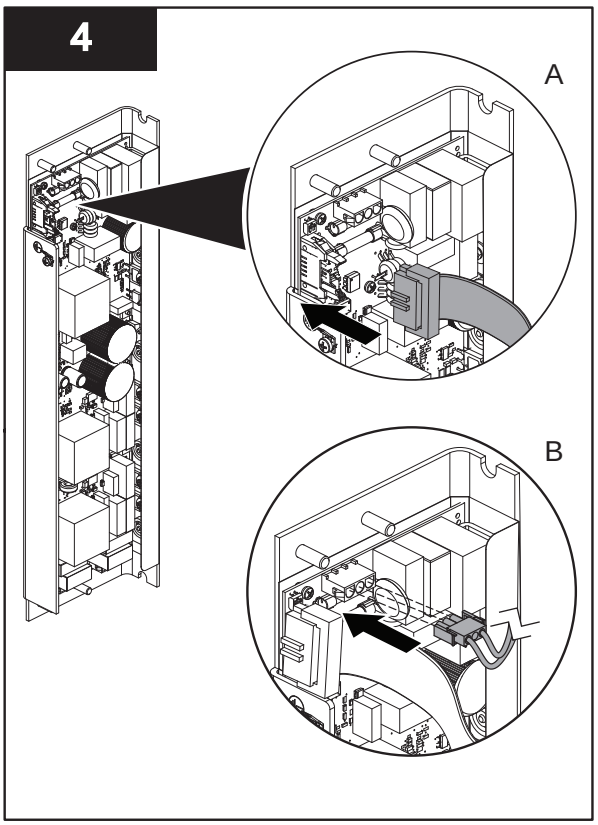


Replace:

1. Set the DIP switches on the new lamp driver to match the settings on the old lamp driver.







9.11.3 Replace the CPP Air Filter

Replace the air filter as part of regular maintenance or when the air filter is dirty.

Prerequisites:

- Open the CPP enclosure. Refer to Section 9.11.1.

Materials:

- New air filter

Procedure:

1. Slide the old air filter out and replace with the new one. Follow all local regulations for filter disposal.

⚠ DANGER

Obey all warning and caution statements. Refer to Section 2.

Read and understand this Operation and Maintenance Manual before operating this equipment. Read all user documentation before performing operations, inspections, repair, or maintenance on this equipment.

Only competent personnel should undertake operation, repairs, maintenance, or servicing of equipment described in this section of the manual. If you do not understand the information or procedure explanations in this manual, STOP and contact your Service Provider for assistance.

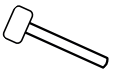
The tasks and safety information described in this section of the manual require major disassembly of the UV Chamber to access internal components.

Routine scheduled maintenance tasks that do not need access to the inside of the UV Chamber are described in detail in this manual.

Service tasks include regularly scheduled inspections and replacements that must be done while the UV Chamber is open and disassembled. Refer to Section 10.3.1 for the service schedule.

Repair tasks are the result of major wear and damage, and may require disassembly of the UV lamp holder assembly.

10.1 Tools and Materials

Symbols	Description	Symbols	Description
	Wrench - Torque		Wrench - Adjustable
	Water - Soapy		Hex Key
	Screwdriver - Phillips		Pliers - Needlenose
	Wrench		Rubber Hammer
	Wrench - Socket		Loctite® 242
	Tape (Plastic or similar)		

10.2 Legend

The symbols in the following table will be used in this Section to define the wiping option provided. Follow the instructions that correspond to the supplied system.

Symbol	Description
A	Automatic Wiping Option
N	Non-wiping Option

10.3 Service

10.3.1 Service Schedule

Inspect all system components during disassembly to determine whether repair is needed. Allow approximately 8 hours to complete service tasks.

Table 4 shows areas that need regular inspection. Table 5 shows scheduled service tasks that are done annually.

Table 4 Inspections

Applies to:		Component	Look for:
N	A		
✓	✓	Sanitary Gasket	Leaking at the sanitary flange Signs of wear, cracking or brittleness
✓	✓	UV Chamber	Excessive sediment build-up, which may indicate a systemic issue
	✓	Drive Nut	Worn threads or signs of damage
	✓	Wiper Plate	Bent plates or warped support rods, buildup
	✓	Drive Screw	Worn or dirty threads
✓	✓	Stop Plate	Bent or warped stop plate; build-up

Table 5 Annual Service

Applies to:		Component	Clean	Replace
N	A			
✓	✓	Sanitary Gasket	—	Section 10.3.2
✓	✓	UV Chamber	Section 10.3.2	—
✓	✓	Sleeve Holder Bushings and Wear Pads	—	Replace if signs of wear are visible, or every 2 years, which ever comes first. Section 10.3.5
	✓	Wiper Seals and Wiper Seal Holders	—	Replace if signs of wear are visible, or every 2 years, which ever comes first. Section 10.3.6
	✓	Bearing Housing and Bearing Housing O-ring	—	Replace bearing housing O-ring annually. Section 10.3.7
✓	✓	Stop Plate	As needed	If bent or otherwise damaged; Section 10.4.1
	✓	Wiper Plate	As needed	If bent or otherwise damaged; Section 10.4.2

Table 5 Annual Service (continued)

Applies to:		Component	Clean	Replace
N	A			
	✓	Drive Nut	As needed	If the driver nuts are worn; Section 10.4.2
	✓	Drive Shaft	As needed	if threads are visibly worn or other signs of wear or damage are visible on the drive shaft; Section 10.4.3

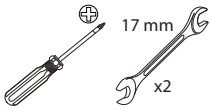
10.3.2 Open the UV Chamber

The UV Chamber must be open with the UV lamp holder assembly removed to do service tasks.

Prerequisites:

- Shutdown the UV system. Refer to Section 7.
- Apply Lockout Tag Out devices as necessary. Refer to Section 4.1.
- Depressurize and drain the UV Chamber, and stand off to the side. Refer to Section 9.4.
- Wait ten minutes to allow UV Lamps to cool.
- Remove the Service End Cap. Refer to Section 9.6.
- Remove the Gear Motor assembly (Automatic Wiping Systems Only). Refer to Section 9.10.1.
- Remove the UV Lamps. Refer to Section 9.7.2.
- Remove the Lamp Sleeves. Refer to Section 9.8.1.

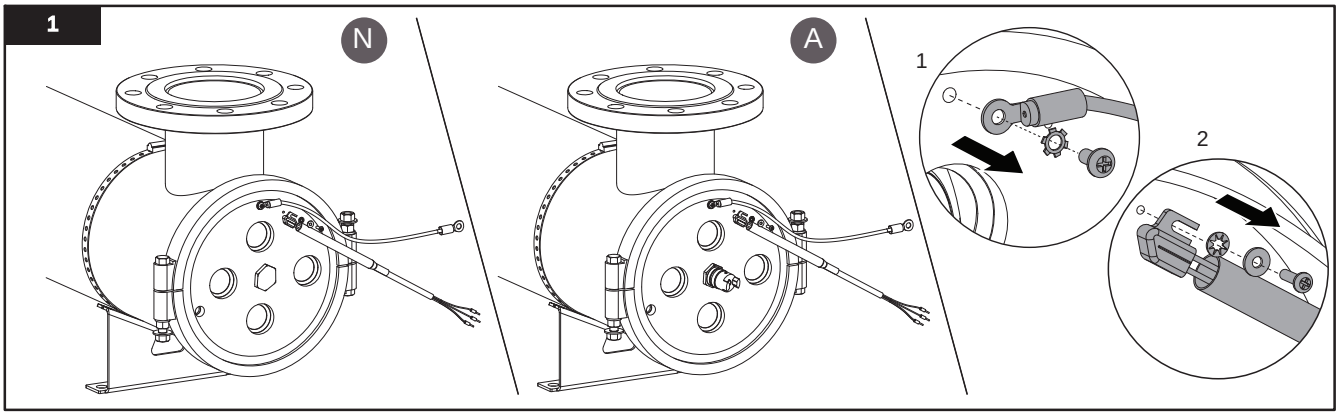
Tools:

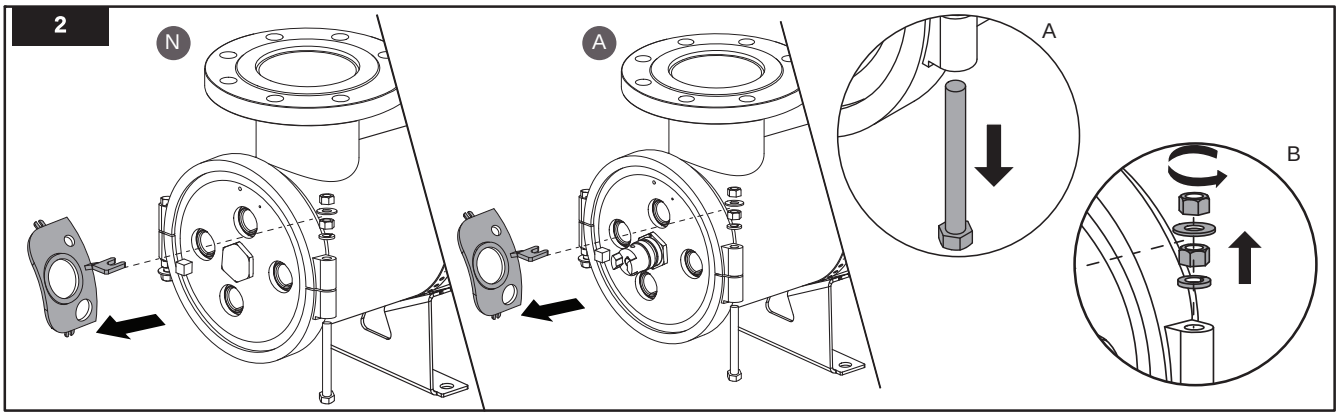


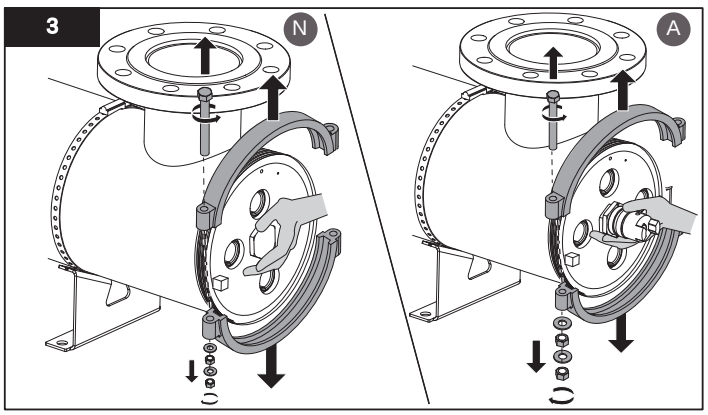
Materials:

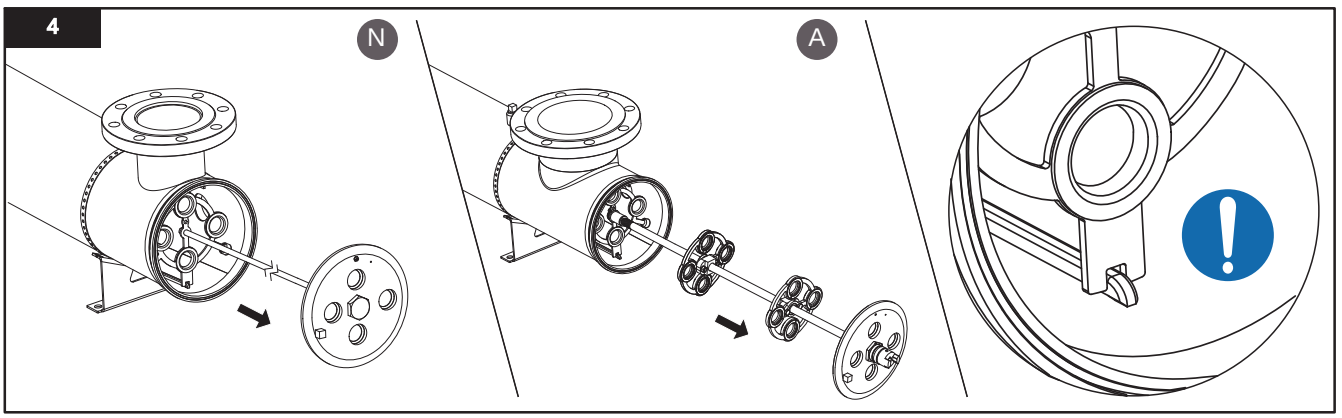
Note: *The End Cap Limit Switch is not shown for clarity in the following procedure.*

Procedure:









The UV Chamber and internal components are now accessible for cleaning and service.

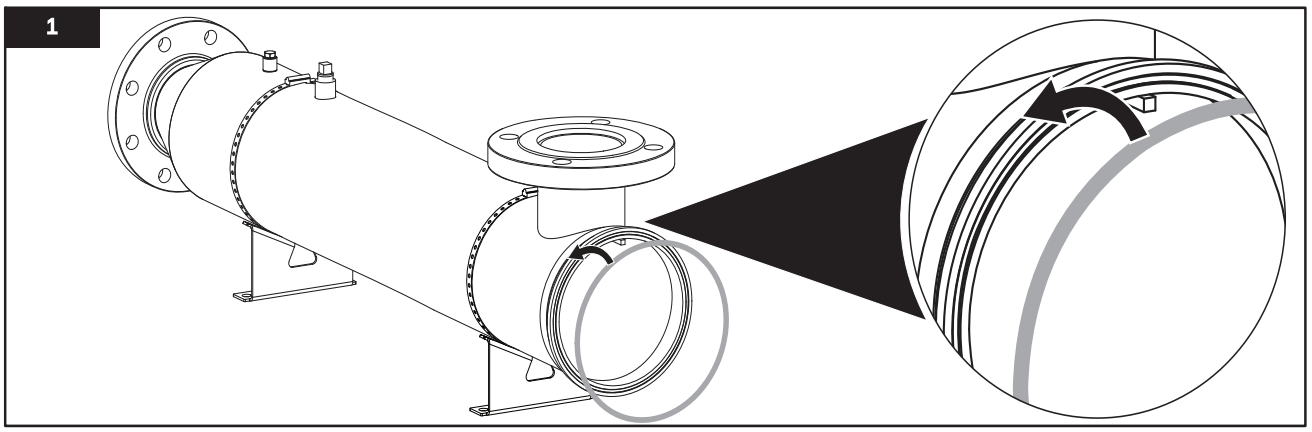
10.3.3 Assemble the UV Chamber

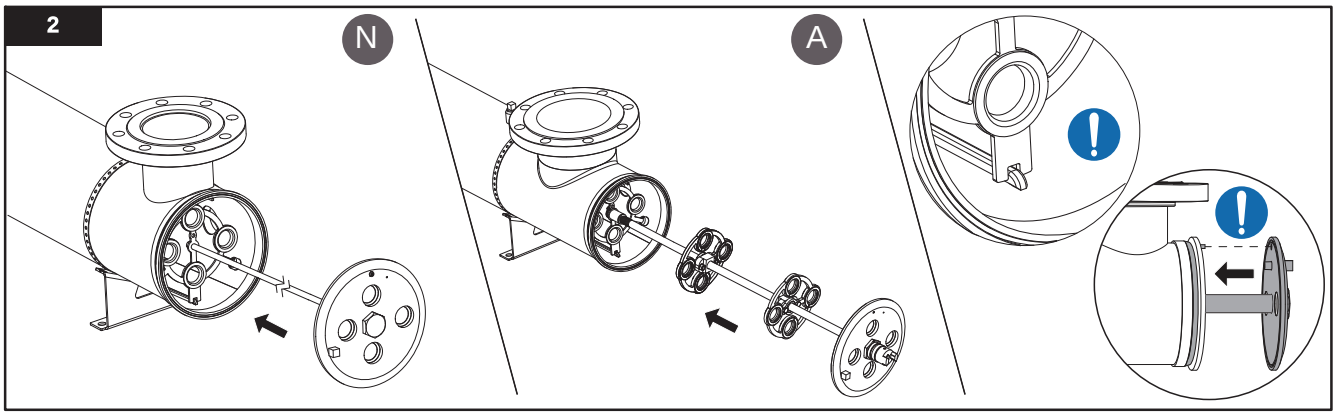
Tools:

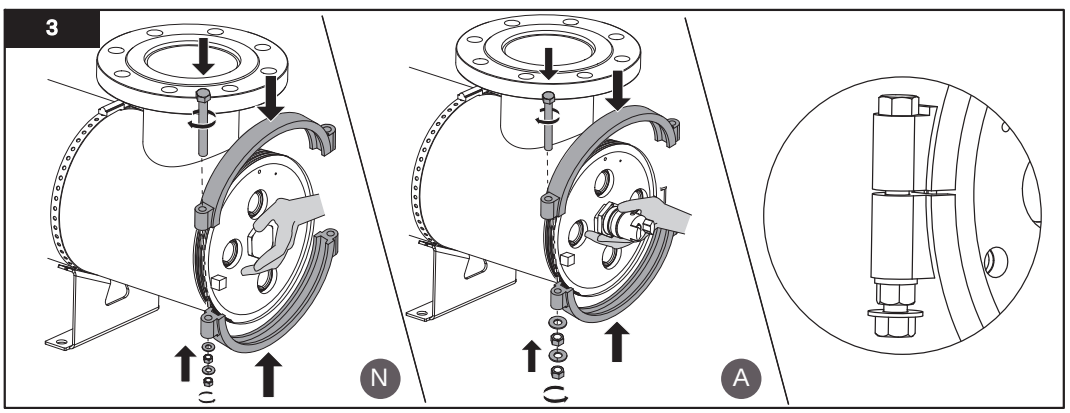
Materials:

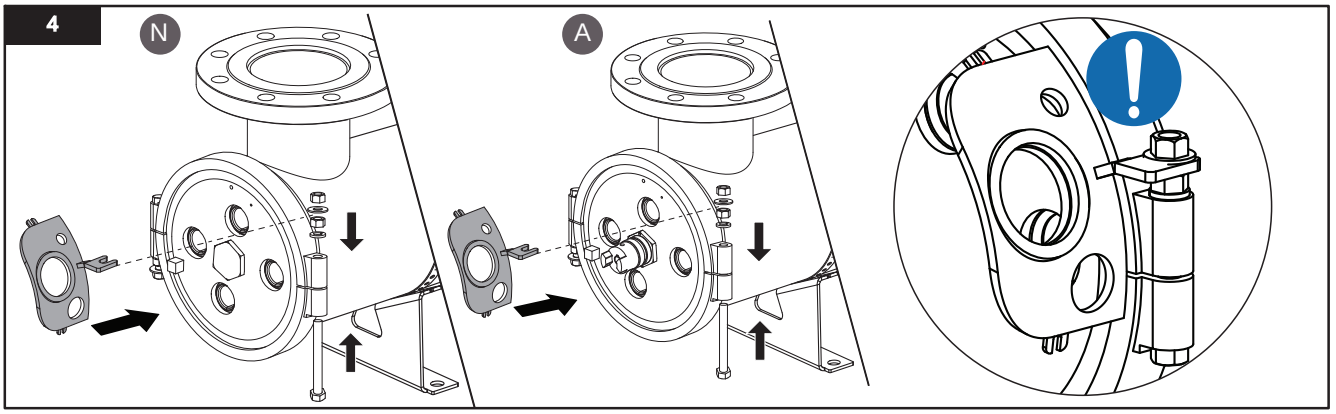
Procedure:

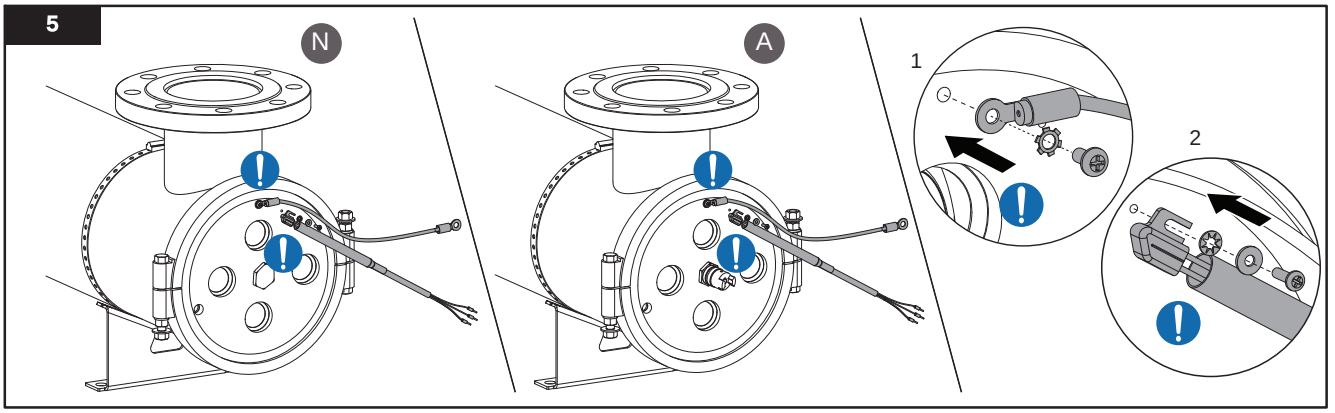
Note: *The End Cap Limit Switch is not shown for clarity in the following procedure*











Post-requisites:

- Install the Lamp Sleeves. Refer to Section 9.8.1.
- Install the UV Lamps. Refer to Section 9.7.2.
- Install the Gear Motor assembly (Automatic Wiping Systems Only). Refer to Section 9.10.1.
- Install the Service End Cap. Refer to Section 9.6.
- Pressurize the UV Chamber, and stand off to the side. Refer to Section 9.5.
- Remove Lockout Tag Out devices as necessary. Refer to Section 4.2.

10.3.4 Clean the UV Chamber Interior

Whenever the UV lamp holder assembly is removed from the UV Chamber, check the interior of the UV Chamber for an excessive build-up of sediment. Excessive buildup is an indication that there may be problems upstream in the treatment facility.

Prerequisites:

- Open the UV Chamber. Refer to Section 10.3.2.

Tools:

- Refer to site-specific procedures

Materials:

- Clean Water

Procedure:

1. Flush the UV Chamber interior with clean water. Refer to site-specific cleaning procedures.

2. When service and repair is complete, assemble the UV Chamber. Refer to Section 10.3.3.

10.3.5 Replace the Sleeve Holder Bushings and Wear Pads

Prerequisites:

- Open the UV Chamber. Refer to Section 10.3.2.

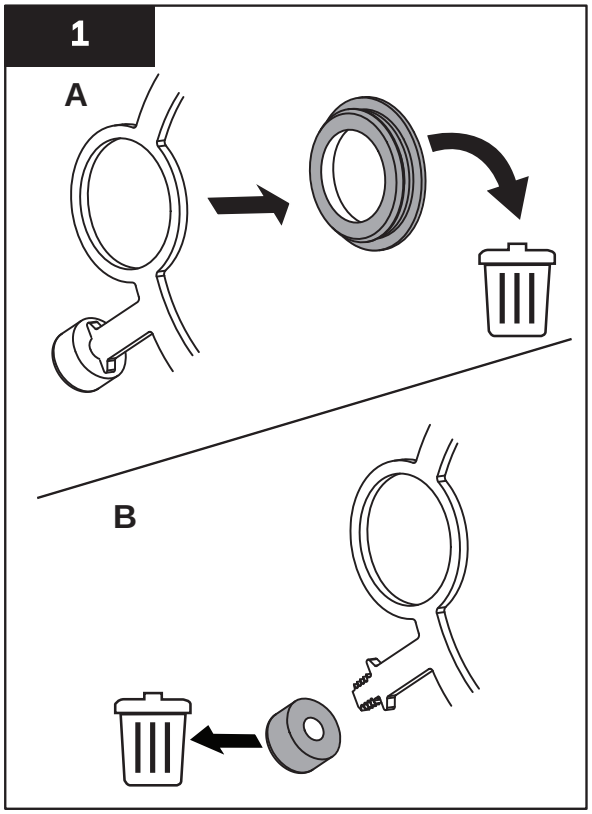
Tools:

Materials:

- Lamp Sleeve Holder Bushings
- Wear Pads

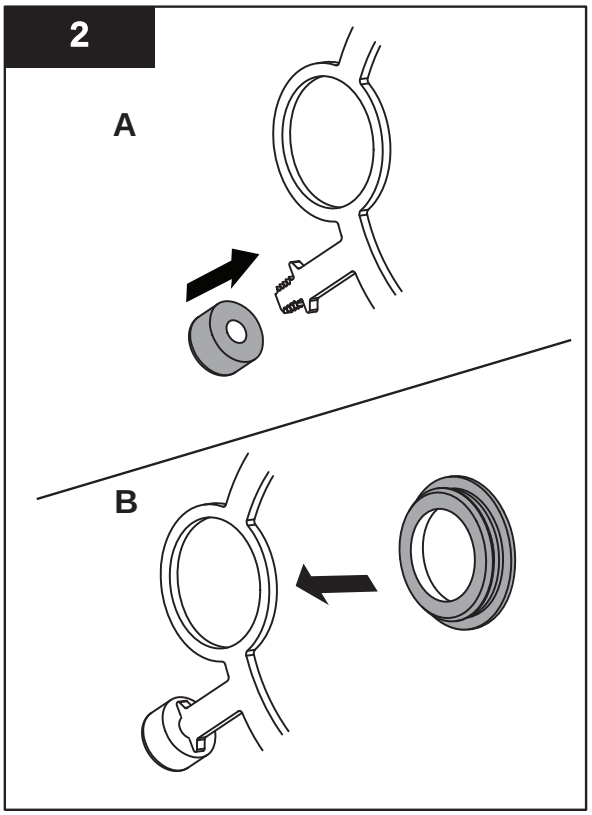
Procedure:

Remove



Note: *Record the orientation of the sleeve holder bushing in the stop plate.*

Replace:



Note: *Insert the new wear pad by gently tapping with a rubber hammer until the wear pad fully seats on the stop plate.*

When service and repair is complete, assemble the UV Chamber. Refer to Section 10.3.3.

10.3.6 Replace the Wiper Seals and Wiper Seal Holders

Note: *Applies to Automatic Wiping Systems only.*

Prerequisites:

- Open the UV Chamber. Refer to Section 10.3.2.

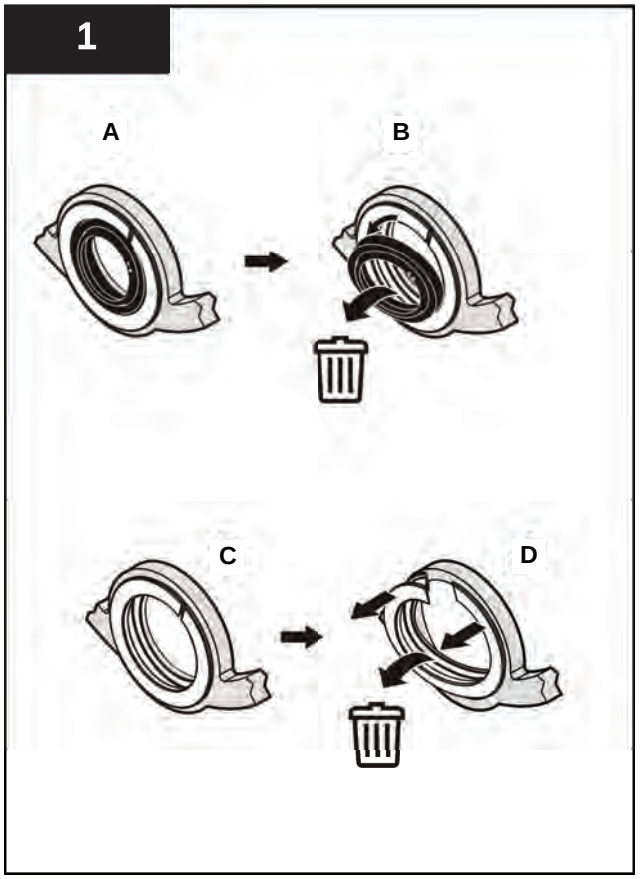
Tools:

Materials:

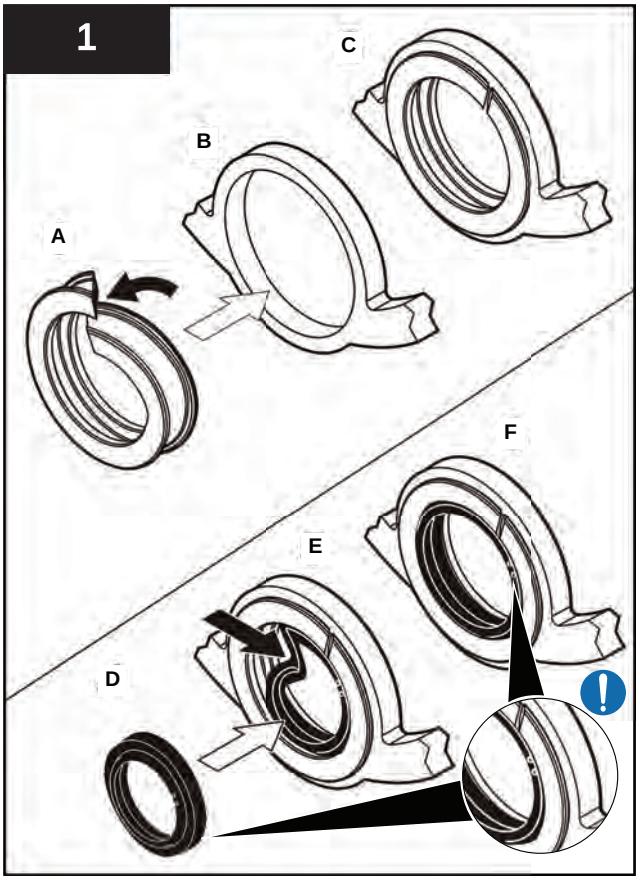
- Lamp Sleeve Wiper Seals
- Lamp Sleeve Wiper Seal Holders

Procedure:

Remove:



Install:



Note: *Ensure the two bumps on the Wiper Seals face outward towards the end plate and the inlet.*

When service and repair is complete, assemble the UV Chamber. Refer to Section 10.3.3.

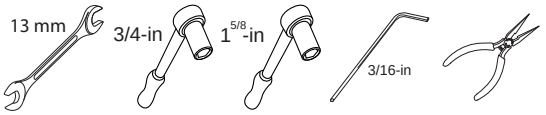
10.3.7 Replace the Bearing Housing and Bearing Housing O-ring*

Note: *Applies to Automatic Wiping Systems only.*

Prerequisites:

- Open the UV Chamber. Refer to Section 10.3.2.

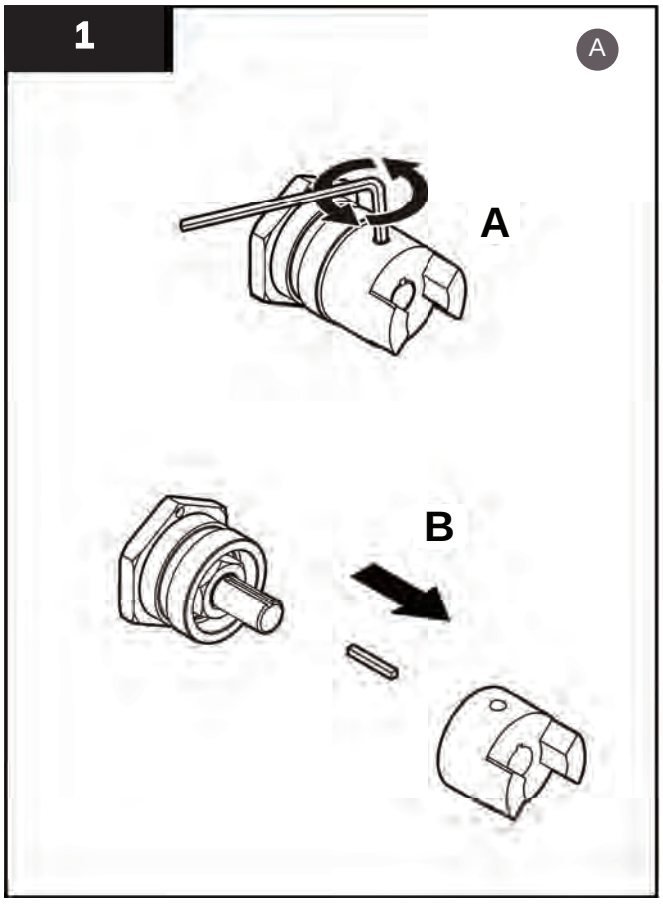
Tools:

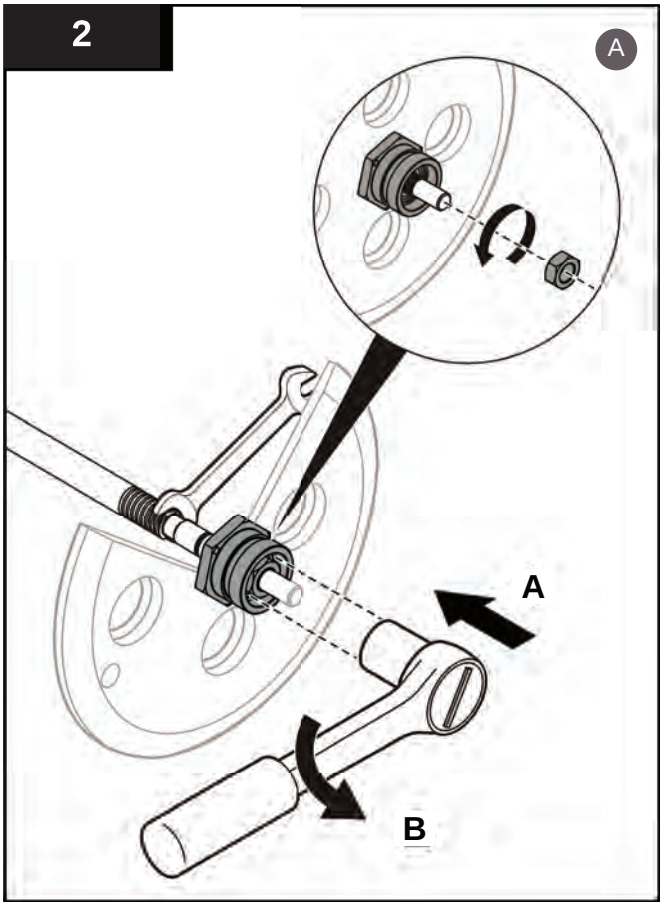


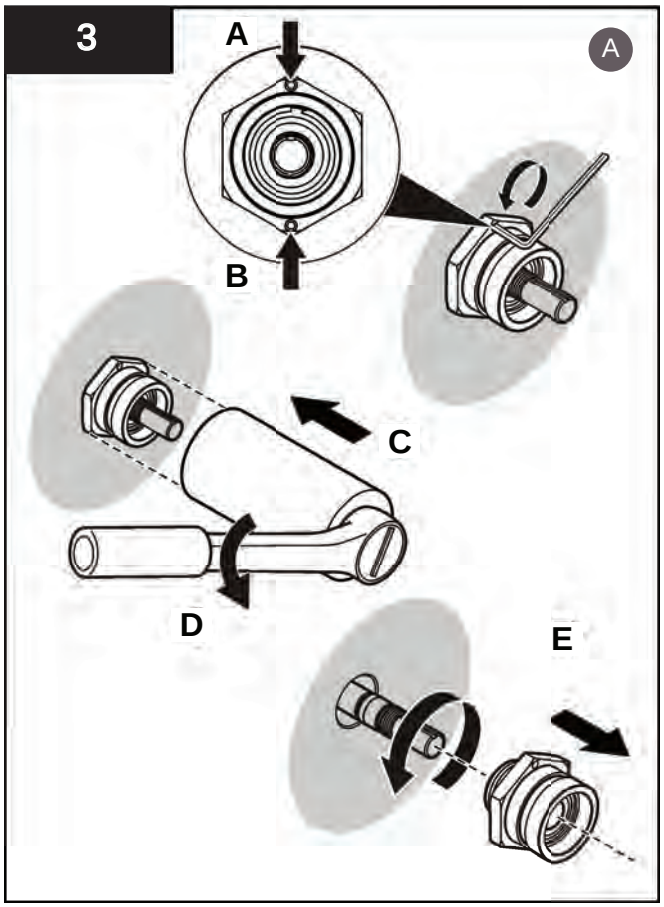
Materials:

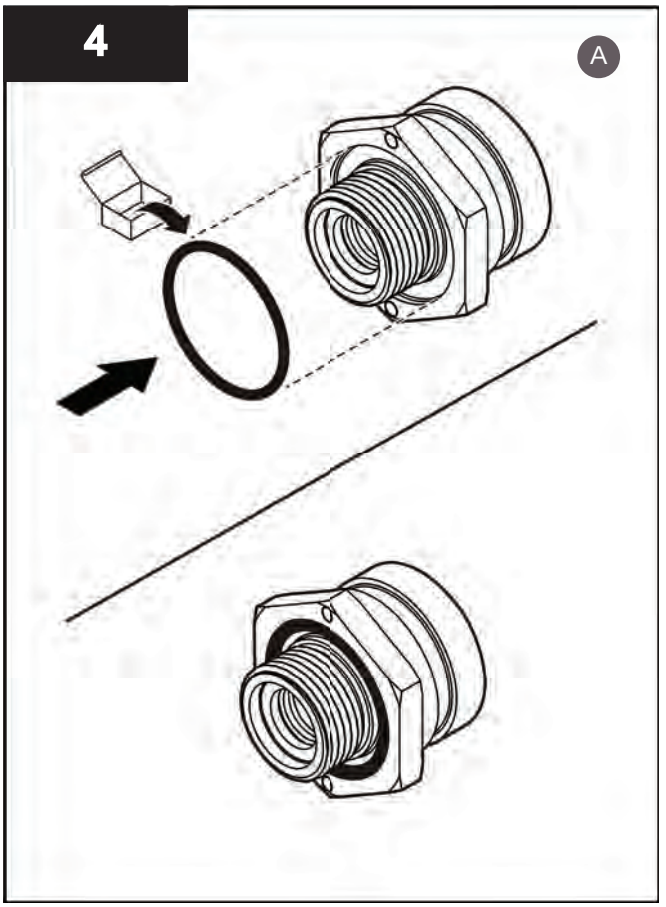
- Bearing Housing Kit
- Bearing Housing O-ring

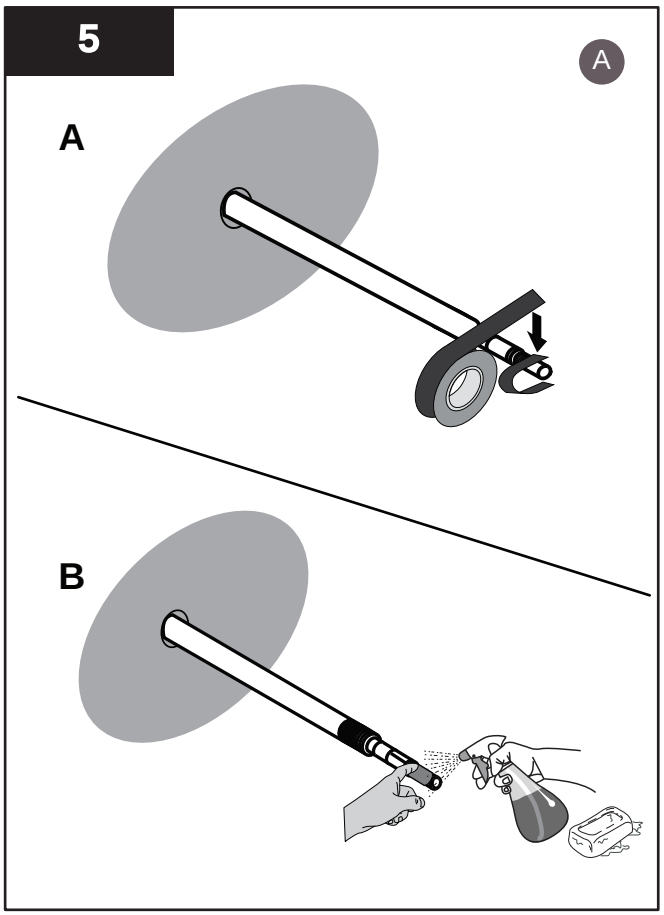
Procedure:



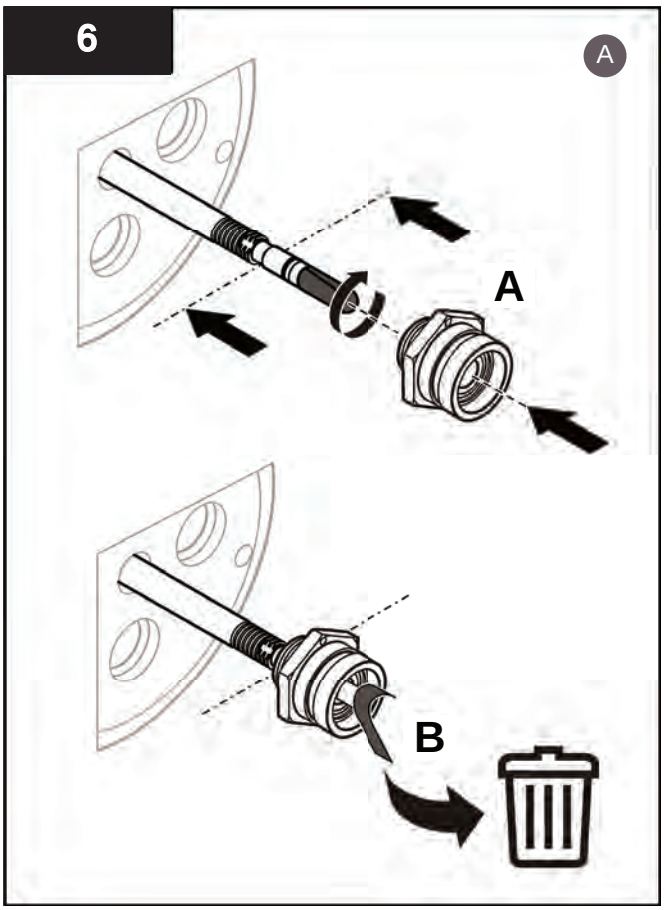




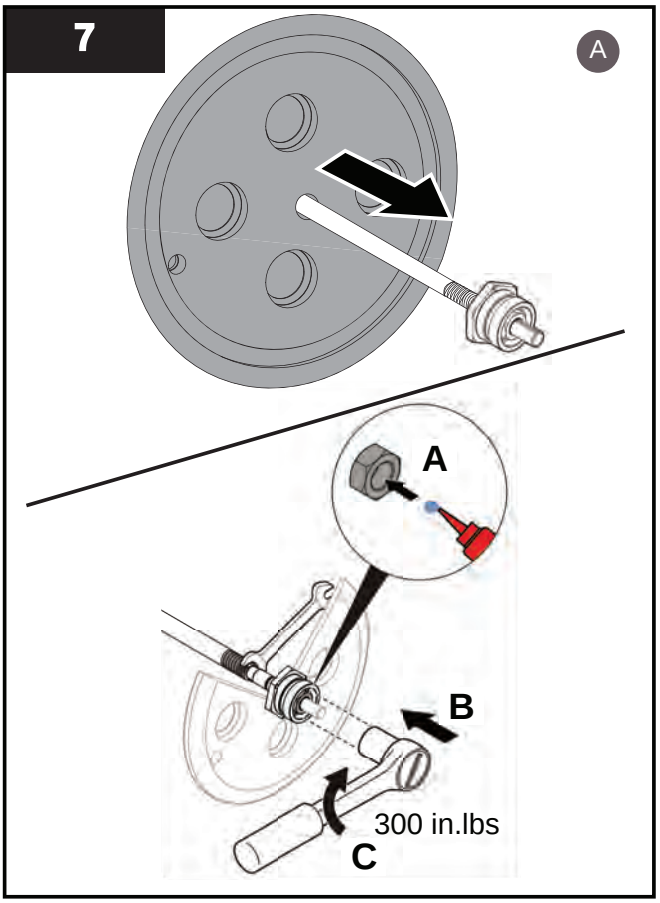


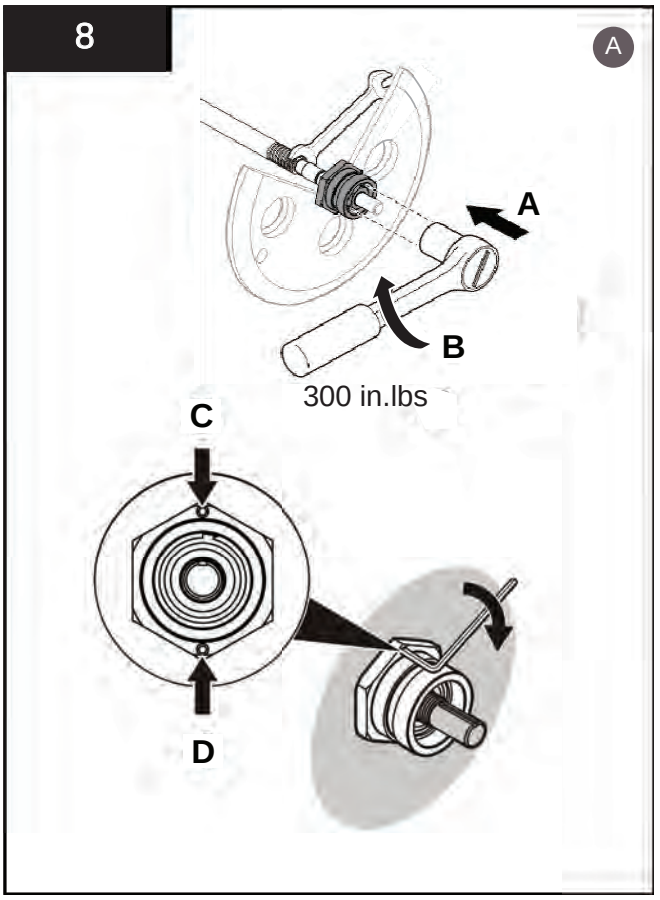


Note: *Apply liquid soap on end of the drive shaft.*



Note: *Remove and dispose of the tape.*





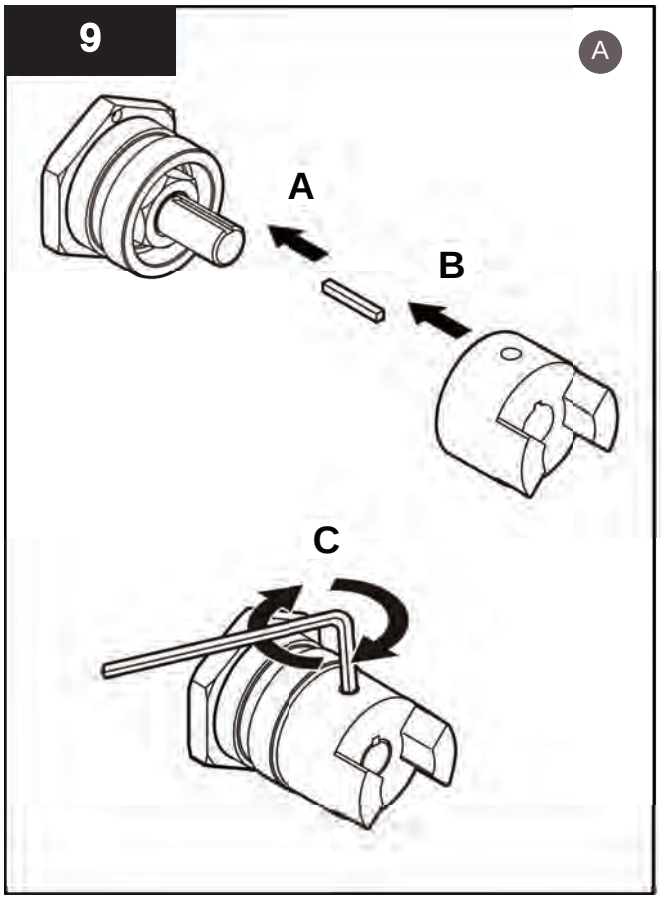


Illustration showing Type 04AL20.

10.4 Repair

Do repair tasks when:

- Service inspection shows wear
- There is damage to the interior components of the UV Chamber

10.4.1 Replace the Stop Plate

Prerequisites:

- Remove the Lamp Sleeve Holder Bushings and Wear Pads. Refer to Section 10.3.5.

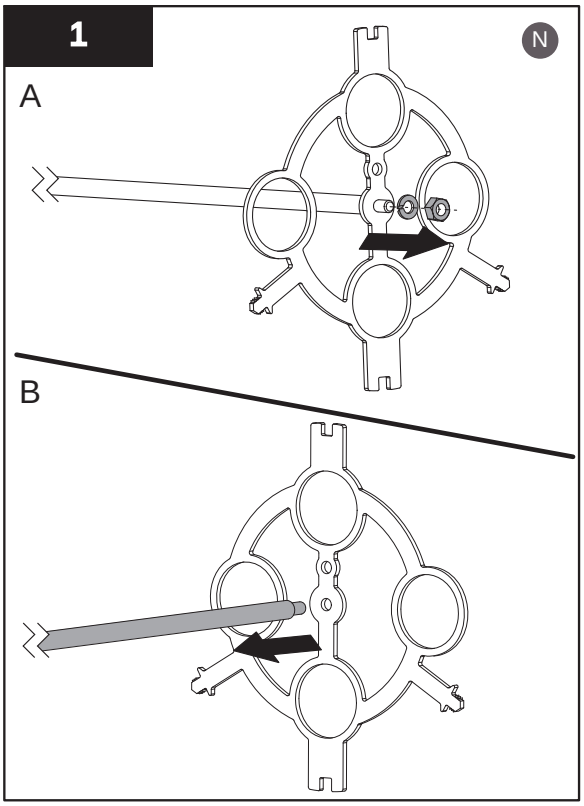
Tools:

Materials:

- New Stop Plate

Procedure:

Remove:



Install:

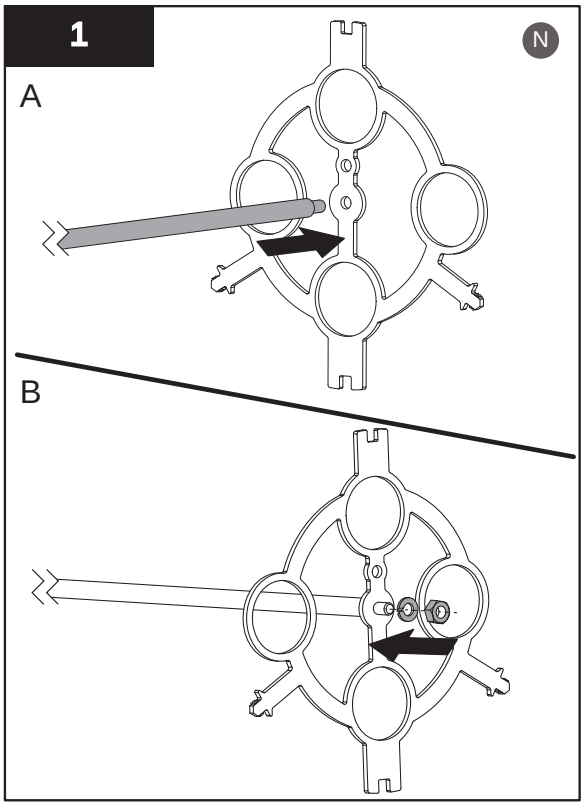
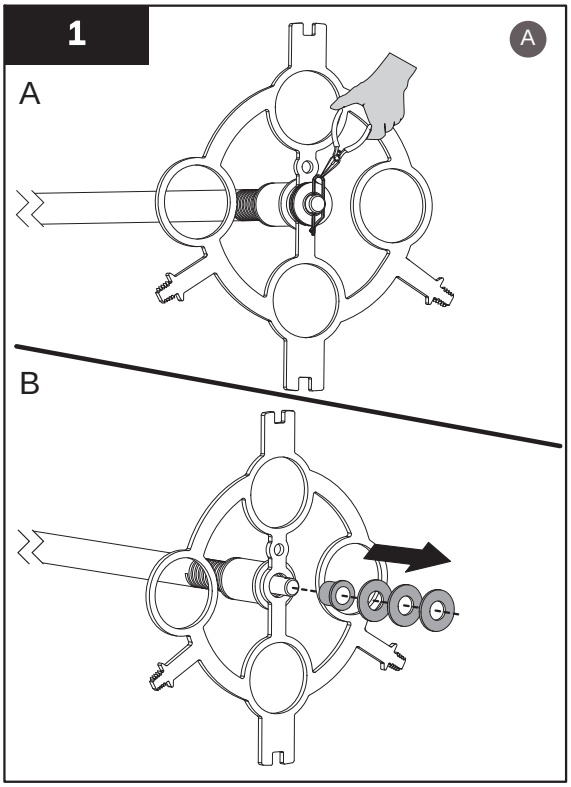
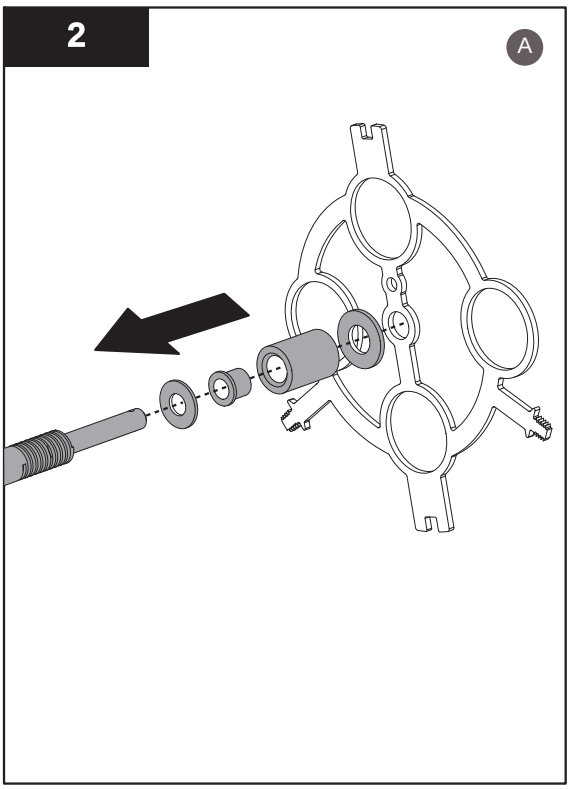


Illustration showing Type 04AL20.

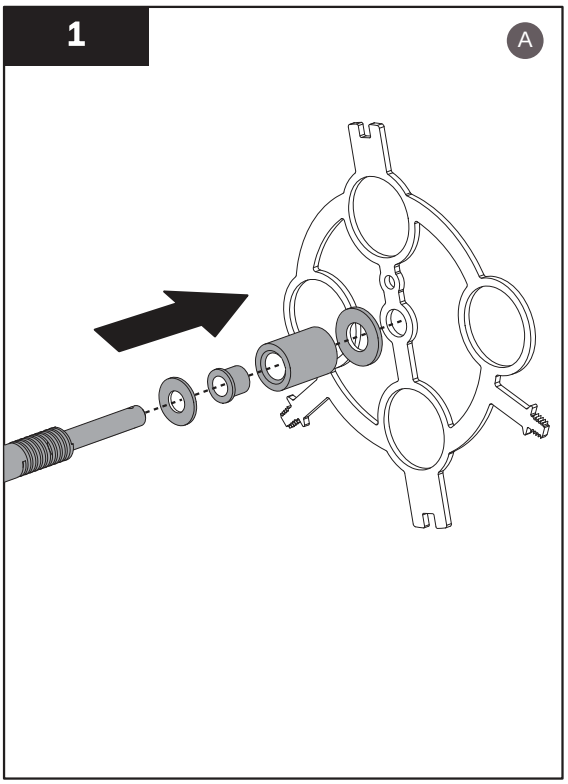
Remove:





Note: *Remove the Cotter Pin using pliers.*

Install:



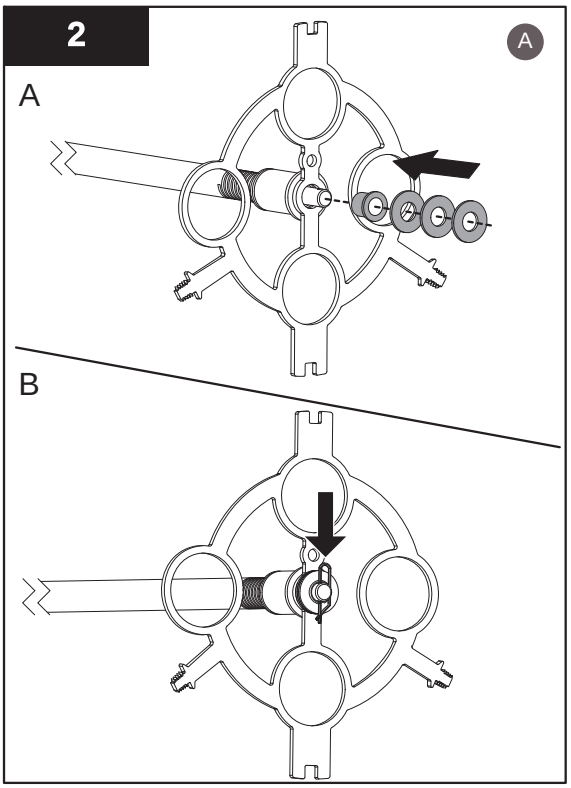


Illustration showing Type 04AL20.

Post-requisites:

- Install the Lamp Sleeve Holder Bushings and Wear Pads. Refer to Section 10.3.5.
- Assemble the UV Chamber. Refer to Section 10.3.3.

10.4.2 Remove and Replace the Wiper Plate

Note: *Applies to Automatic Wiping Systems only.*

Prerequisites:

- Open the UV Chamber. Refer to Section 10.3.2.
- Remove the Stop Plate. Refer to Section 10.4.1.

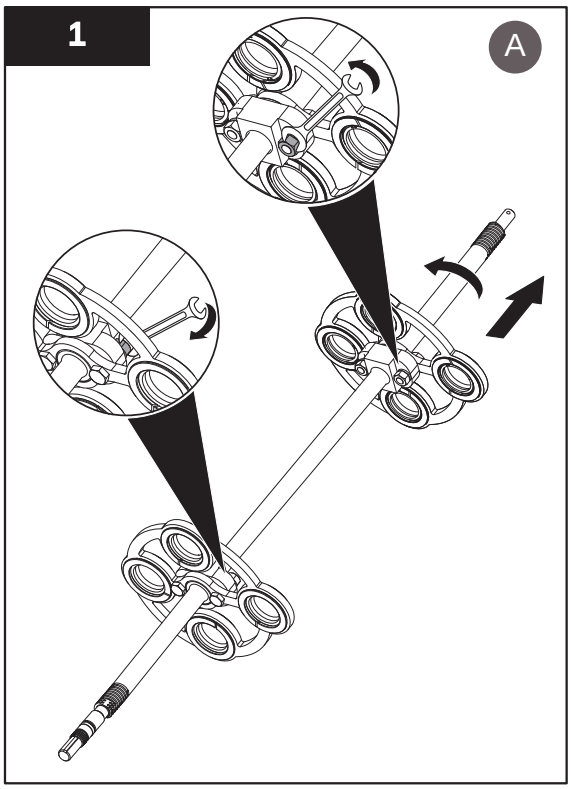
Tools:

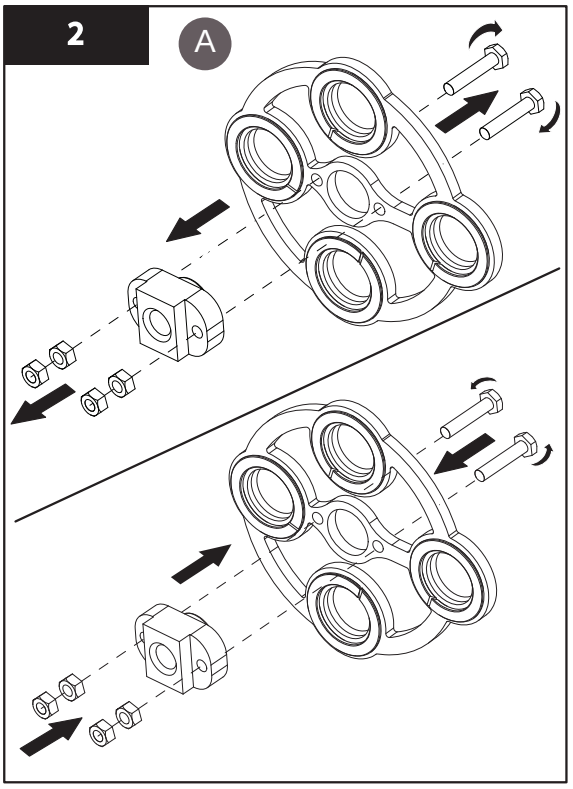
Materials:

- New Wiper Plate
- New Lamp Sleeve Wiper Holder (if required)
- New Drive Nuts (if required)
- New Wiper Seals (if required)

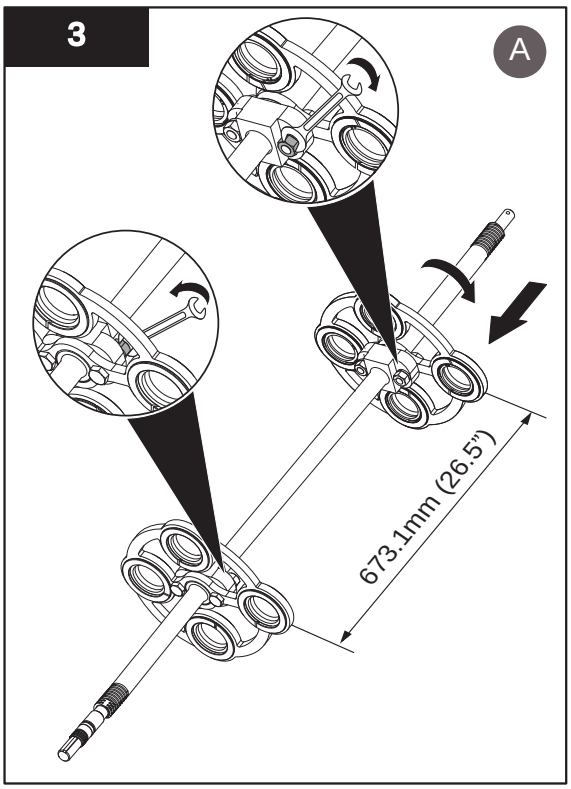
Procedure:

Remove/Replace





Note: *Note the position and orientation of the drive nuts on the drive shaft. Install in the same position and orientation.*



Notes: *1) Ensure the drive shaft turns freely by hand after the drive nuts are tightened. Do not tighten the drive nut hardware.*

2) Install the new wiper plate on the drive shaft in original orientation.

Illustrations showing Type 04AL20.

Notes: *1) Install Lamp Sleeve Wiper Holders and Wiper Seals into replacement Wiper Plate (Section 10.3.6).*

2) Inspect the drive nuts for wear on the threads. Replace if required.

10.4.3 Replace the Drive Shaft*

Note: *Applies to Automatic Wiping Systems only.*

Prerequisites:

- Remove the Bearing Housing. Refer to Section 10.3.7.
- Remove the Stop Plate. Refer to Section 10.4.1.
- Remove the Wiper Plate. Refer to Section 10.4.2.

Materials:

- New Drive Shaft
- New Drive Nuts

Procedure:

1. Dispose of the damaged drive shaft as per local requirements.

2. Inspect the drive nuts for wear on the threads. Replace if required.
3. Assemble wiper plate and stop plate components onto a new drive shaft in reverse order of disassembly.
4. When service is complete, assemble the prerequisites in the reverse order of the disassembly.

Section 11 Troubleshooting

DANGER

Obey all warning and caution statements. Refer to Section 2.

Read and understand this manual before operating this equipment. Read all user documentation before performing operations, inspections, repair, or maintenance on this equipment.

Only competent personnel should undertake operation, repairs, maintenance, or servicing of equipment described in this section of the manual. If you do not understand the information or procedure explanations in this manual, STOP and contact your Service Provider for assistance.

NOTICE

Injury or damage to the equipment due to improper testing, handling or maintenance will not be covered under the manufacturer's warranty and is the responsibility of the individual performing the troubleshooting. If there is any question about a procedure, contact Trojan Technologies before service.

11.1 Alarm Conditions

NOTICE

For optimum system performance, resolve every alarm condition as it occurs.

Current active alarms are shown in the active (current) alarms screen, from the most recent alarm to the oldest alarm. When an alarm condition is corrected, the alarm is removed from the list. Delay times for many alarms are user-adjustable.

An archived history of alarms is shown in the alarm history screen. When the buffer is full, the oldest alarm is deleted from the archive.

11.2 CPP Alarms

CPP alarms are divided into three categories: critical, major and minor.

Status items listed in Table 6 indicate that an alarm or alarms in the group are active.

Table 6 Alarm Status Indicators

Common Alarm names and status	Active when	Alarm delay	Control action
System Warming	During 3 minute warm-up	No delay	Alarm relay is "closed circuit". LED is on.
System On-line	After warm-up and there are no alarms	10 seconds	
System In-Operation	After warm-up	No delay	
Common Alarm	Any minor, major or critical alarm is active.	No delay	Alarm relay is configurable for either open or closed circuits.
Common Minor Alarm	Any minor alarm is active.		
Common Major Alarm	Any major alarm is active.		
Low UV Common Minor	Any sensor minor. UV intensity for UV Systems with multiple sensors is active.	10 seconds in operation or 3:10 minutes in startup	
Low UV Common Major	A common major siren. Any major or critical alarm is active.		
Wiper Alarms - Applies to Automatic Wiping Systems only.			
Wiper General Alarm	Any of the three wiper alarms occur in the first 10 seconds of operation or in the first 28 seconds of startup.	No delay	Alarm relay is configurable for either open or closed circuits.

11.2.1 Minor Alarms

When a minor alarm occurs, the UV Chamber remains on-line. Minor alarms show on the CPP and the alarm relays are deactivated. When a minor alarm occurs, take action to correct the problem soon after the alarm occurs. System performance may or may not be compromised. Refer to Table 7 for alarm definitions.

Table 7 Minor Alarms Defined

Minor Alarm name	Active when	Alarm delay	Control action
Low UVT Minor	The UVT value measured is lower than the setpoint.	10 seconds in operation or 3:10 minutes in startup	Alarm relay is configurable for either open or closed circuits.
Valve Open	The minor valve is open greater than the minor alarm setpoint.		
End Of UV lamp Life Hours	The UV lamp has exceeded the end of UV lamp life hours according to the factory-programmed setpoint.	No delay	
UV lamp xx Alarm Minor	UV Lamp Fault Lamp Driver Fault Loss of UV Lamp Fault Signal	Alarm Delay (10s default)	Alarm relay is configurable for either open or closed circuits.
Low UV Intensity[1] Minor	No UV Intensity signal	Alarm Delay (10s default)	Alarm relay is configurable for either open or closed circuits.
Wiper Alarms - Applies to Automatic Wiping Systems only.			
Wiper Revolution	An incomplete wiper cycle occurs. There is a motor failure or mechanical jam. No revolution counts in 1 second.	No delay	Alarm relay is configurable for either open or closed circuits.
Wiper Home Alarm	A wiper failure occurs during a home cycle. There is a motor failure or mechanical jam. No revolution counts in 1 second.		
Wiper Limit Switch Alarm	A limit switch failure occurs in the “closed circuit” position. (Normally “open circuit” LED off.)		
Wiper General Alarm (System with wiper)	Wiper Home Alarm OR Wiper Limit SW Alarm OR Wiper Revolution Alarm	None	Alarm relay is configurable for either open or closed circuits.

11.2.2 Major Alarms

When a major alarm occurs, take immediate action to correct the problem. Make sure that system performance is not compromised. Alarm relays are deactivated. Refer to Table 8 for alarm definitions.

Table 8 Major Alarms Definition

Major Alarm name	Active when	Alarm delay	Control action
Low UV Intensity[1] Major	The UV measured is less than the calculated low UV major alarm setpoint.	10 seconds in operation or 3:10 minutes in startup	Alarm relay is configurable for either open or closed circuits.
Multiple UV lamp Alarms	Multiple UV lamps are not functioning. Factory based set number of 1 or more, that is dependant on the dose required.		
Low Dose Major	The dose measured is less than the setpoint.	Factory set (30 seconds)	Alarm relay is configurable for either open or closed circuits.
RED Low Major	Multiple lamp Major Fault Lamp driver Fault RED target not met	Lamp or lamp driver Alarm delay OR Dose Alarm Delay OR None	Alarm relay is configurable for either open or closed circuits.
UV Lamp Alarm XX Major	Either: There is no UV lamp function. Power is lost. CPP/CCB communication is lost.	10 seconds in operation or 3:10 minutes in startup	Alarm relay is configurable for either open or closed circuits.
Lamp Driver XX Alarm Major	Either: There is no lamp driver function. Power is lost. CPP/CCB communication is lost.		
High Flow Alarm Major	The flow rate is greater than the major alarm setpoint.	10 seconds in operation or 3:10 minutes in startup	Alarm relay is configurable for either open or closed circuits.
Valve Open Major	The valve is open greater than the major alarm setpoint.		
No Flow Alarm Major	The flow rate signal is not present below 2.0 mA.		
No Valve Data Major	The valve signal is not present below 2.0 mA.		
SCADA Comm.	UV Chamber in SCADA operation mode		

11.2.3 Critical Alarms

When a critical fault occurs, the UV Chamber is set to shutdown. On a critical alarm, the system CPP takes immediate action to prevent damage to the equipment. Take immediate action to make sure that system performance is not compromised. Refer to Table 9 for alarm definitions.

Table 9 Critical Alarm Definitions

Critical alarm name	Active when	Alarm delay	Control action
UV Chamber High Temperature Critical DIGITAL is Standard.[1]	The end plate temperature switch is above 50 °C (122 °F) due to hot water, hot air or low flow rate. A chamber hi temp shutdown delay of 0-15 minutes can be set. This lets operators correct the problem or bring other equipment on-line before the UV lamps are turned off. This alarm clears when the UV Chamber temperature cools below the switch default value of 50 °C (122 °F) ±5 °C/°F. The UV Chamber then restarts.	10 seconds in operation or startup.	Alarm relay is configurable for either open or closed circuits.
End Cap Off Critical	Loss of digital signal	20 seconds	Alarm relay is configurable for either open or closed circuits
Major Hi Temp Setpoint (analog option temp only)	The analog signal is above the setpoint that is set by the user due to hot water, hot air or low flow rate. A chamber hi temp shutdown delay of 0-15 minutes can be set. This lets operators correct the problem or bring other equipment on-line before the UV lamps are turned off. This alarm clears when the UV Chamber temperature cools below the switch default value of 50 °C (122 °F) ±5 °C/°F. The UV Chamber then restarts.	10 seconds in operation or startup.	Alarm relay is configurable for either open or closed circuits

[1] For the Chamber High Temperature Alarm, a Chamber Hi Temp Shutdown delay timer can be set to allow for Operators to correct the problem or bring other equipment on-line.

11.2.4 Standard Inputs and Outputs

UV Sensor	Input	Analog	4-20 mA	System I/O
Alarms (1-7)	Output	Digital	Normally open (NO)	Customer I/O
UV Chamber High Temp Switch (shuts off UV lamps at 50 °C.)	Input	Digital	Voltage sensing input	Customer I/O
End cap limit switch (shuts off UV lamps)	Input	Digital	Voltage sensing input	Customer I/O

11.2.5 Optional Inputs and Outputs

Note: *Optional inputs and outputs cannot typically override standard provided inputs and outputs.*				
Analog (4)	Output	Analog	4-20 mA	System I/O
Remote ON/OFF	Input	Digital	Voltage sensing input	Customer I/O
Wiper Alarms - Applies to Automatic Wiping Systems only.				
Wiper Option – Revolution UV Sensor	Input	Digital	9.4 Hz Pulse	System I/O
Wiper Option – Home Limit Switch	Input	Digital	Normally closed (NC)	System I/O
Wiper Option – Extend (forward)	Output	Digital	Normally open (NO)	System I/O
Wiper Option – Retract (reverse)	Output	Digital	Normally open (NO)	System I/O

11.2.6 Additional Inputs and Outputs

The inputs and outputs in this table are available for custom applications. This list is not intended to cover all options. It is a representative list of options that sites can exercise in order to wire device information in to the UV System. The controller provides a graphical display of the information only. If a signal is brought in, it can be wired out of the system to another as needed. For a specific request, contact the manufacturer. Additional inputs and outputs can not typically override standard provided inputs and outputs.				
Note: *Up to five analog inputs and four analog outputs in total are possible.*				
Flow	Input / Output	Analog	4-20 mA	System and/or customer I/O
UVT	Input / Output	Analog	4-20 mA	System and/or customer I/O
Valve position	Input / Output	Analog	4-20 mA	System and/or customer I/O
UV Chamber high water temperature	Input / Output	Analog	4-20 mA	System and/or customer I/O
RED Value (EPA)	Output	Analog	4-20 mA	System and/or customer I/O
Dose Achieved	Output	Analog	4-20 mA	System and/or customer I/O

11.3 CPP Communication Control Board Electrical and I/O Details

The CPP communication control board (CCB) is powered by a 24 VDC power supply that is located in the CPP. The CCB is configured using the microprocessor user interface. The user can reset the CCB to the original factory settings.

In addition to standard CPP alarms, optional analog and digital sources can be configured to the CPP microprocessor CCB relays for additional alarms.

11.3.1 Communication Control Board (CCB) - Automatic Wiping Systems

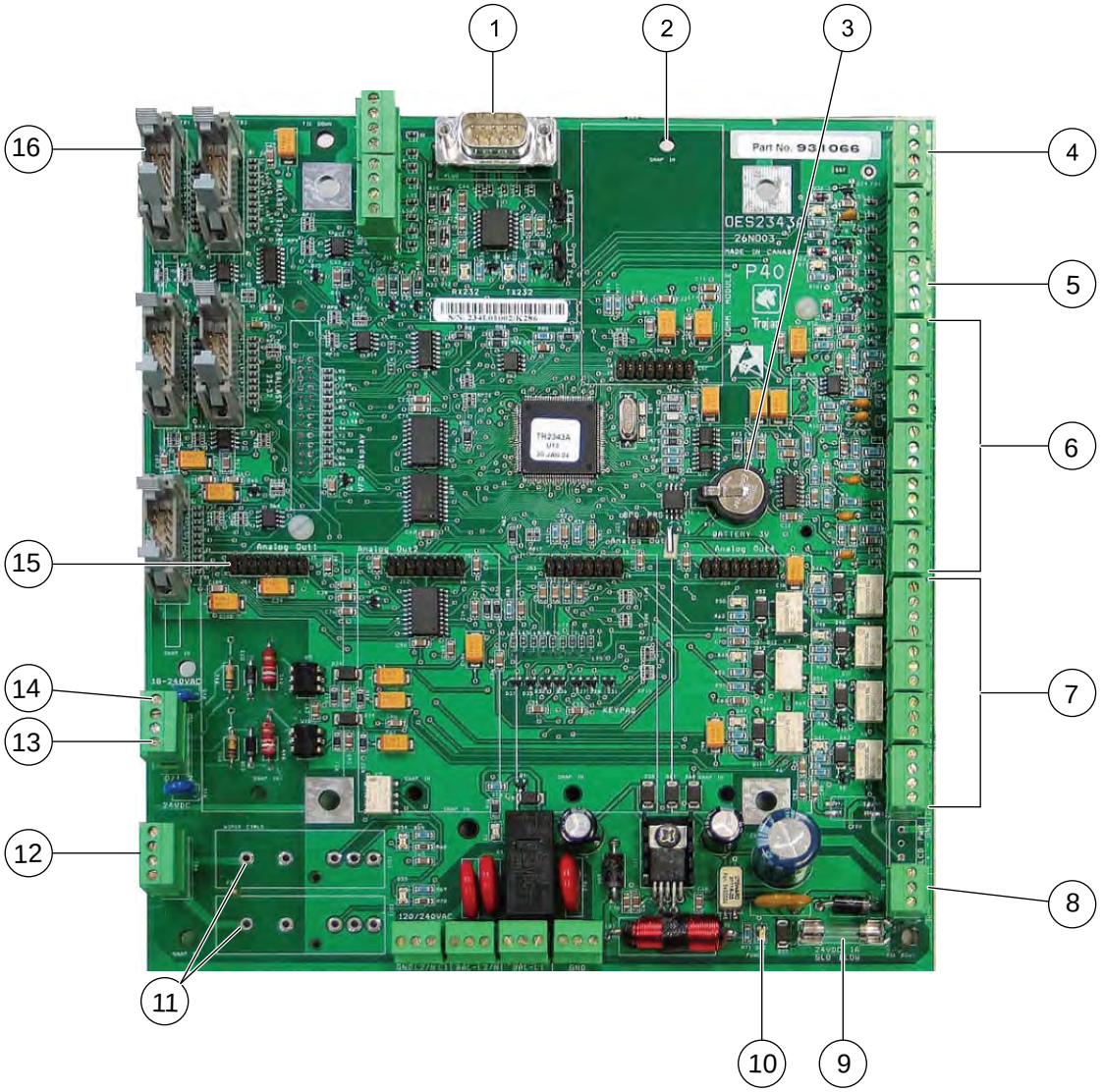


Figure 21 Microprocessor Communication Control Board (CCB)

1	RS232 Communication Port	**9**	Fuse - Slow Blow 1 A
2	SCADA Communication Module Location	**10**	Power Indicator LED
3	Battery, 3 V Lithium CR1220	**11**	Wiper Control Relay Sockets
4	Temperature Switch	**12**	Relay Outputs for Wiper Control
5	Wiper Revolution Sensor	**13**	End Cap attached
6	24 VDC Analog Inputs (5x)	**14**	Remote On/OFF
7	24 VDC Digital Alarm Outputs (7x)	**15**	Analog Output Modules Location (4x)
8	24 VDC Board Input Power	**16**	Lamp Driver Communication Connectors

11.3.2 Communication Control Board (CCB) - Non Wiping Systems

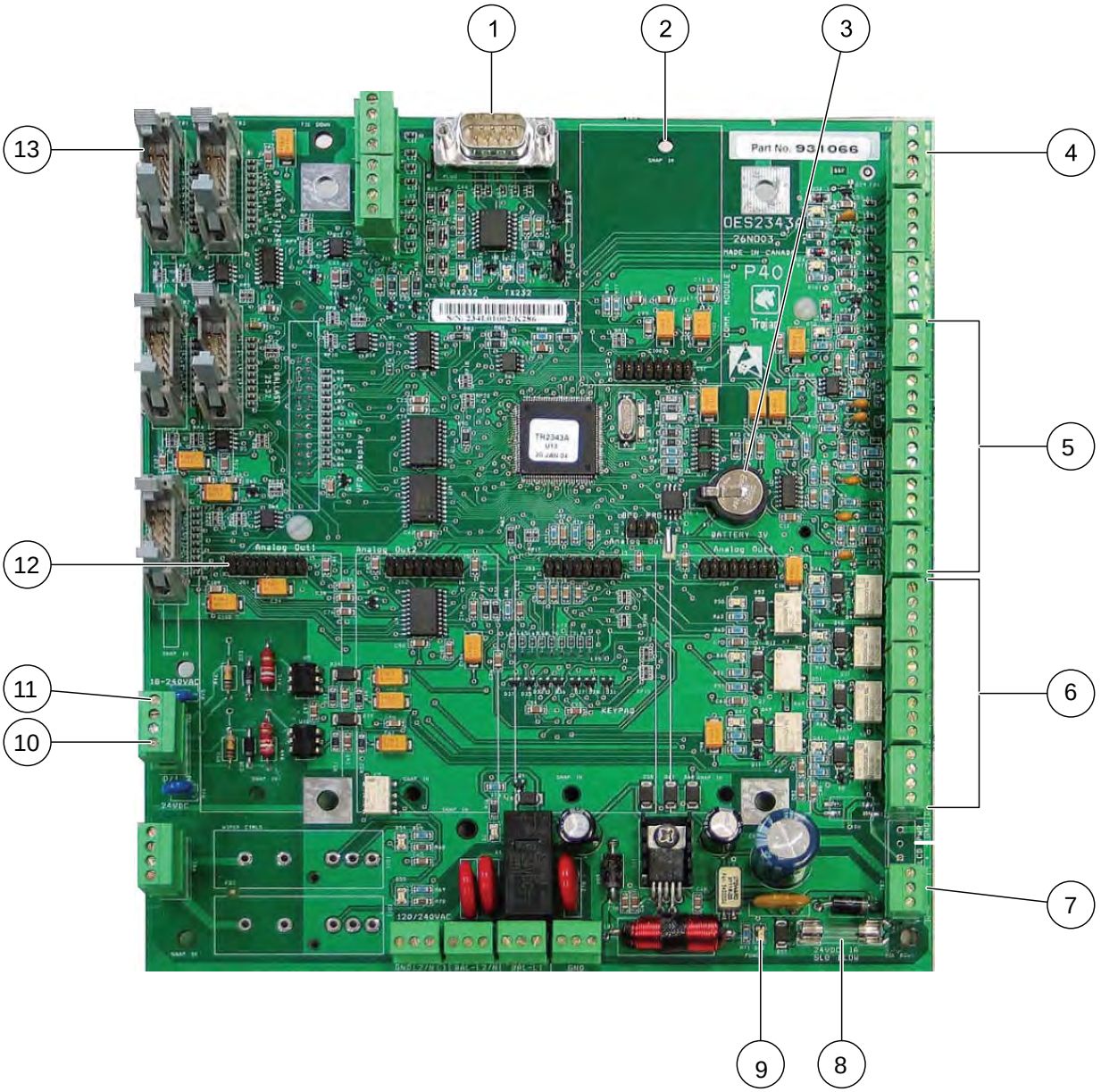


Figure 22 Microprocessor Communication Control Board (CCB)

1	RS232 Communication Port	**8**	Fuse - Slow Blow 1 A
2	SCADA Communication Module Location	**9**	Power indicator LED
3	Battery, 3 V Lithium CR1220	**10**	End Cap attached
4	Temperature Switch	**11**	Remote ON/OFF
5	24 VDC Analog Inputs (5x)	**12**	Analog Output Modules Location (4x)
6	24 VDC Digital Alarm Outputs (7x)	**13**	Lamp Driver Communication Connectors
7	24 VDC Board Input Power		

Section 12 Replacement Parts and Accessories

Contact your Service Provider with the listed information to order replacement parts.

Provide the:

- Product name and model number (refer to the front of this manual)
- Part number and description of the replacement part or accessory

If a replacement part is not listed, contact your Service Provider.

12.1 UV Lamp and Lamp Sleeve

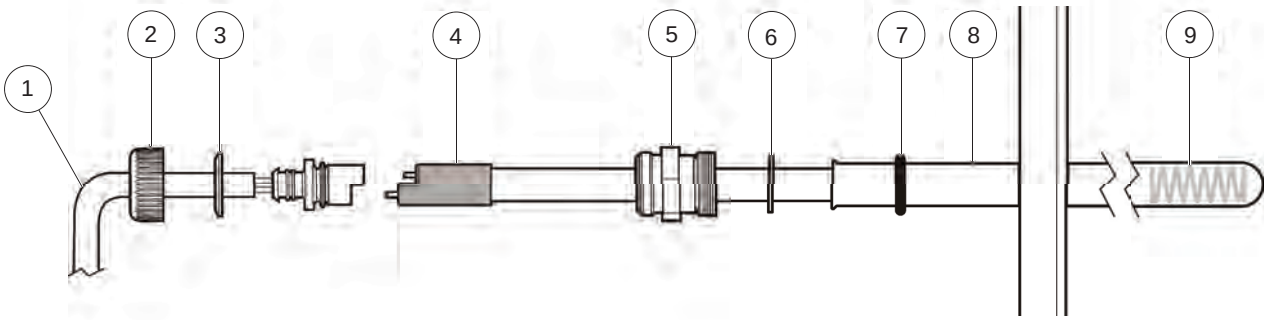


Figure 23 UV Lamp and Lamp Sleeve components

Component	Description	Part Number
1	Lamp Power Cable	
	17 ft (4.5 m)	792718-1175
	28 ft (7.5 m)	792718-1275
	52 ft (15 m)	792718-1525
	79 ft (23 m)	792718-1775
2	Lamp Sleeve Cup Nut	316148
3	Lamp Sleeve Cup Nut Washer	793859
4	UV Lamp*	794447-0GN
5	Sleeve Bolt, Lamp Sleeve	795751
6	Sleeve Bolt Washer	792931
7	O-Ring, Lamp Sleeve, Viton	002190-215F
8	Lamp Sleeve, UV Lamp	793024
9	Compression Spring	796054

* This component contains MERCURY. Dispose according to Local, State, or Federal Laws.

12.2 UV Sensor

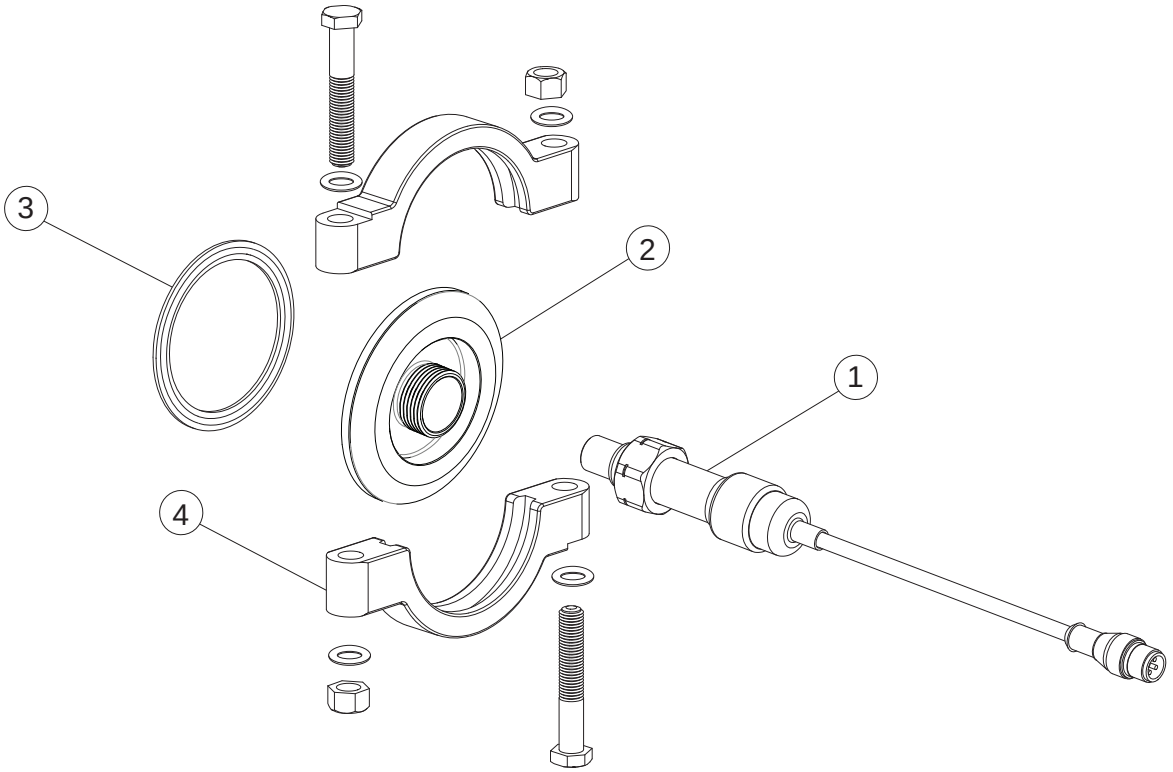


Figure 24 UV Sensor components

Component	Description	Part Number
1	UV Sensor	793200-014
2	Adaptor, Sensor	794287
3	Gasket, Sanitary 2 in.	002285-020
4	Clamp, Sanitary BLT 2 in.	013213-200

12.3 Non Wipe Kit

Note: *For Non-Wiping Systems only.*

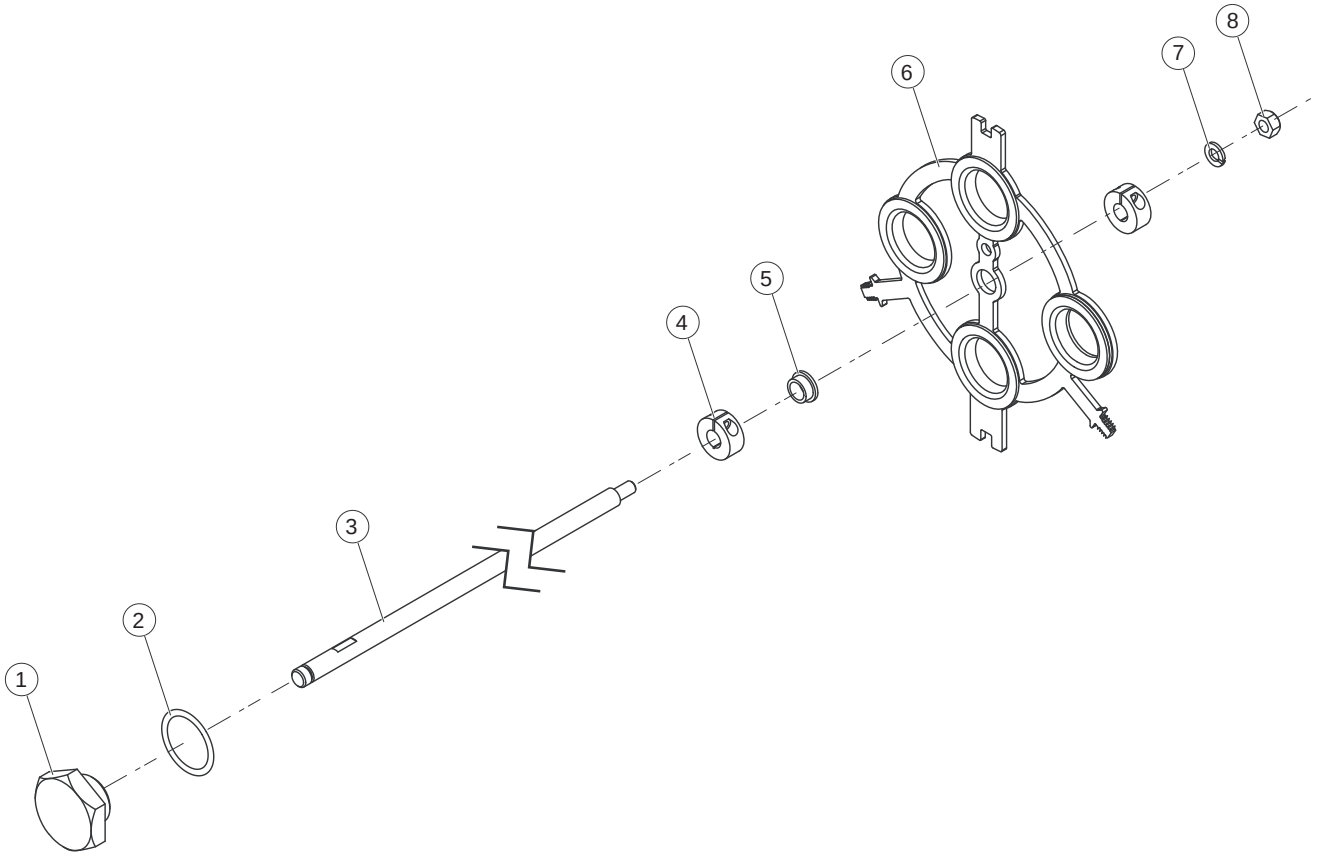


Figure 25 Non Wipe Kit

Component	Description	Part Number
1	Plug, 1/4in Thread Hex 316 SST	794225-001
2	O-Ring, 1-3/16 x 3/32 Viton	01290-123F
3	Rod, Lamp Holder	793299-001
4	Collar, Shaft 3/8in	794184
5	Flange Bushing	798123-002
6	Stop Plate (Middle) (04AL20)	794875-003
6	Stop Plate (Middle) (08AL20)	794875-007
7	Washer, 1/4 Splitlock 316 SST	010035
8	Nut, 1/4-20 UNC Hex 316 SST	011017

12.4 Gear Motor Drive

Note: *For Automatic Wiping Systems only.*

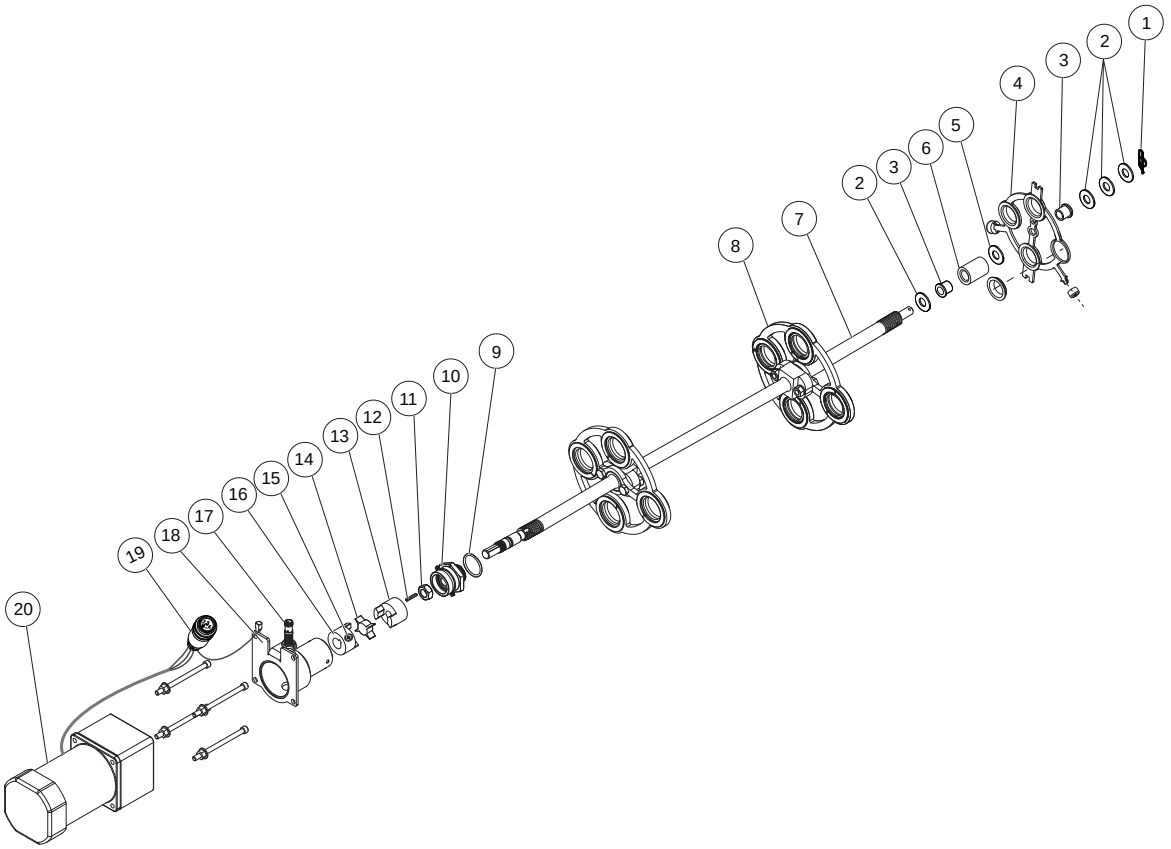


Figure 26 Gear Motor Drive components

Component	Description	Part Number
1	Cotter pin, 3/8-in SST	013207
2	Washer, 3/8" Flat 316 SST	010026
3	Flange Bushing	798123-001
4	Stop plate	Refer to Section 12.6
5	Washer, 1/2" Flat 316 SST	012003
6	Rubber Spring	794151
7	Rod, wiper	794915-001
8	Wiper Assembly	Refer to Section 12.5
9	O-Ring, bearing housing	002190-123F
10	Bearing Housing Kit	794872
11	Retaining Nut	011051-04AMF316
12	Square Key, 3/32 x 3/4 in.	820682-0648
13	Coupler, 7/16 in.	794909-001
14	Coupler, spider	794909-003
15	Screw, 1/4-20 x 3/8 in. pan head	010077
16	Coupler, 5/8 in.	794909-002
17	Inductive Proximity Sensor	914172-050
18	Motor Mount	795788

Component	Description	Part Number
19	Wiper Motor Power Connector	916774-1521326
20	Gear Motor, 3:1 gear ratio	792949

12.5 Lamp Sleeve Wiping System

Note: *For Wiping Systems only.*

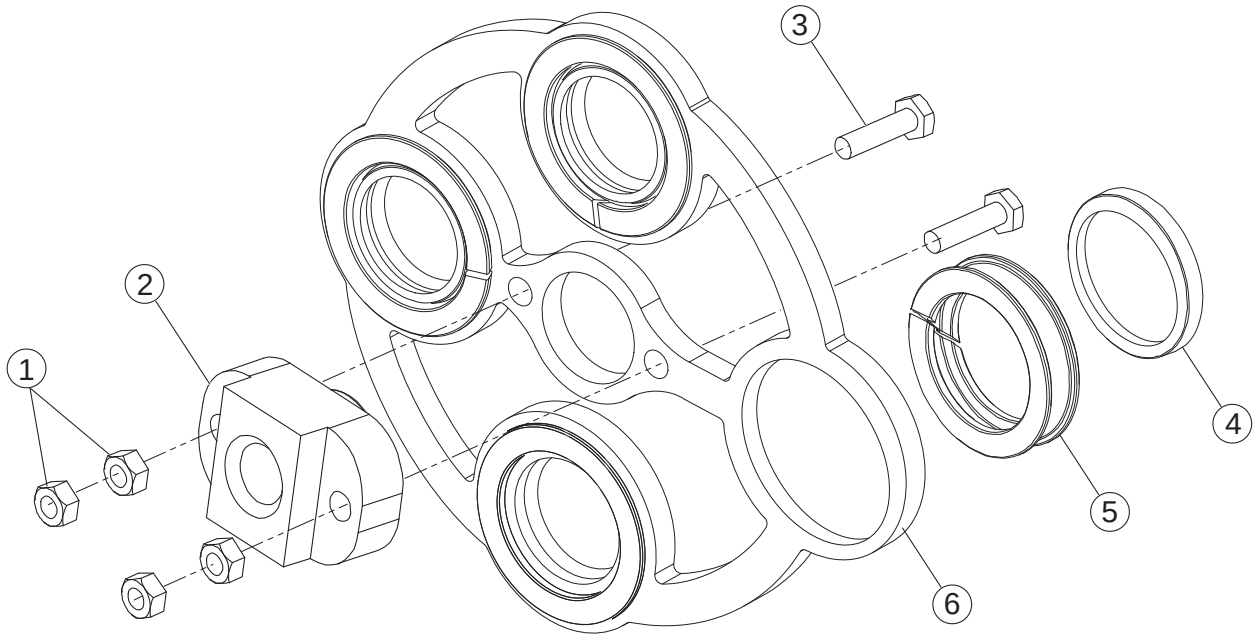


Figure 27 Automatic Wipe Components

Component	Description	Part Number
1	Nut, 1/4-20 UNC, 316 SST	011017
2	Drive Nut	794375
3	Bolt, 1/4-20 X 1.25" Hex 316 SST	793770
4	Wiper Seal, Viton 06VT7CR	795853
5	Holder, Lamp Sleeve Wiper	795816
6	Wiper Plate	
	04AL20	794178-002
	08AL20	794178-004

Illustration showing Type 04AL20.

12.6 Stop Plate

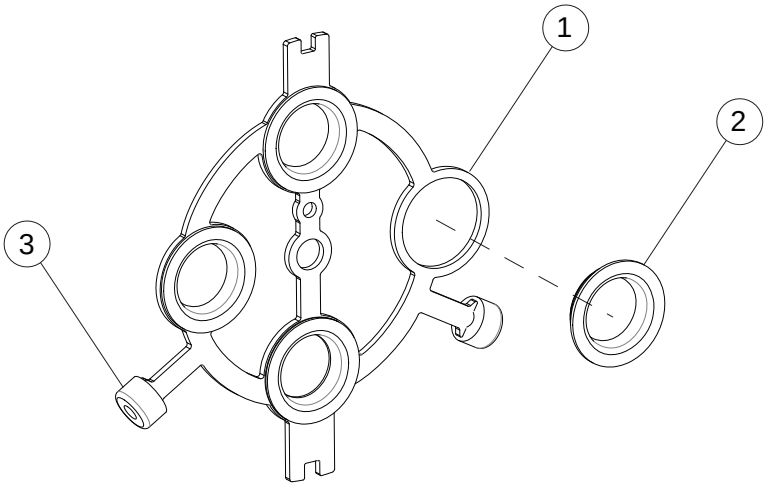


Figure 28 Stop Plate components

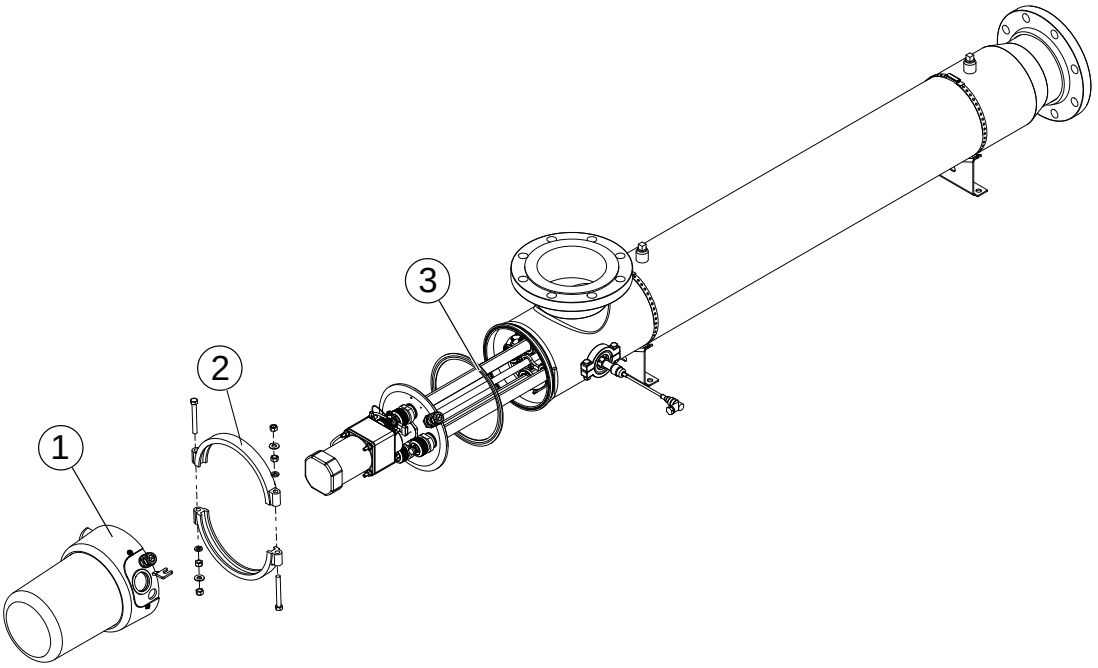
		System Model			
		04AL20 AW*	04AL20 NW*	08AL20 AW*	08AL20 NW*
Component	**Description**	**Part Number**			
1	Stop Plate	794875-003	794875-004	794875-007	794875-008
2	Lamp Sleeve Holder Bushing	792942			
3	Wear Pad	792916			

Illustration showing Type 04AL20.

*AW = Automatic Wipe
*NW = Non Wipe

12.7 UV Chamber

Automatic Wiping



Non-Wiping

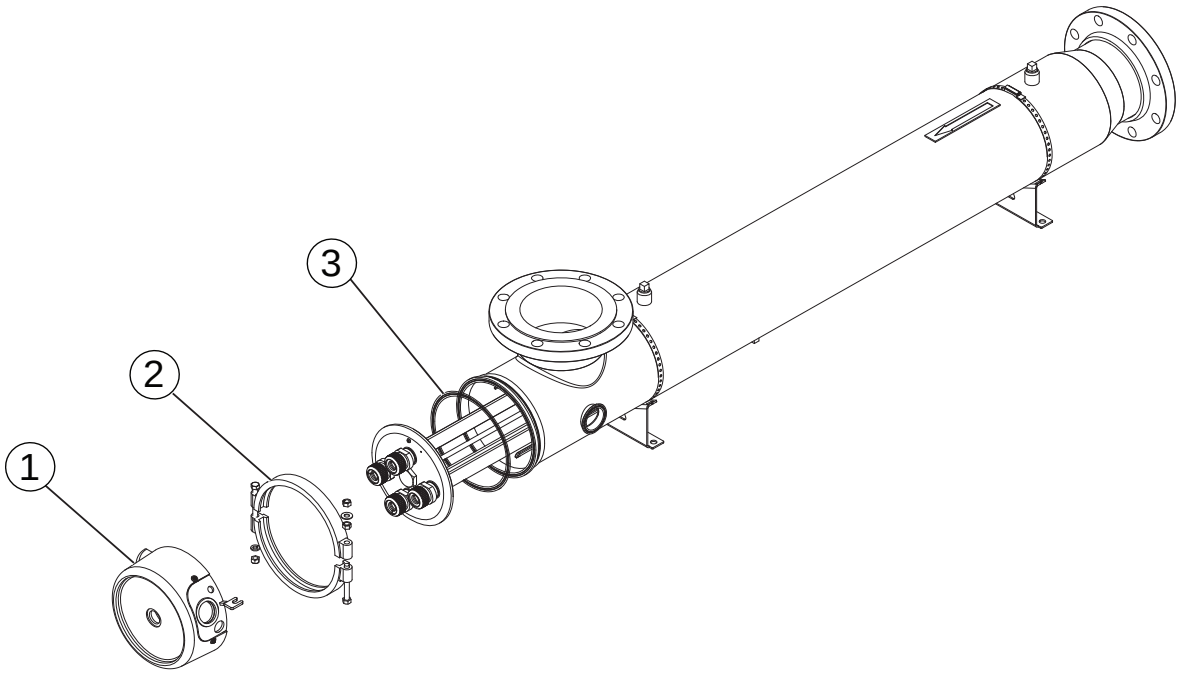


Figure 29 UV Chamber

Component	Description	Part Number
1	Service End Cap	
	Non Wipe - UVI Sensor Horizontal Install Orientation	700222-005
	Non Wipe - UVI Sensor Vertical Install Orientation	700222-006
	Automatic Wipe - UVI Sensor Horizontal Install Orientation	700222-002
	Automatic Wipe - UVI Sensor Vertical Install Orientation	700222-004
2	Clamp, Sanitary	794228
3	Gasket, Sanitary	002285-080

12.8 CPP Components

Description	Part Number
Power supply, 24 VDC (for the CCB)	916051-310
Lamp driver, electronic	917067
Board, UV microprocessor communication control board	931066-003
Board, P40 Ethernet/IP	931122-001
Board, P40 Ethernet Modbus TCP	931122-002
Board, P40 Ethernet Profinet	931122-003
Microprocessor Modbus RTU RS485 circuit board	931080-001
Microprocessor analog output circuit board	931067

12.9 Miscellaneous Components

Description	Part Number
Temperature Sensor Assembly	798037
Temperature Switch	
4.5m Length	795761-2175
7.5m Length	795761-2275
15m Length	795761-2525
23m Length	795761-2775
Air Vent Kit, Horizontal Installation	792715-003
Air Vent Kit, Vertical Installation	794261-003

PART 6

Standby Power Operation and Maintenance Manual

Transfer Switch Operation & Maintenance Manual

SEBU9348-08 (en-us)
August 2018

Operation and Maintenance Manual

C4.4 Generator Sets

TX3 1-UP (Generator Set)
CN3 1-UP (Generator Set)
MZT 1-UP (Generator Set)
TXB 1-UP (Generator Set)
CN6 1-UP (Generator Set)
L4R 1-UP (Generator Set)
TX2 1-UP (Generator Set)
CN4 1-UP (Generator Set)
L4T 1-UP (Generator Set)

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards, including human factors that can affect safety. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you verify that you are authorized to perform this work, and have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “DANGER”, “WARNING” or “CAUTION”. The Safety Alert “WARNING” label is shown below.

⚠ WARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

A non-exhaustive list of operations that may cause product damage are identified by “NOTICE” labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. You must not use this product in any manner different from that considered by this manual without first satisfying yourself that you have considered all safety rules and precautions applicable to the operation of the product in the location of use, including site-specific rules and precautions applicable to the worksite. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that you are authorized to perform this work, and that the product will not be damaged or become unsafe by the operation, lubrication, maintenance or repair procedures that you intend to use.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Cat dealers have the most current information available.

⚠ WARNING

When replacement parts are required for this product Caterpillar recommends using Cat replacement parts.

Failure to follow this warning may lead to premature failures, product damage, personal injury or death.

In the United States, the maintenance, replacement, or repair of the emission control devices and systems may be performed by any repair establishment or individual of the owner's choosing.

Table of Contents

Foreword

California Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

WARNING – This product can expose you to chemicals including ethylene glycol, which is known to the State of California to cause birth defects or other reproductive harm. For more information go to:

www.P65Warnings.ca.gov

Do not ingest this chemical. Wash hands after handling to avoid incidental ingestion.

WARNING – This product can expose you to chemicals including lead and lead compounds, which are known to the State of California to cause cancer, birth defects, or other reproductive harm. For more information go to:

www.P65Warnings.ca.gov

Wash hands after handling components that may contain lead.

Literature Information

This manual contains safety, operation instructions, lubrication, and maintenance information. This manual should be stored in or near the engine area in a literature holder or literature storage area. Read, study, and keep it with the literature and engine information.

English is the primary language for all Cat publications. The English used facilitates translation and consistency in electronic media delivery.

Some photographs or illustrations in this manual show details or attachments that may be different from your engine. Guards and covers may have been removed for illustrative purposes. Continuing improvement and advancement of product design may have caused changes to your engine which are not included in this manual Whenever a question arises regarding your engine, or this manual, please consult with your Cat dealer for the latest available information.

Safety

This safety section lists basic safety precautions. In addition, this section identifies hazardous, warning situations. Read and understand the basic precautions listed in the safety section before operating or performing lubrication, maintenance, and repair on this product.

Operation

Operating techniques outlined in this manual are basic. They assist with developing the skills and techniques required to operate the engine more efficiently and economically. Skill and techniques develop as the operator gains knowledge of the engine and its capabilities.

The operation section is a reference for operators. Photographs and illustrations guide the operator through procedures of inspecting, starting, operating, and stopping the engine. This section also includes a discussion of electronic diagnostic information.

Maintenance

The maintenance section is a guide to engine care. The illustrated, step-by-step instructions are grouped by fuel consumption, service hours and/or calendar time maintenance intervals. Items in the maintenance schedule are referenced to detailed instructions that follow.

Use fuel consumption or service hours to determine intervals. Calendar intervals shown (daily, annually, etc.) may be used instead of service meter intervals if they provide more convenient schedules and approximate the indicated service meter reading.

Recommended service should be performed at the appropriate intervals as indicated in the Maintenance Interval Schedule. The actual operating environment of the engine also governs the Maintenance Interval Schedule. Therefore, under severe, dusty, wet, or freezing cold operating conditions, more frequent lubrication, and maintenance than is specified in the Maintenance Interval Schedule may be necessary.

The maintenance schedule items are organized for a preventive maintenance management program. If the preventive maintenance program is followed, a periodic tune-up is not required. The implementation of a preventive maintenance management program should minimize operating costs through cost avoidances resulting from reductions in unscheduled downtime and failures.

Maintenance Intervals

Perform maintenance on items at multiples of the original requirement. Each level and/or individual items in each level should be shifted ahead or back depending upon your specific maintenance practices, operation, and application. We recommend that the maintenance schedules be reproduced and displayed near the engine as a convenient reminder. We also recommend that a maintenance record be maintained as part of the engine's permanent record.

See the section in the Operation and Maintenance Manual, “Maintenance Records” for information regarding documents that are accepted as proof of maintenance or repair. Your authorized Cat dealer can assist you in adjusting your maintenance schedule to meet the needs of your operating environment.

Overhaul

Major engine overhaul details are not covered in the Operation and Maintenance Manual except for the interval and the maintenance items in that interval. Major repairs are best left to trained personnel or an authorized Cat dealer. Your Cat dealer offers various options regarding overhaul programs. If you experience a major engine failure, there are also numerous after failure overhaul options available from your Cat dealer. Consult with your dealer for information regarding these options.

Safety Section

i07476136

Safety Messages

SMCS Code: 1000; 7405

There may be several specific safety messages on your generator set. The exact location and a description of the safety messages are reviewed in this section. Become familiar with all safety messages.

Ensure that all the safety messages are legible. Clean the safety signs or replace the safety messages if the words cannot be read or if the illustrations are not visible. Use a cloth, water, and soap to clean the safety messages. Do not use solvents, gasoline, or other harsh chemicals. Solvents, gasoline, or harsh chemicals could loosen the adhesive that secures the safety messages. The safety messages that are loosened could drop off the engine.

Replace any safety message that is damaged or missing. If a safety message is attached to a part of the engine that is replaced, install a new safety message on the replacement part. Your Caterpillar dealer can provide new safety messages.

⚠ WARNING

Do not operate or work on this engine unless you have read and understand the instructions and warnings in the Operation and Maintenance Manual. Failure to follow the instructions or heed the warnings could result in injury or death. Contact any Caterpillar dealer for replacement manuals. Proper care is your responsibility.

⚠ WARNING

Electrical backfeed into a utility's distribution system can cause property damage, severe injury, or death. Do not connect generator to a building's main switch has been used to isolate the building from the utility power system. For permanent installations, connection shall only be a double throw switch as to isolate the building from a utility power system. Consult a qualified technician for proper use and installation. Comply with all applicable laws and electrical codes.

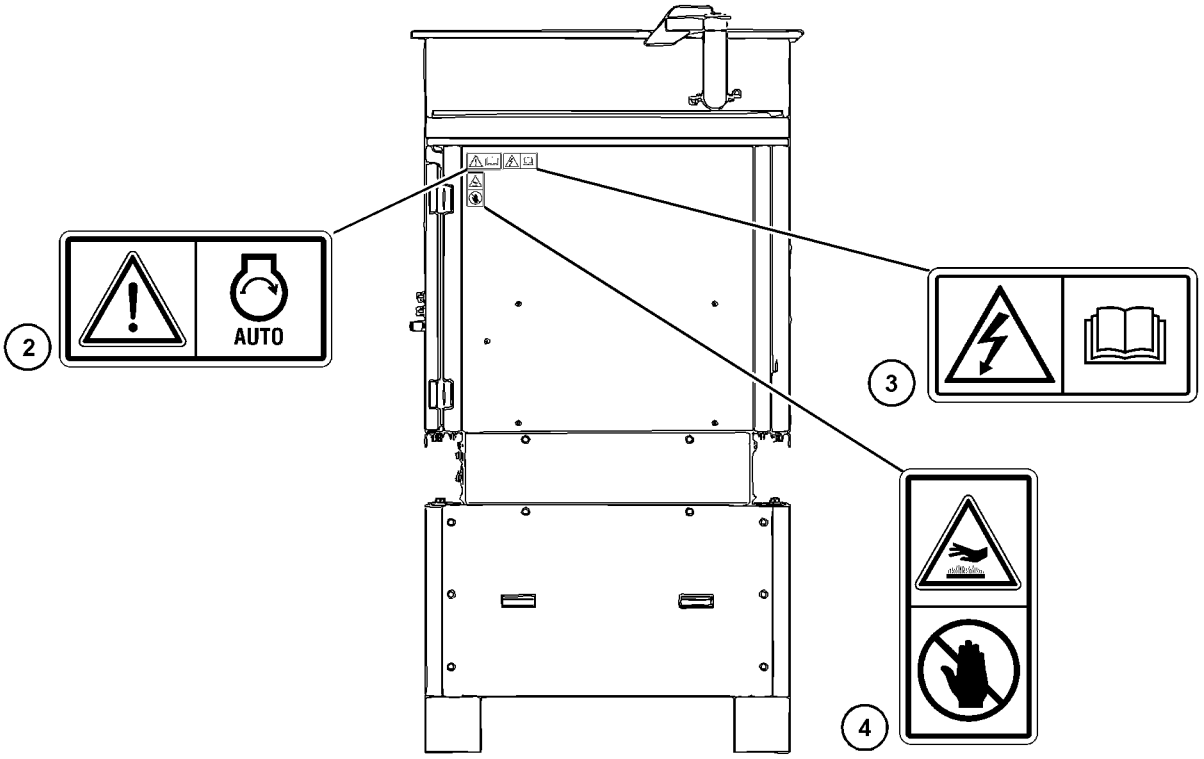


Illustration 1 g06075397

View of the control panel

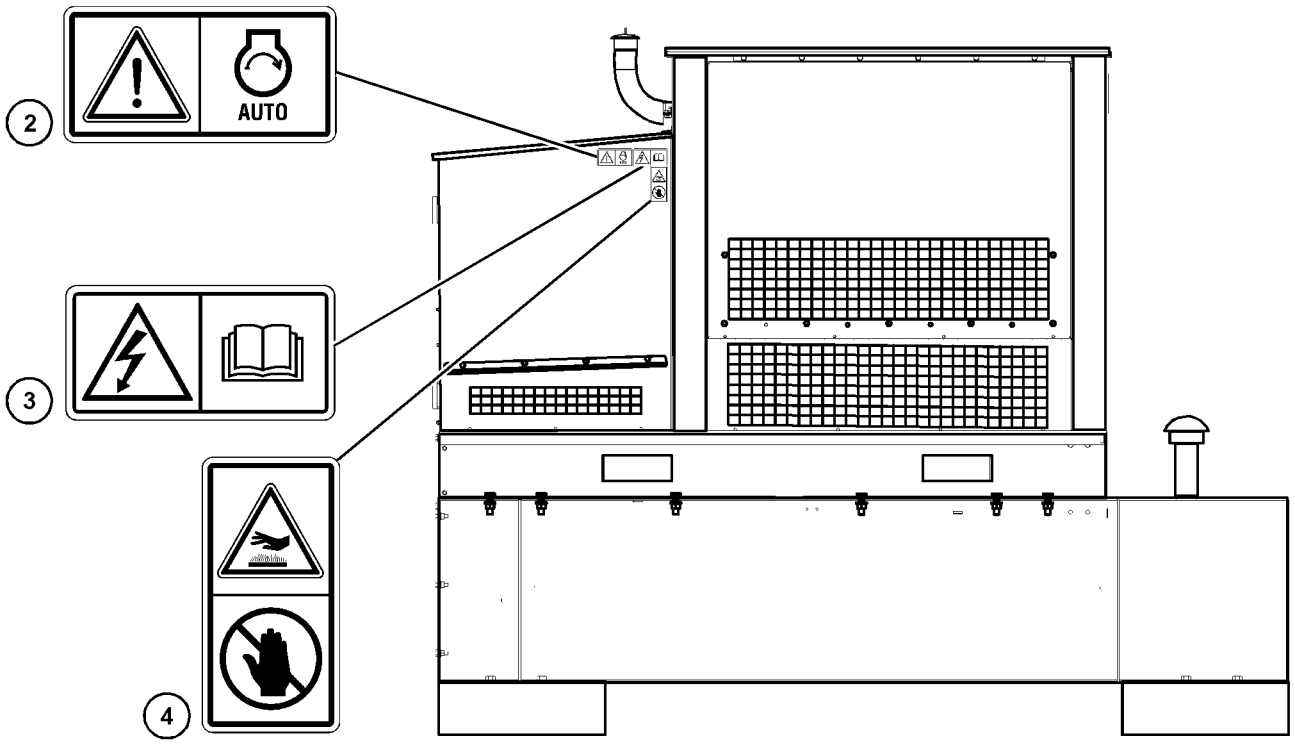


Illustration 2 g06075404

Side view of the generator set

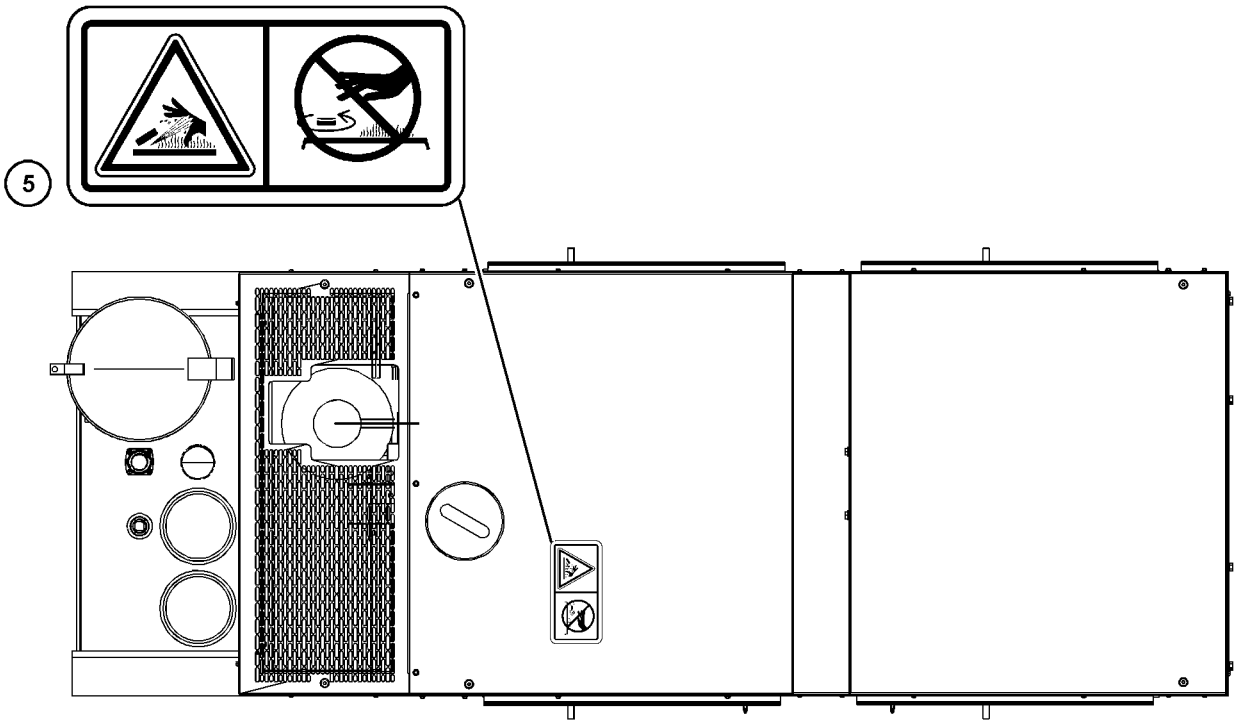


Illustration 3 g06075408

Top view of the generator set

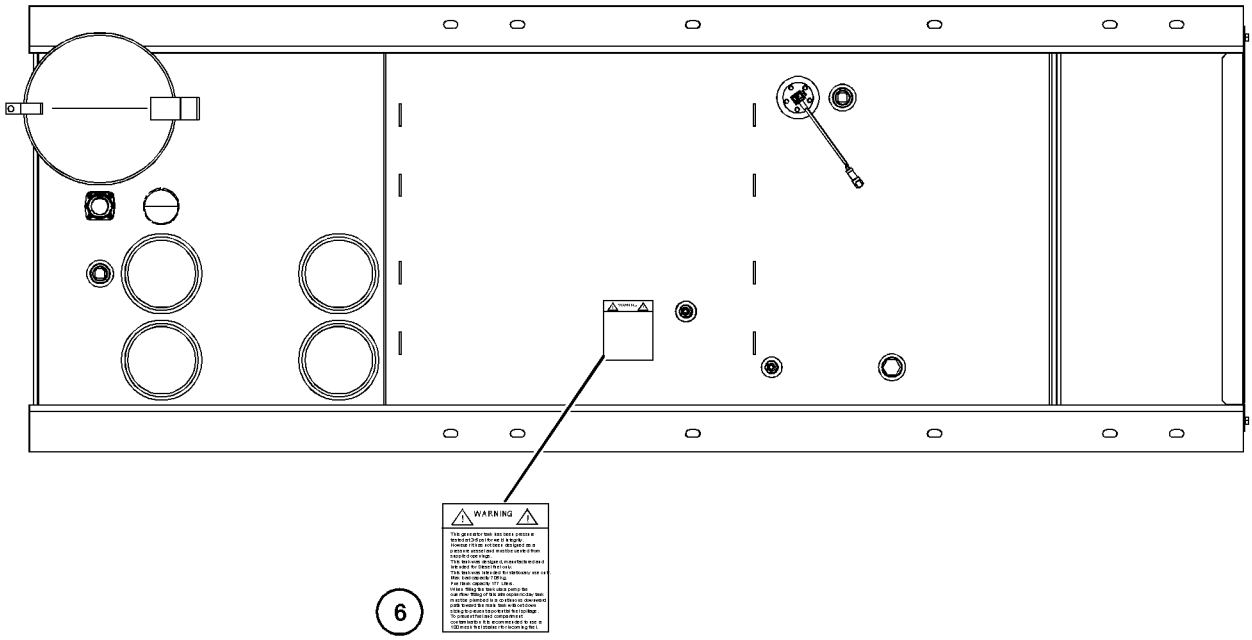


Illustration 4 g06075406

View of the fuel tank

Universal Warning (1)

This safety message is on both sides of the engine.

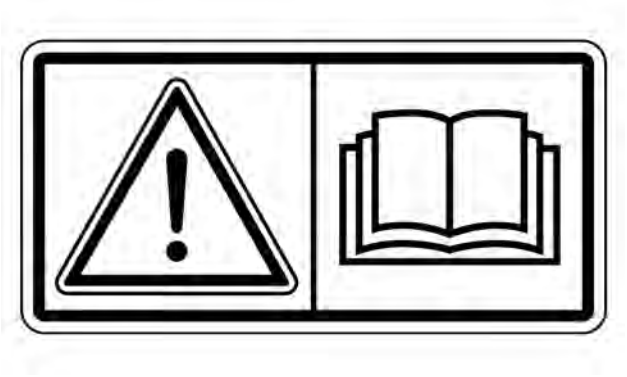


Illustration 5 g01370904

WARNING

Do not operate or work on this equipment unless you have read and understand the instructions and warnings in the Operation and Maintenance Manuals. Failure to follow the instructions or heed the warnings could result in serious injury or death.

Automatic Starting (2)

This safety message is on the sides of the enclosure and on the enclosure above the door for the control panel.

Illustration 6 g01392484

WARNING

When the engine is in the AUTOMATIC mode, the engine can start at any moment. To avoid personal injury, always remain clear of the the engine when the engine is in the AUTOMATIC mode.

Electrocution (3)

This safety message is on the sides of the enclosure and on the enclosure above the door for the control panel.

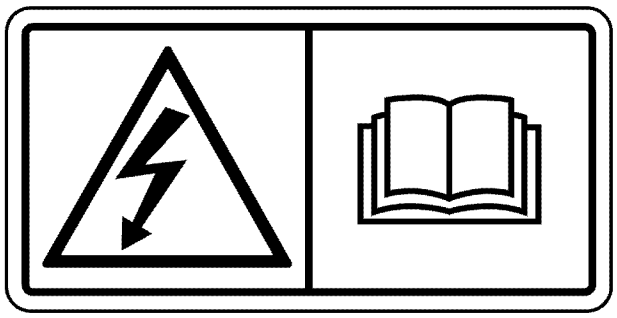


Illustration 7 g03430411

DANGER

DANGER: Shock/Electrocution Hazard-Do not operate this equipment or work on this equipment unless you have read and understand the instructions and warnings in the Operation and Maintenance Manual. Failure to follow the instructions or heed the warnings will result in serious injury or death.

⚠ WARNING

Do not connect generator to a utility electrical distribution system unless it is isolated from the system. Electrical feedback into the distribution system can occur and could cause personal injury or death.

Open and secure main distribution system switch, or if the connection is permanent, install a double throw transfer switch to prevent electrical feedback. Some generators are specifically approved by a utility to run in parallel with the distribution system and isolation may not be required. Always check with your utility as to the applicable circumstances.

Hot Surface (4)

This safety message is on the top of the enclosure and the sides of the enclosure.

Illustration 8 g01372256

⚠ WARNING

Hot parts or hot components can cause burns or personal injury. Do not allow hot parts or components to contact your skin. Use protective clothing or protective equipment to protect your skin.

Hot Fluid Under Pressure (5)

This safety message is located by the cooling system filler cap.

Illustration 9 g01371640

⚠ WARNING

Pressurized system! Hot coolant can cause serious burns, injury or death. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure. Read and understand the Operation and Maintenance Manual before performing any cooling system maintenance.

Fuel Tank Vent (6)

This safety message is on the fuel tank next to the vent.

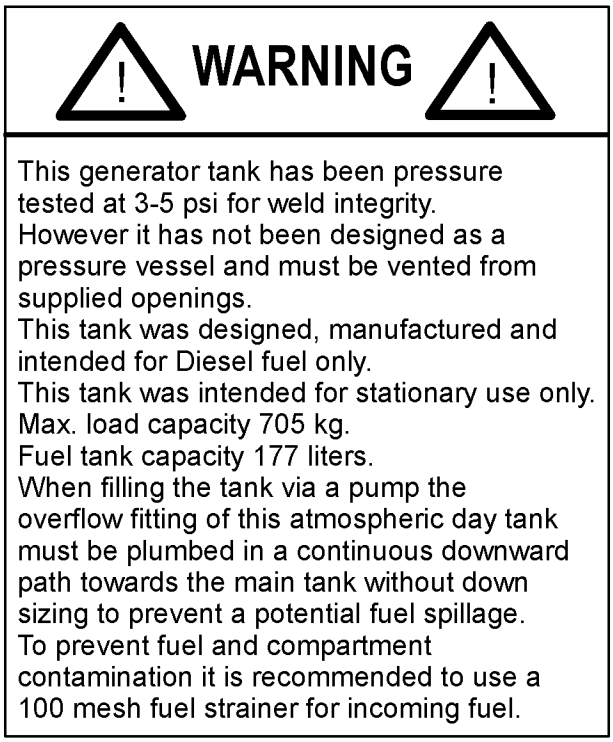


Illustration 10 g01175225

WARNING

This generator tank has been pressure tested at 3-5 PSI for weld integrity.

However it has not been designed as a pressure vessel and must be vented from supplied openings.

This tank was designed, manufactured and intended for Diesel fuel only.

This tank was intended for stationary use only.

Max. load capacity 705 kg (1554 lb).

Fuel tank capacity 177 L (47 US gal).

When filling the tank via a pump the overflow fitting of this atmospheric day tank must be plumbed in a continuous downward path toward the main tank without downsizing to prevent a potential fuel spillage.

To prevent fuel and compartment contamination it is recommended to use a 100 mesh fuel strainer for incoming fuel.

i06683276

Additional Messages

SMCS Code: 1000; 7405

There are several specific messages on these machines. The exact location of the messages and the description of the messages are reviewed in this section. Become familiarized with all messages.

Make sure that all the messages are legible. Clean the messages or replace the messages if the words or images are unreadable. When you clean the messages, use a cloth, water, and soap. Do not use solvent, gasoline, or other harsh chemicals to clean the messages. Solvents, gasoline, or harsh chemicals could loosen the adhesive that secures the messages. Loose adhesive will allow the messages to fall.

Replace any message that is damaged, or missing. If a message is attached to a part that is replaced, install a message on the replacement part. Any Caterpillar dealer can provide new messages.

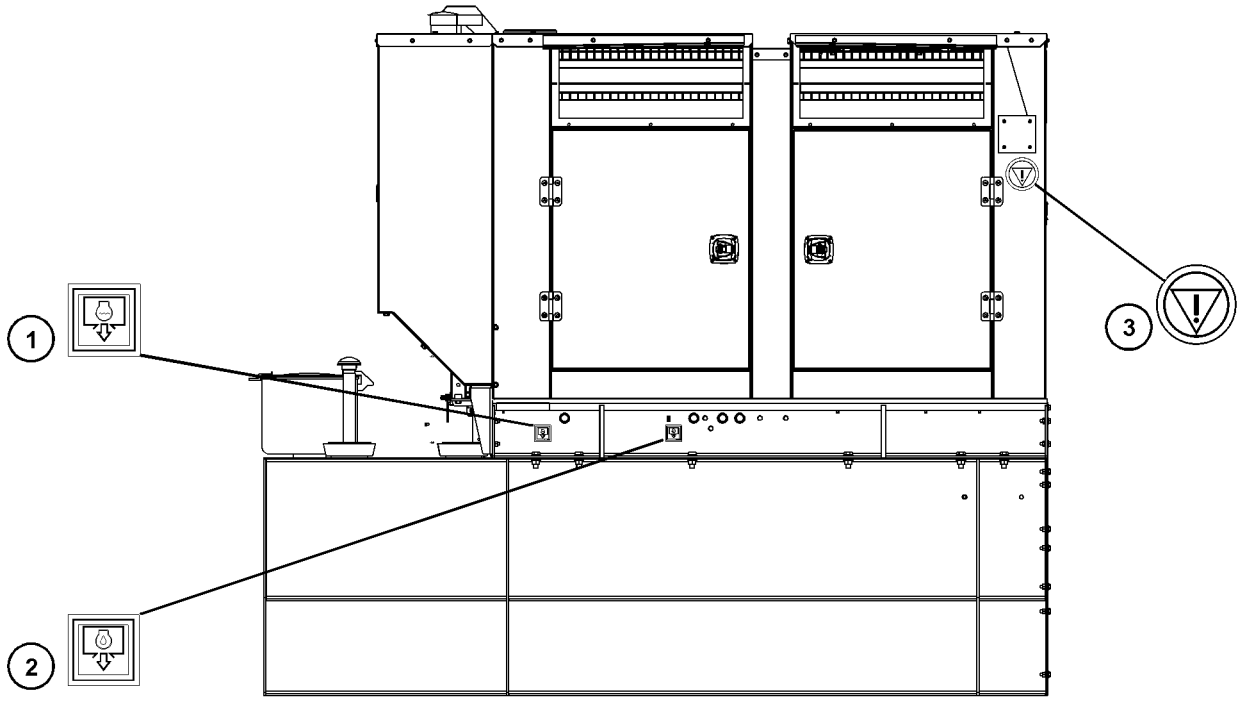


Illustration 11 g06073912

Engine Coolant Drain (1)

This message is on the side of the generator set toward the bottom of the generator set.

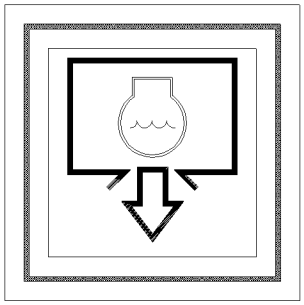


Illustration 12 g01151053

This is the location of the engine coolant drain. Refer to this Operation and Maintenance Manual, “Cooling System Coolant (ELC) - Change”.

WARNING

Personal injury can result from hot coolant. Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

Engine Oil Drain (2)

This message is on the side of the generator set toward the bottom of the generator set.

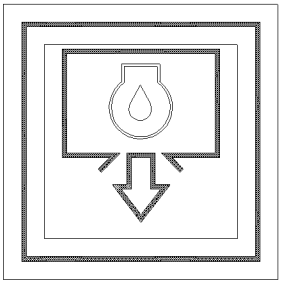


Illustration 13 g01151083

This is the location of the engine oil drain. Refer to this Operation and Maintenance Manual, “Engine Oil and Filter - Change”.

⚠ WARNING

Hot oil and components can cause personal injury. Do not allow hot oil or components to contact skin.

Emergency Stop Button (3)

This message is located near the emergency stop button.

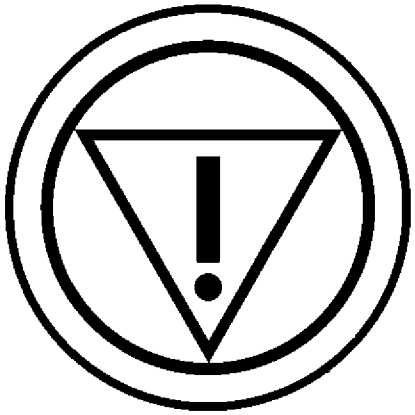


Illustration 14 g06074018

i06300340

General Hazard Information

SMCS Code: 1000; 4450; 7405

Illustration 15 g03838041

Attach a “Do Not Operate” warning tag to the start switch or controls before the engine is serviced or repaired. These warning tags (Special Instruction, SEHS7332) are available from your Cat dealer. Attach the warning tags to the engine and to each operator control station. When appropriate, disconnect the starting controls.

Do not allow unauthorized personnel on the engine, or around the engine when the engine is being serviced.

Cautiously remove the following parts. To help prevent spraying or splashing of pressurized fluids, hold a rag over the part that is being removed.

- Filler caps
- Grease fittings
- Pressure taps
- Breathers
- Drain plugs

Use caution when cover plates are removed. Gradually loosen, but do not remove the last two bolts or nuts that are located at opposite ends of the cover plate or the device. Before removing the last two bolts or nuts, pry the cover loose in order to relieve any spring pressure or other pressure.

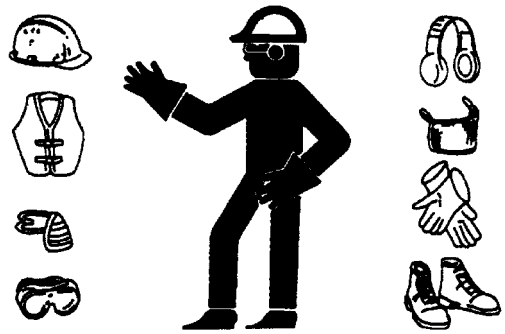


Illustration 16 g00702020

- Wear a hard hat, protective glasses, and other protective equipment, as required.
- When work is performed around an engine that is operating, wear protective devices for ears in order to help prevent damage to hearing.
- Do not wear loose clothing or jewelry that can snag on controls or on other parts of the engine.
- Ensure that all protective guards and all covers are secured in place on the engine.
- Never put maintenance fluids into glass containers. Glass containers can break.
- Use all cleaning solutions with care.
- Report all necessary repairs.

Unless other instructions are provided, perform the maintenance under the following conditions:

- The engine is stopped. Ensure that the engine cannot be started.
- The protective locks or the controls are in the applied position.
- Disconnect the batteries when maintenance is performed or when the electrical system is serviced. Disconnect the battery ground leads. Tape the leads in order to help prevent sparks.
- When starting a new engine, make provisions to stop the engine if an overspeed occurs. If an engine has not been started since service has been performed, make provisions to stop the engine if an overspeed occurs. Shutting down the engine may be accomplished by shutting off the fuel supply and/or the air supply to the engine.
- Do not attempt any repairs that are not understood. Use the proper tools. Replace any equipment that is damaged or repair the equipment.
- Start the engine with the operator controls. Never short across the starting motor terminals or the batteries. This method of starting the engine could bypass the engine neutral start system and/or the electrical system could be damaged.

Pressurized Air and Water

Pressurized air and/or water can cause debris and/or hot water to be blown out which could result in personal injury.

The maximum air pressure for cleaning purposes must be reduced to 205 kPa (30 psi) when the air nozzle is deadheaded and used with effective chip guarding (if applicable) and personal protective equipment. The maximum water pressure for cleaning purposes must be below 275 kPa (40 psi).

When pressurized air and/or pressurized water is used for cleaning, wear protective clothing, protective shoes, and eye protection. Eye protection includes goggles or a protective face shield. Always wear eye protection for cleaning the cooling system.

Avoid direct spraying of water on electrical connectors, connections, and components. When using air for cleaning, allow the machine to cool to reduce the possibility of fine debris igniting when redeposited on hot surfaces.

Fluid Penetration

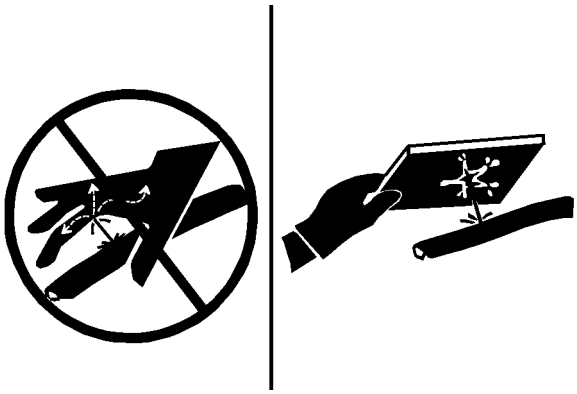


Illustration 17 g00687600

Always use a board or cardboard when you check for a leak. Leaking fluid that is under pressure can penetrate body tissue. Fluid penetration can cause serious injury and possible death. A pin hole leak can cause severe injury. If fluid is injected into your skin, you must get treatment immediately. Seek treatment from a doctor that is familiar with this type of injury.

Containing Fluid Spillage

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Cat Dealer Service Tool Catalog” or refer to Special Publication, PECJ0003, “Cat Shop Supplies and Tools Catalog” for tools and supplies suitable to collect and contain fluids on Cat products.

Dispose of all fluids according to local regulations and mandates.

Static Electricity Hazard when Fueling with Ultra-low Sulfur Diesel Fuel

The removal of sulfur and other compounds in ultra-low sulfur diesel fuel (ULSD fuel) decreases the conductivity of ULSD and increases the ability of ULSD to store static charge. Refineries may have treated the fuel with a static dissipating additive. Many factors can reduce the effectiveness of the additive over time. Static charges can build up in ULSD fuel while the fuel is flowing through fuel delivery systems. Static electricity discharge when combustible vapors are present could result in a fire or explosion. Ensure that the entire system used to refuel your machine (fuel supply tank, transfer pump, transfer hose, nozzle, and others) is properly grounded and bonded. Consult with your fuel or fuel system supplier to ensure that the delivery system complies with fueling standards for proper grounding and bonding.

⚠ WARNING

Avoid static electricity risk when fueling. Ultra-low sulfur diesel fuel (ULSD fuel) poses a greater static ignition hazard than earlier diesel formulations with a higher sulfur contents. Avoid death or serious injury from fire or explosion. Consult with your fuel or fuel system supplier to ensure the delivery system is in compliance with fueling standards for proper grounding and bonding practices.

Lines, Tubes, and Hoses

Do not bend or strike high-pressure lines. Do not install lines, tubes, or hoses that are damaged.

Repair any fuel lines, oil lines, tubes, or hoses that are loose or damaged. Leaks can cause fires.

Inspect all lines, tubes, and hoses carefully. Do not use bare hands to check for leaks. Always use a board or cardboard for checking engine components for leaks. Tighten all connections to the recommended torque.

Check for the following conditions:

- End fittings that are damaged or leaking
- Outer covering that is chafed or cut
- Wire that is exposed in reinforced hose
- Outer covering that is ballooning locally
- Flexible part of the hose that is kinked or crushed
- Armoring that is embedded in the outer covering

Ensure that all of the clamps, the guards, and the heat shields are installed correctly. Correct installation of these components will help to prevent these effects: vibration, rubbing against other parts and excessive heat during operation.

Inhalation

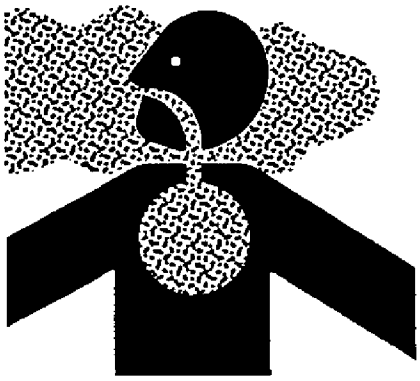


Illustration 18 g02159053

Exhaust

Use caution. Exhaust fumes can be hazardous to your health. If you operate the equipment in an enclosed area, adequate ventilation is necessary.

Asbestos Information

Cat equipment and replacement parts that are shipped from Caterpillar are asbestos free. Caterpillar recommends the use of only genuine Cat replacement parts. Use the following guidelines when you handle any replacement parts that contain asbestos or when you handle asbestos debris.

Use caution. Avoid inhaling dust that might be generated when you handle components that contain asbestos fibers. Inhaling this dust can be hazardous to your health. The components that may contain asbestos fibers are brake pads, brake bands, lining material, clutch plates, and some gaskets. The asbestos that is used in these components is bound in a resin or sealed in some way. Normal handling is not hazardous unless airborne dust that contains asbestos is generated.

If dust that may contain asbestos is present, there are several guidelines that should be followed:

- Never use compressed air for cleaning.
- Avoid brushing materials that contain asbestos.
- Avoid grinding materials that contain asbestos.
- Use a wet method in order to clean up asbestos materials.
- A vacuum cleaner that is equipped with a high efficiency particulate air filter (HEPA) can also be used.
- Use exhaust ventilation on permanent machining jobs.
- Wear an approved respirator if there is no other way to control the dust.
- Comply with applicable rules and regulations for the work place. In the United States, use Occupational Safety and Health Administration (OSHA) requirements. These OSHA requirements can be found in “29 CFR 1910.1001”.
- Obey environmental regulations for the disposal of asbestos.
- Stay away from areas that might have asbestos particles in the air.

Softwrap

Keep the engine room ventilation operating at full capacity. Wear a particulate respirator that has been approved by the National Institute of Occupational Safety and Health (NIOSH). Wear appropriate protective clothing in order to minimize direct contact. Use good hygiene practices and wash hands thoroughly after handling Softwrap material. Do not smoke until washing hands thoroughly after handling Softwrap material. Clean up debris with a vacuum or by wet sweeping. Do not use pressurized air to clean up debris.

Reference: The applicable material safety data sheets can be found at the following web site by searching using part number or the name:

https://catmsds.cat.com/MSDSSearch/servlet/cat.cis.ecs.msdsSearch.controller.UserIdentificationDisplayServlet

Dispose of Waste Properly

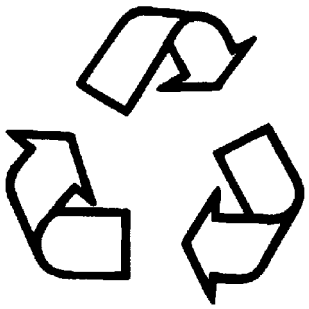


Illustration 19 g00706404

Improperly disposing of waste can threaten the environment. Potentially harmful fluids should be disposed of according to local regulations.

Always use leakproof containers when you drain fluids. Do not pour waste onto the ground, down a drain, or into any source of water.

i04422525

Burn Prevention

SMCS Code: 1000; 4450; 7405

Do not touch any part of an operating engine. Allow the engine to cool before any maintenance is performed on the engine. Relieve all pressure in the air system, in the hydraulic system, in the lubrication system, in the fuel system, or in the cooling system before any lines, fittings or related items are disconnected.

Coolant

When the engine is at operating temperature, the engine coolant is hot. The coolant is also under pressure. The radiator and all lines to the heaters or to the engine contain hot coolant.

Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

Check the coolant level after the engine has stopped and the engine has been allowed to cool.

Ensure that the filler cap is cool before removing the filler cap. The filler cap must be cool enough to touch with a bare hand. Remove the filler cap slowly in order to relieve pressure.

Cooling system conditioner contains alkali. Alkali can cause personal injury. Do not allow alkali to contact the skin, the eyes, or the mouth.

Oils

Hot oil and hot lubricating components can cause personal injury. Do not allow hot oil to contact the skin. Also, do not allow hot components to contact the skin.

i04823639

Fire Prevention and Explosion Prevention

SMCS Code: 1000; 4450; 7405

Illustration 20 g00704000

All fuels, most lubricants, and some coolant mixtures are flammable.

Flammable fluids that are leaking or spilled onto hot surfaces or onto electrical components can cause a fire. Fire may cause personal injury and property damage.

A flash fire may result if the covers for the engine crankcase are removed within 15 minutes after an emergency shutdown.

Determine whether the engine will be operated in an environment that allows combustible gases to be drawn into the air inlet system. These gases could cause the engine to overspeed. Personal injury, property damage, or engine damage could result.

If the application involves the presence of combustible gases, consult your Cat dealer for additional information about suitable protection devices.

Remove all flammable materials such as fuel, oil, and debris from the engine. Do not allow any flammable materials to accumulate on the engine.

Store fuels and lubricants in properly marked containers away from unauthorized persons. Store oily rags and any flammable materials in protective containers. Do not smoke in areas that are used for storing flammable materials.

Do not expose the engine to any flame.

Exhaust shields (if equipped) protect hot exhaust components from oil or fuel spray in a line, a tube, or a seal failure. Exhaust shields must be installed correctly.

Do not weld on lines or tanks that contain flammable fluids. Do not flame cut lines or tanks that contain flammable fluid. Clean any such lines or tanks thoroughly with a nonflammable solvent prior to welding or flame cutting.

Wiring must be kept in good condition. Check all electrical wires daily. Ensure that all electrical wires are properly routed and securely attached. Repair any wires that are loose or frayed before you operate the engine. Clean all electrical connections and tighten all electrical connections.

Eliminate all wiring that is unattached or unnecessary. Do not use any wires or cables that are smaller than the recommended gauge. Do not bypass any fuses and/or circuit breakers.

Arcing or sparking could cause a fire. Secure connections, recommended wiring, and properly maintained battery cables will help to prevent arcing or sparking.

Inspect all lines and hoses for wear or for deterioration. Properly route all hoses. The lines and hoses must have adequate support and secure clamps. Tighten all connections to the recommended torque. Leaks can cause fires.

Properly install all oil filters and fuel filters. The filter housings must be tightened to the proper torque.

Illustration 21 g00704059

Use caution when you are refueling an engine. Do not smoke while you are refueling an engine. Do not refuel an engine near open flames or sparks. Always stop the engine before refueling.

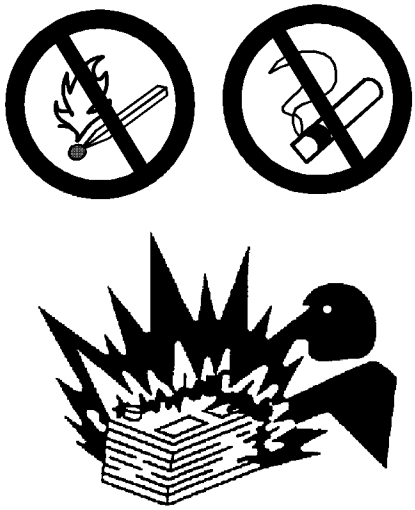


Illustration 22 g02298225

Gases from a battery can explode. Keep any open flames or sparks away from the top of a battery. Do not smoke in battery charging areas.

Never check the battery charge by placing a metal object across the terminal posts. Use a voltmeter or a hydrometer.

Improper jumper cable connections can cause an explosion that can result in injury. Refer to the Operation Section of this manual for specific instructions.

Do not charge a frozen battery. Charging a frozen battery may cause an explosion.

The batteries must be kept clean. The covers (if equipped) must be kept on the cells. Use the recommended cables, connections, and battery box covers when the engine is operated.

Fire Extinguisher

Make sure that a fire extinguisher is available. Be familiar with the operation of the fire extinguisher. Inspect the fire extinguisher and service the fire extinguisher regularly. Obey the recommendations on the instruction plate.

Ether

⚠ WARNING

Do not use ether. This machine is equipped with glow plugs. Using ether can create explosions or fires that can cause personal injury or death. Read and follow the engine starting procedure in the Operation and Maintenance Manual.

Lines, Tubes, and Hoses

Do not bend high-pressure lines. Do not strike high-pressure lines. Do not install any lines that are bent or damaged.

Repair any lines that are loose or damaged. Leaks can cause fires. Consult your Cat dealer for repair or for replacement parts.

Check lines, tubes, and hoses carefully. Do not use your bare hand to check for leaks. Use a board or cardboard to check for leaks. Tighten all connections to the recommended torque.

Replace the parts if any of the following conditions are present:

- End fittings are damaged or leaking.
- Outer coverings are chafed or cut.
- Wires are exposed.
- Outer coverings are ballooning.
- Flexible parts of the hoses are kinked.
- Outer covers have embedded armoring.
- End fittings are displaced.

Make sure that all clamps, guards, and heat shields are installed correctly in order to revent vibration, rubbing against other parts, and excessive heat.

i01359666

Crushing Prevention and Cutting Prevention

SMCS Code: 1000; 4450; 7405

Support the component properly when work beneath the component is performed.

Unless other maintenance instructions are provided, never attempt adjustments while the engine is running.

Stay clear of all rotating parts and of all moving parts. Leave the guards in place until maintenance is performed. After the maintenance is performed, reinstall the guards.

Keep objects away from moving fan blades. The fan blades will throw objects or cut objects.

When objects are struck, wear protective glasses in order to avoid injury to the eyes.

Chips or other debris may fly off objects when objects are struck. Before objects are struck, ensure that no one will be injured by flying debris.

i04597969

Mounting and Dismounting

SMCS Code: 1000; 4450; 7405

Inspect the steps, the handholds, and the work area before mounting the unit. Keep these items clean and keep these items in good repair.

Mount the unit and dismount the unit only at locations that have steps and/or handholds. Do not climb on the engine, and do not jump off the engine.

Face the unit in order to mount the unit or dismount the unit. Maintain a three-point contact with the steps and handholds. Use 2 feet and one hand or use 1 foot and two hands. Do not use any controls as handholds.

Some units require access to the roof of the enclosure to perform maintenance. Do not stand on components which cannot support your weight. Use an adequate ladder or use a work platform. Secure the climbing equipment so that the equipment will not move.

Do not carry tools or supplies when you mount the engine or when you dismount the engine. Use a hand line to raise and lower tools or supplies.

i05322934

High Pressure Fuel Lines

SMCS Code: 1274

S/N: CN31–Up

S/N: TX31–Up

S/N: MZT1–Up

⚠ WARNING

Contact with high pressure fuel may cause fluid penetration and burn hazards. High pressure fuel spray may cause a fire hazard. Failure to follow these inspection, maintenance and service instructions may cause personal injury or death.

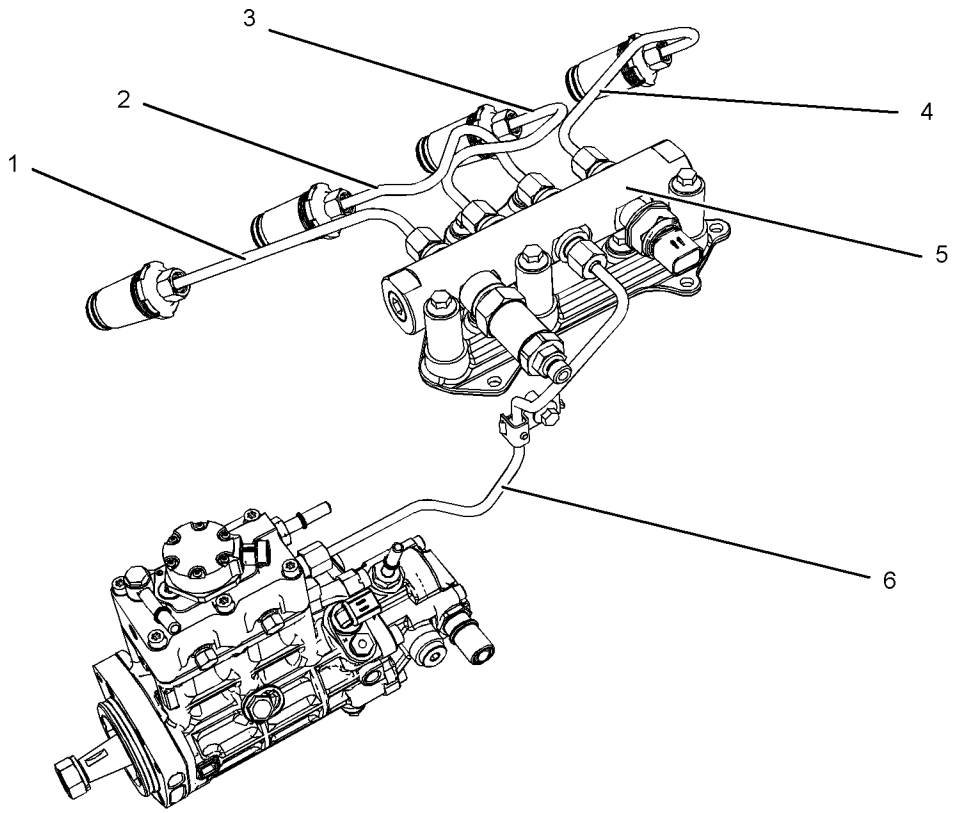


Illustration 23 g01425090

(1) High-pressure line
(2) High-pressure line
(3) High-pressure line
(4) High-pressure line
(5) High-pressure fuel manifold (rail)
(6) High-pressure line

The high-pressure fuel lines are the fuel lines that are between the high-pressure fuel pump and the high-pressure fuel manifold and the fuel lines that are between the fuel manifold and cylinder head. These fuel lines are different from fuel lines on other fuel systems.

The differences are as follows:

- The high-pressure fuel lines are constantly charged with high pressure.
- The internal pressures of the high-pressure fuel lines are higher than other types of fuel system.
- The high-pressure fuel lines are formed to shape and then strengthened by a special process.

Do not step on the high-pressure fuel lines. Do not deflect the high-pressure fuel lines. Do not bend or strike the high-pressure fuel lines. Deformation or damage of the high-pressure fuel lines may cause a point of weakness and potential failure.

Do not check the high-pressure fuel lines with the engine or the starting motor in operation. After the engine has stopped, allow 10 minutes to pass in order to allow the pressure to be purged before any service or repair is performed on the engine fuel lines.

Do not loosen the high-pressure fuel lines in order to remove air from the fuel system. This procedure is not required.

Visually inspect the high-pressure fuel lines before the engine is started. This inspection should be each day.

If you inspect the engine in operation, always use the proper inspection procedure in order to avoid a fluid penetration hazard. Refer to Operation and Maintenance Manual, “General Hazard Information”.

- Inspect the high pressure for the following: damage, deformation, a nick, a cut, a crease, or a dent
- Do not operate the engine with a fuel leak. If there is a leak, do not tighten the connection in order to stop the leak. The connection must only be tightened to the recommended torque. Refer to Disassembly and Assembly Manual, “Fuel Injection Lines - Remove and Fuel Injection Lines - Install”.
- If the high-pressure fuel lines are torqued correctly, and the high-pressure fuel lines are leaking, the high-pressure fuel lines must be replaced.
- Ensure that all clips on the high-pressure fuel lines are in place. Do not operate the engine with clips that are damaged, missing, or clips that are loose.
- Do not attach any other item to the high-pressure fuel lines.
- Loosened high-pressure fuel lines must be replaced. Also removed high-pressure fuel lines must be replaced. Refer to Disassembly and Assembly Manual, “ Fuel Injection Lines - Install”.

i05463931

High Pressure Fuel Lines

SMCS Code: 1274

S/N: TX21–Up

S/N: CN31–Up

S/N: CN41–Up

S/N: CN61–Up

S/N: TXB1–Up

S/N: L4R1–Up

S/N: L4T1–Up

⚠ WARNING

Contact with high pressure fuel may cause fluid penetration and burn hazards. High pressure fuel spray may cause a fire hazard. Failure to follow these inspection, maintenance and service instructions may cause personal injury or death.

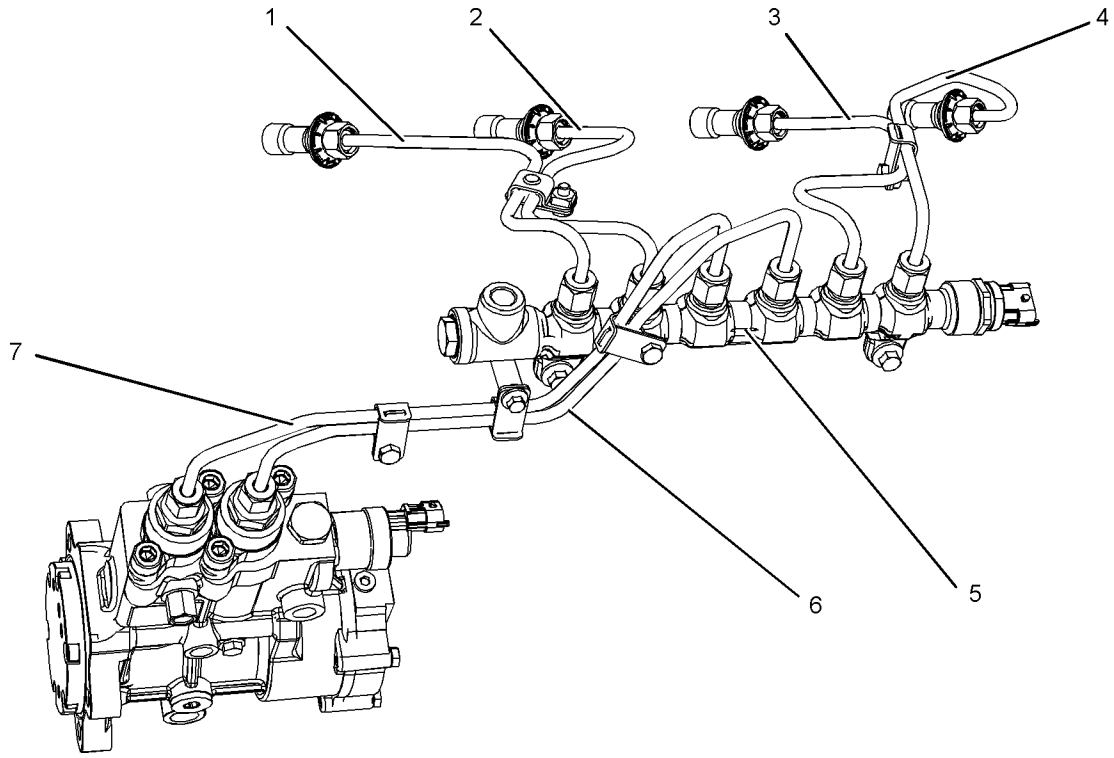


Illustration 24 g03452057

(1) High-pressure line
(2) High-pressure line
(3) High-pressure line
(4) High-pressure line
(5) High-pressure fuel manifold (rail)
(6) High-pressure supply line
(7) High-pressure supply line

The high-pressure fuel lines are the fuel lines that are between the high-pressure fuel pump and the high-pressure fuel manifold and the fuel lines that are between the fuel manifold and cylinder head. These fuel lines are different from fuel lines on other fuel systems.

This difference is because of the following items:

- The high-pressure fuel lines are constantly charged with high pressure.
- The internal pressures of the high-pressure fuel lines are higher than other types of fuel system.
- The high-pressure fuel lines are formed to shape and then strengthened by a special process.

Do not step on the high-pressure fuel lines. Do not deflect the high-pressure fuel lines. Do not bend or strike the high-pressure fuel lines. Deformation or damage of the high-pressure fuel lines may cause a point of weakness and potential failure.

Do not check the high-pressure fuel lines with the engine or the starting motor in operation. After the engine has stopped, allow 90 seconds to pass in order to allow the pressure to be purged before any service or repair is performed on the engine fuel lines.

Do not loosen the high-pressure fuel lines in order to remove air from the fuel system. This procedure is not required.

Visually inspect the high-pressure fuel lines before the engine is started. This inspection should be each day.

If you inspect the engine in operation, always use the proper inspection procedure in order to avoid a fluid penetration hazard. Refer to Operation and Maintenance Manual, “General hazard Information”.

- Inspect the high-pressure fuel lines for damage, deformation, a nick, a cut, a crease, or a dent.
- Do not operate the engine with a fuel leak. If there is a leak, do not tighten the connection in order to stop the leak. The connection must only be tightened to the recommended torque. Refer to Disassembly and Assembly, “Fuel injection lines - Remove and Fuel injection lines - Install”.
- If the high-pressure fuel lines are torqued correctly and the high-pressure fuel lines are leaking, the high-pressure fuel lines must be replaced.

- Ensure that all clips on the high-pressure fuel lines are in place. Do not operate the engine with clips that are damaged, missing, or loose.
- Do not attach any other item to the high-pressure fuel lines.
- Loosened high-pressure fuel lines must be replaced. Also removed high-pressure fuel lines must be replaced. Refer to Disassembly and assembly manual, " Fuel Injection Lines - Install".

NOTICE
The low-pressure fuel system can be pressurized for a time period after the engine has stopped operating. The operating pressure of the low-pressure fuel system can be 500 kPa (73 psi). The secondary fuel filters should be drained before any maintenance of the low-pressure fuel system is carried out.

i04642173

Battery Information

SMCS Code: 1401

The servicing of batteries is to be performed or supervised by personnel knowledgeable of batteries and the required precautions. Keep unauthorized personnel away from batteries.

Never check the battery charge by placing a metal object across the terminal posts. Use a voltmeter or a hydrometer to check the battery charge.

The batteries must be kept clean. The covers (if equipped) must be kept on the cells. Use the recommended cables, connections, and battery box covers when the engine is operated.

Generator set applications commonly use a constant charge such as a float charge during operation. The use of this type of constant charge shortens the life of the battery if the battery is not maintained properly. Using accessible batteries allows proper maintenance and service to the batteries.

The nominal system voltage for this generator set is 12V.

When replacing batteries, use the same number and 12 V.

⚠ WARNING

A battery presents a risk of electrical shock and high short circuit current.

The following precautions are to be observed when working on batteries:

- Remove watches, rings, or other metal objects.
- Use tools with insulated handles.
- Do not lay tools or metal parts on top of batteries.
- Disconnect charging source prior to connecting or disconnecting battery terminals. Never disconnect any charging unit circuit or battery circuit cable from the battery when the charging unit is operating.
- Determine if the battery is inadvertently grounded. When inadvertently grounded, remove source of ground. Contact with any part of a grounded battery is capable of resulting in electrical shock. The risk of such shock is reduced when such grounds are removed during installation and maintenance (applicable to a generator not having a grounded supply circuit).

Disconnect the batteries when maintenance is performed or when the electrical system is serviced. Disconnect the battery ground leads. Tape the leads in order to help prevent sparks.

⚠ WARNING

A battery presents a risk of fire and explosion.

Do not dispose of battery or batteries in a fire. The battery is capable of exploding.

Do not charge a frozen battery. This may cause an explosion.

A spark can cause the combustible gases that are produced by some batteries to ignite.

To help prevent sparks from igniting combustible gases that are produced by some batteries, the negative "-" jump-start cable should be connected last from the external power source to the negative "-" terminal of the starting motor. If the starting motor is not equipped with a negative "-" terminal, connect the jump-start cable to the engine block.

Arcing or sparking could cause a fire. Secure connections, recommended wiring, and properly maintained battery cables will help to prevent arcing or sparking.

Improper jumper cable connections can cause an explosion that can result in injury. Refer to the Operation Section of this manual for specific instructions. Gases from a battery can explode. Keep any open flames or sparks away from the top of a battery. Do not smoke in battery charging areas.

Lead-acid batteries present a risk of fire because they generate hydrogen gas. The following procedures are to be followed:

- DO NOT SMOKE when near batteries.
- DO NOT cause flame or spark in battery area.

- Discharge static electricity from body before touching batteries by first touching a grounded metal surface.

⚠ WARNING

A battery presents a potential burn hazard.

The electrolyte is a dilute sulfuric acid that is harmful to the skin and eyes and is toxic. The electrolyte is electrically conductive and corrosive.

The following procedures are to be observed:

- Do not open or mutilate the battery or batteries.
- Wear full eye protection and protective gloves and clothing.
- Where electrolyte contacts the skin, wash off immediately with water.
- Where electrolyte contacts the eyes, flush thoroughly and immediately with water and seek medical attention.
- Spilled electrolyte is to be washed down with an acid neutralizing agent. A common practice is to use a solution of 500 g (1 lb) bicarbonate of soda to 4 L (1 US gal) of water. The bicarbonate of soda solution is to be added until the evidence of reaction (foaming) has ceased. The resulting liquid is to be flushed with water and the area dried.
- Wash hands after touching the batteries and connectors.

Refer to Special Instruction, SEHS7633, “Battery Test Procedure” for additional instruction.

i03560601

Before Starting Engine

SMCS Code: 1000

NOTICE
For initial start-up of a new or rebuilt engine, and for start-up of an engine that has been serviced, make provision to shut the engine off should an overspeed occur. This may be accomplished by shutting off the air and/or fuel supply to the engine.

⚠ WARNING

Engine exhaust contains products of combustion which may be harmful to your health. Always start and operate the engine in a well ventilated area and, if in an enclosed area, vent the exhaust to the outside.

Inspect the engine for potential hazards.

Do not start the engine or move any of the controls if there is a “DO NOT OPERATE” warning tag or similar warning tag attached to the start switch or to the controls.

Before starting the engine, ensure that no one is on, underneath, or close to the engine. Ensure that the area is free of personnel.

If equipped, ensure that the lighting system for the engine is suitable for the conditions. Ensure that all lights work properly, if equipped.

All protective guards and all protective covers must be installed if the engine must be started in order to perform service procedures. To help prevent an accident that is caused by parts in rotation, work around the parts carefully.

Do not bypass the automatic shutoff circuits. Do not disable the automatic shutoff circuits. The circuits are provided in order to help prevent personal injury. The circuits are also provided in order to help prevent engine damage.

See the Service Manual for repairs and for adjustments.

i02207232

Engine Starting

SMCS Code: 1000

⚠ WARNING

Do not use aerosol types of starting aids such as ether. Such use could result in an explosion and personal injury.

If a warning tag is attached to the engine start switch or to the controls, DO NOT start the engine or move the controls. Consult with the person that attached the warning tag before the engine is started.

All protective guards and all protective covers must be installed if the engine must be started in order to perform service procedures. To help prevent an accident that is caused by parts in rotation, work around the parts carefully.

Start the engine from the operator's compartment or from the engine start switch.

Always start the engine according to the procedure that is described in the Operation and Maintenance Manual, “Engine Starting” topic in the Operation Section. Knowing the correct procedure will help to prevent major damage to the engine components. Knowing the procedure will also help to prevent personal injury.

To ensure that the jacket water heater (if equipped) and/or the lube oil heater (if equipped) is working correctly, check the water temperature gauge and the oil temperature gauge during the heater operation.

Engine exhaust contains products of combustion which can be harmful to your health. Always start the engine and operate the engine in a well ventilated area. If the engine is started in an enclosed area, vent the engine exhaust to the outside.

Note: The engine is equipped with an automatic device for cold starting for normal conditions of operation. If the engine will be operated in very cold conditions, then an extra cold starting aid may be required. Normally, the engine will be equipped with the correct type of starting aid for your region of operation.

The engines are equipped with a glow plug starting aid in each individual cylinder that heats the intake air in order to improve starting.

i01928905

Engine Stopping

SMCS Code: 1000

Stop the engine according to the procedure in the Operation and Maintenance Manual, “Engine Stopping (Operation Section)” in order to avoid overheating of the engine and accelerated wear of the engine components.

Use the Emergency Stop Button (if equipped) ONLY in an emergency situation. Do not use the Emergency Stop Button for normal engine stopping. After an emergency stop, DO NOT start the engine until the problem that caused the emergency stop has been corrected.

Stop the engine if an overspeed condition occurs during the initial start-up of a new engine or an engine that has been overhauled. This may be accomplished by shutting off the fuel supply to the engine and/or shutting off the air supply to the engine.

i04422544

Electrical System

SMCS Code: 1000; 1400

Check the electrical wires for wires that are loose or frayed. Tighten all loose electrical wires before the engine is operated. Repair all frayed electrical wires before the engine is started. See the Operation and Maintenance Manual, “Engine Starting” for specific starting instructions.

Grounding Practices

The electrical system for the engine must be properly grounded. Proper grounding is necessary for optimum engine performance and reliability. Improper grounding will result in uncontrolled electrical circuit paths and in unreliable electrical circuit paths.

Uncontrolled electrical circuit paths can result in damage to main bearings, to crankshaft bearing journal surfaces, and to aluminum components. Uncontrolled electrical circuit paths can also cause electrical noise.

The alternator, the starting motor, and all of the electrical systems MUST be grounded to the negative battery terminal.

For engines which have an alternator that is grounded to an engine component, a ground strap MUST connect that component to the negative battery terminal and the component MUST be electrically isolated from the engine.

A bus bar with a direct path to the negative “-” battery terminal is permissible and recommended for use for all components that require a negative “-” battery connection. The bus bar should be directly connected to the negative “-” battery terminal. A bonding cable should also be connected from the cylinder block to the bus bar on the negative “-” battery connection.

Use of a bus bar ensures that the Electronic Control Module (ECM) and all of the components that are connected to the ECM have a common reference point.

i05322947

Engine Electronics

SMCS Code: 1000; 1900

⚠ WARNING

Tampering with the electronic system installation or the OEM wiring installation can be dangerous and could result in personal injury or death and/or engine damage.

This engine has a comprehensive, programmable Engine Monitoring System. The Engine Control Module (ECM) is able to monitor the engine operating conditions. If any of the engine parameters extend outside an allowable range, the ECM will initiate an immediate action.

The following actions are available for engine monitoring control: WARNING, DERATE and SHUTDOWN. These engine monitoring modes are able to limit engine speed and/or the engine power.

Many of the parameters that are monitored by the ECM can be programmed for the engine monitoring functions. The following parameters can be monitored as a part of the Engine Monitoring System:

- Engine Coolant Level
- Engine Coolant Temperature
- Engine Oil Pressure
- Engine Speed
- Fuel Temperature
- Intake Manifold Air Temperature
- System Voltage

The Engine Monitoring package can vary for different engine models and different engine applications. However, the monitoring system and the engine monitoring control will be similar for all engines.

Note: Many of the engine control systems and display modules that are available for Caterpillar Engines will work in unison with the Engine Monitoring System. Together, the two controls will provide the engine monitoring function for the specific engine application. Refer to the Troubleshooting Manual for more information.

i03491163

Generator Isolating for Maintenance

SMCS Code: 4450

Note: If the rated output voltage of the generator is greater than 600 volts, the generator and connected load cable capacitances must be discharged prior to servicing the generator.

When you service an electric power generation set or when you repair an electric power generation set, follow the procedure below:

1. Stop the engine.

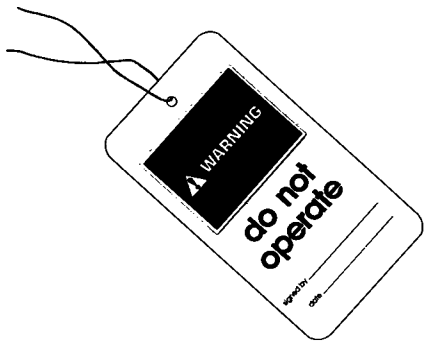


Illustration 25 g00104545

2. Attach a “DO NOT OPERATE” or similar warning tag to the engine prime mover starting circuit. Disconnect the engine starting circuit.

3. Disconnect the generator from the distribution system.

4. Lock out the circuit breaker. Attach a “DO NOT OPERATE” or similar warning tag to the circuit breaker. Refer to the electrical diagram. Verify that all points of possible reverse power flow have been locked out.

5. For the following circuitry, remove the transformer's fuses:

- Power
- Sensing
- Control

6. Attach a “DO NOT OPERATE” or similar warning tag to the generator excitation controls.

7. Remove the cover of the generator's terminal box.

8. Use an audio/visual proximity tester in order to verify that the generator is de-energized. This tester must be insulated for the proper voltage rating. Follow all guidelines in order to verify that the tester is operational.

9. Determine that the generator is in a de-energized condition. Ensure that any power source is in this condition: removed, disabled, locked state, tagged out and tested out. Add ground straps to the conductors or terminals. Connect the ground straps to the electrical distribution system's common grounding location or to the ground system. During the entire work period, these ground straps must remain connected to the conductors and generator terminals.

Product Information Section

General Information

i05285334

Model View Illustrations

SMCS Code: 1000

The following model views display typical features of the generator sets that are described in this manual. The operator should become familiar with the locations of these items. Due to individual applications, your generator set may appear different from the illustrations.

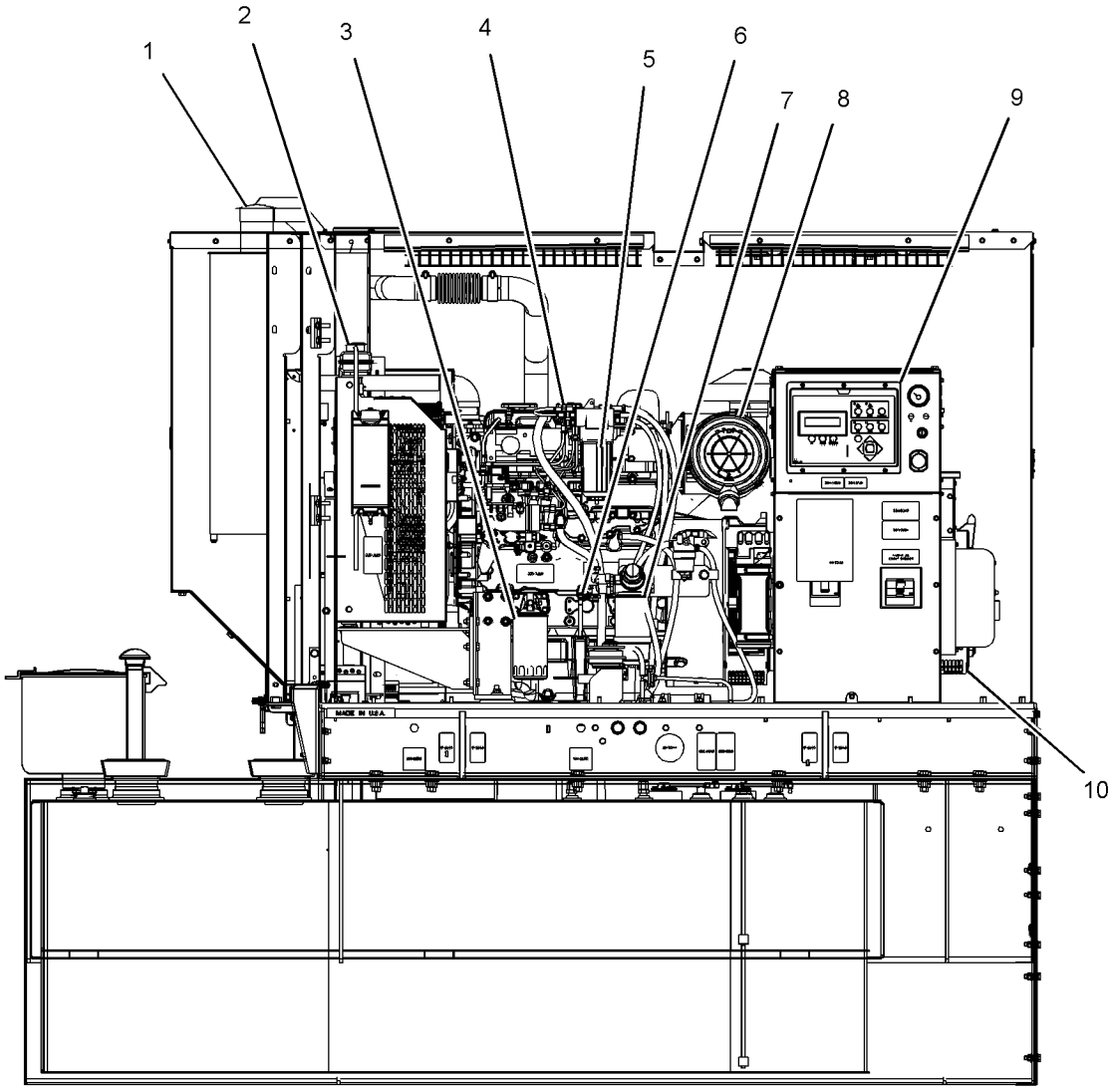


Illustration 26 g03357803

Typical example of a C4.4 generator set with an enclosure and a fuel tank base

(1) Rain Cap for Exhaust System
(2) Coolant Filler Cap
(3) Engine Oil Filter
(4) Engine Oil Filler Cap
(5) Fuel Filter
(6) Engine Oil Level Gauge (dipstick)
(7) Water Separator
(8) Engine Air Cleaner
(9) Control Panel
(10) Generator

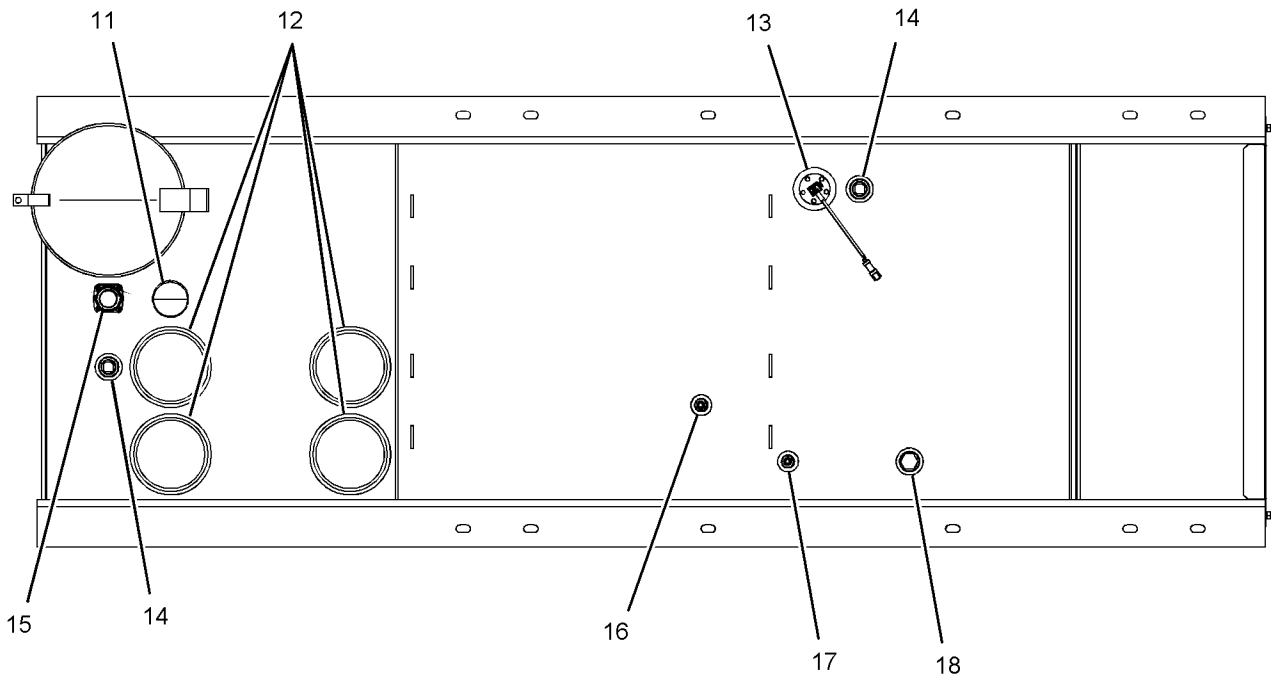


Illustration 27 g03358018

Top view of a fuel tank and base

Fuel tanks will vary. Items on the fuel tank have labels.

(11) Fuel Tank Vent
(12) Emergency Fuel Tank Vent
(13) Fuel Level Switch
(14) Customer Port
(15) Fuel Level Gauge
(16) Fuel Supply to Engine
(17) Fuel Return to Tank
(18) Leakage Detector

i05322950

Product Description

SMCS Code: 1000; 4450; 4491

Intended Use

This Power Generator is intended for use in the generation of electrical power.

Engine Information

These Caterpillar Engines provide the following features:

- Four stroke cycle
- Electronic engine control
- Direct injection fuel system
- Turbocharger

Engine Specifications

Note: The front end of the engine is opposite the flywheel end of the engine. The left side and the right side of the engine are determined from the flywheel end. The number 1 cylinder is the front cylinder.

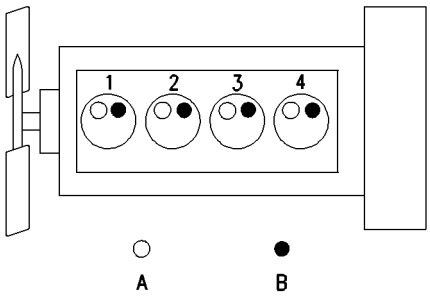


Illustration 28 g00984281

A typical example of the layout of the valves

(A) Inlet valves
(B) Exhaust valves

Table 1

C4.4 Engine Specifications	
Cylinders and Arrangement	In-line four cylinder
Bore	105 mm (4.134 inch)
Stroke	127 mm (5.0 inch)
Displacement	4.4 L (269 cubic inch)
Firing Order	1-3-4-2
Rotation (flywheel end)	Counterclockwise

Electronic Engine Features

These Caterpillar Engines are designed for electronic controls. These engines have an integral on board computer that is called an Electronic Control Module (ECM). The ECM monitors current engine conditions and power requirements. The optimum engine response is calculated and instructions are sent to the engine control systems. The systems respond and the engine responds accordingly. Total engine control is realized through the control of the fuel system and the engine speed/timing system. The electronic engine control system provides the following features:

- Engine speed governing
- Injection timing control
- Automatic air/fuel ratio control
- Torque rise shaping
- Engine monitoring and protection

The ECM provides the electronic governing of fuel delivery in order to dictate the following engine controls: engine speed setpoint, engine timing accuracy, air/fuel ratio control and torque rise fuel setting.

Fuel metering is controlled by an electrical signal that is sent to the injector solenoid from the ECM. High fuel injection pressures are produced by the unit injector pump. High injection pressures and accurate fuel metering ensure good fuel atomization and thorough combustion. This state-of-the-art technology provides the engine with the following benefits: reduced fuel consumption, controlled smoke emissions and electronically controlled acceleration ramp rates.

The engine timing control and speed control are provided by the ECM. The speed/timing circuit consists of two speed/timing sensors. During engine cranking, the ECM uses the timing signal from the secondary speed/timing sensor. The timing signal from the primary speed/timing sensor is used by the ECM while the engine speed is greater than cranking speed. Utilizing two sensors for this circuit has several advantages. Each of the speed/timing sensors is treated as a discrete component by the ECM. If the signal from one of the sensors becomes suspect the ECM will use the signal from the other sensor in order to keep the engine operational.

Injection duration is also managed by the ECM. The duration of the fuel injection cycle determines the engine speed. The placement of the injection cycle in relation to the crankshaft position will determine the timing advance. The speed/timing circuit provides information to the fuel cooled ECM for detection of crankshaft position and engine speed. This information is utilized by the ECM in order to control desired engine speed and engine timing.

The ECM changes injection timing according to engine operating conditions and demand. Improved timing control results in improved performance. Improvements in several aspects of engine operation will be realized: better engine starting ability, shorter response times, reduced emissions, reduced noise and optimized fuel consumption.

Engine monitoring and interactive diagnostics are also provided by the ECM. Essential engine operating conditions and diagnostic information are monitored and recorded in the ECM memory. The ECM quantifies the information. The information is then compared to an acceptable range of values. If the values are not within the acceptable range, then the diagnostic information is communicated to the operator and the abnormal condition is stored in ECM memory.

Engine Cooling and Lubrication

The cooling system consists of the following components:

- Self-priming centrifugal type pump that is driven by gears
- Water temperature regulators which regulate the engine coolant temperature
- Engine oil cooler which is used to transfer excess heat from the engine oil to the cooling system
- Radiator

The engine lubricating oil is supplied by a high-pressure oil pump. The engine lubricating oil is cooled and filtered. Bypass valves provide unrestricted flow of lubrication oil to the engine components during the following conditions:

- High oil viscosity
- Plugged oil cooler or plugged oil filter elements (paper cartridge)

Engine Service Life

Engine efficiency and maximum utilization of engine performance depend on the adherence to proper operation and maintenance recommendations. In addition, use recommended fuels, coolants, and lubricants. Use the Operation and Maintenance Manual as a guide for required engine maintenance.

Expected engine life is predicted by the average power that is demanded. The average power that is demanded is based on fuel consumption of the engine over a time period. Reduced hours of operation at the full throttle and/or operating at reduced throttle settings result in a lower average power demand. Reduced hours of operation will increase the length of operating time before an engine overhaul is required.

Generator Description

These brushless generators are used with the following loads: mixed loads of motors and lights, SCR-controlled equipment, computer centers, installations of communications and petroleum drilling applications. The elimination of the brushes in the field circuit reduces maintenance. The elimination of the brushes in the field circuit increases reliability. The elimination of brushes provides a higher degree of protection in potentially hazardous atmospheres.

The generator set packages can be utilized for prime power generation or standby power generation. The generator set packages can be used in land-based applications or marine applications.

The generators have four poles. The generators have 4 or 12 lead configurations. The configuration depends on the frame size. The generators can produce electrical power in either 50 Hz or 60 Hz applications.

Aftermarket Products and Caterpillar Engines

NOTICE
Caterpillar requires the use of a 4 micron(c) secondary fuel filter for the following reasons: to maximize fuel system life and to prevent premature wear out from abrasive particles in the fuel. Cat high efficiency fuel filters meet these requirements. Consult your Cat dealer for the proper part numbers.

When auxiliary devices, accessories, or consumables (filters, additives, catalysts, etc.) which are made by other manufacturers are used on Caterpillar products, the Caterpillar warranty is not affected simply because of such use.

However, failures that result from the installation or use of other manufacturers' devices, accessories, or consumables are NOT Caterpillar defects. Therefore, the defects are NOT covered under the Caterpillar warranty.

Product Identification Information

i05322969

Plate Locations and Film Locations

SMCS Code: 1000; 4450

Caterpillar engines are identified by serial numbers and by arrangement numbers. These numbers are shown on the engine serial number plate. Caterpillar dealers need these numbers in order to determine the components that were included with the engine. Providing accurate numbers permits accurate identification of replacement part numbers.

Serial Number Plate

The engine serial number plate is located on the left side of the engine block for all engine models in the series.

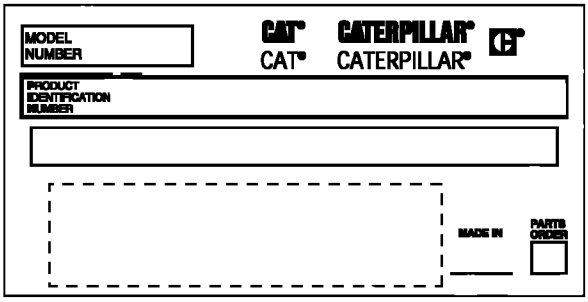


Illustration 29 g01422006

Typical Serial number plate

Emission Certification Film

Note: This information is pertinent in the united States and Canada.

Typical examples are shown.

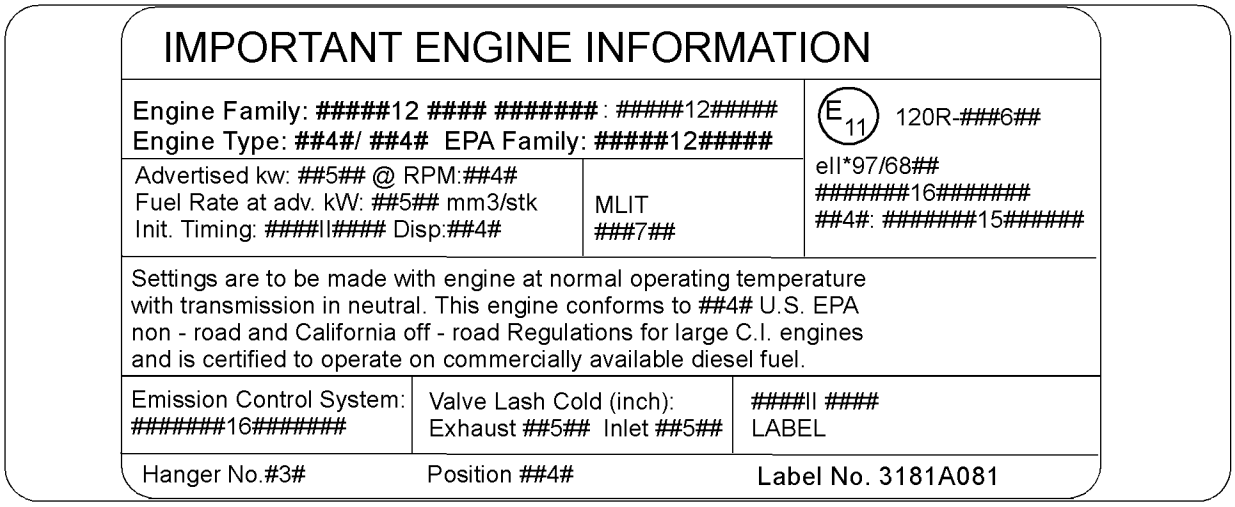


Illustration 30 g01350379

This label is installed on engines that comply with the laws on emissions from the EPA.

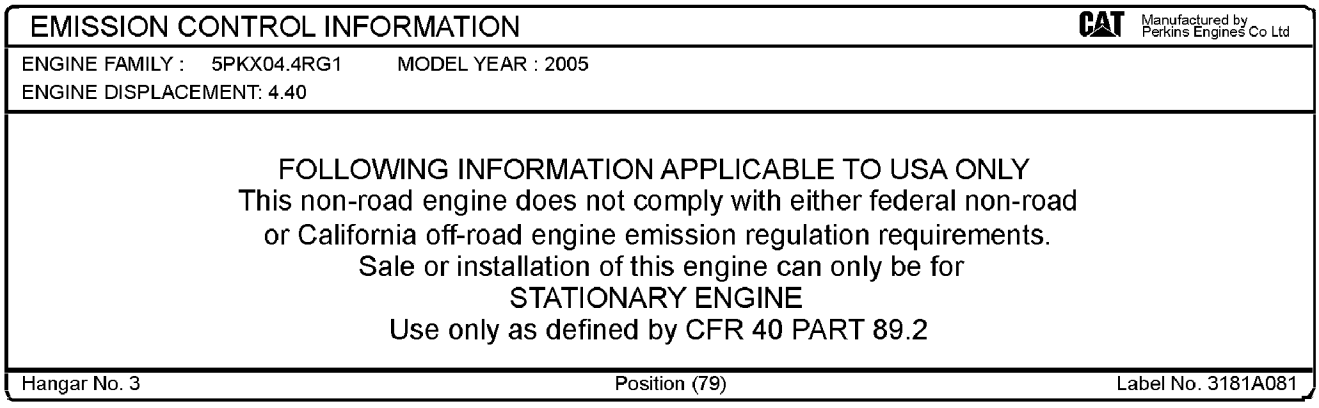


Illustration 31 g01153881

This label is installed on engines that do not comply with the laws on emissions from the EPA.

Operation Section

Lifting and Storage

i02472970

Product Lifting

SMCS Code: 7000; 7002

Lifting of Generator Sets

NOTICE
Never bend the eyebolts and the brackets. Only load the eyebolts and the brackets under tension. Remember that the capacity of an eyebolt is less as the angle between the supporting members and the object becomes less than 90 degrees.

When it is necessary to remove a component at an angle, only use a link bracket that is properly rated for the weight.

Use a hoist to remove heavy components. Use an adjustable lifting beam, if necessary. All supporting members (chains and cables) should be parallel to each other. The chains and cables should be perpendicular to the top of the object that is being lifted.

Some removals require lifting the fixtures in order to obtain proper balance and safety. Consult your Caterpillar dealer for information regarding fixtures for proper lifting of your complete package.

Lifting eyes are designed and installed for the specific arrangement. Alterations to the lifting eyes and/or the engine make the lifting eyes and the lifting fixtures obsolete. If alterations are made, ensure that proper lifting devices are provided. Consult your Caterpillar dealer for information regarding fixtures for proper engine lifting.

On some enclosed generator sets, it may be necessary to remove a top panel of the enclosure in order to access the lifting eye.

Illustration 32 g01034418

The lifting labels are located on the lifting eyes. These labels designate the proper lifting locations for the generator set. Some generator sets may be lifted at the base of the generator set and other generator sets may have a single lifting point on top of the generator set.

Engine Lifting with a Fuel Tank

Do not lift the unit with fuel in the fuel tank.

i02046791

Product Storage

SMCS Code: 7002

If the engine will not be started for several weeks, the lubricating oil will drain from the cylinder walls and from the piston rings. Rust can form on the cylinder liner surface, which will increase engine wear which can reduce engine service life.

To help prevent excessive engine wear, use the following guidelines:

- Complete all of the lubrication recommendations that are listed in this Operation and Maintenance Manual, “Maintenance Interval Schedule” (Maintenance Section).
- If freezing temperatures are expected, check the cooling system for adequate protection against freezing. See this Operation and Maintenance Manual, “Refill Capacities and Recommendations” (Maintenance Section).

If an engine is out of operation and if use of the engine is not planned, special precautions should be made. If the engine will be stored for more than one month, a complete protection procedure is recommended.

Your Caterpillar dealer will have instructions for preparing the engine for extended storage periods.

For more detailed information on engine storage, see Special Instruction, SEHS9031, “Storage Procedure for Caterpillar Products”.

Generator Storage

For information on generator storage, see the literature that is provided by the OEM of the generator. Consult your Caterpillar dealer for assistance.

Installation

i06682050

Product Installation

SMCS Code: 1000; 1404; 4450; 7002

Receiving Inspection

If the generator is received during cold weather, allow the unit to reach room temperature before you remove the protective packing material. Warming the generator to room temperature will prevent the following problems:

- Water condensation on cold surfaces
- Early failures due to wet windings
- Early failures due to wet insulating materials

Unpacking

Moving the Generator

⚠ WARNING

Improper lift rigging can allow unit to tumble causing injury and damage.

NOTICE
Do not use the engine lifting eyes to remove the engine and generator together.

Unpack the equipment with care to avoid scratching painted surfaces. Move the unit to the mounting location. Follow the instructions under the “Product Lifting” topic. The hoist and the hoist cables should have a rating that is greater than the weight of the generator.

Storage

If the generator is not installed immediately, refer to the “Product Storage” topic for the proper considerations for storing the unit.

Location

The location of the generator must comply with all local regulations. The location of the generator must also comply with all special industrial regulations. Locate the generator in an area that meets the following requirements:

- Clean
- Dry
- Ventilated
- Easily accessible for inspection and maintenance
- Open generator sets shall be installed and located in a manner that contact with people is minimized.

Do not obstruct air inlet openings. Do not obstruct discharge openings. Air flow must reach these openings. If the generator is exposed to harsh environmental conditions, the generator can be modified in the field to add filters and space heaters. In addition, a more rigid periodic maintenance schedule should be established.

Note: For further information concerning the installation of this generator set, see the appropriate Application and Installation Guide.

Underwriters Laboratories (UL) 2200

IMPORTANT SAFETY INSTRUCTIONS

SAVE THESE INSTRUCTIONS

This manual contains important instructions for all Cat UL Listed stationary engine generator assembly models, that should be followed during installation, and maintenance of the generator and batteries.

Load Connections – Generator Set Output

For units equipped with ABB Tmax ® circuit breaker: Installer shall connect and size conductors based upon ampacities found in the 75° C (167° F) column within Table 310.15(B) of the “National Electrical Code®, ANSI/NFPA 70”. An ampacity of no less than 115 percent (115%) of the maximum rated circuit current during normal operating conditions shall be used. All conductor insulation shall be rated 90° C (194° F) or greater.

For units equipped with power terminal strips: UL Listed field wiring terminals shall be sized for the connection of a conductor having an ampacity based upon ampacities found in the 75° C (167° F) column within Table 310.15(B) of the “National Electrical Code®, ANSI/NFPA 70”. An ampacity of no less than 115 percent (115%) of the maximum rated circuit current during normal operating conditions shall be used. All conductor insulation shall be rated 90° C (194° F) or greater. Field wiring terminals shall be installed in accordance with tooling and instructions recommended by their manufacturer.

A field wiring terminal shall be sized for the connection of a conductor having an ampacity based on the 75° C (167° F) column of Table 310.15(B) of the “National Electrical Code®, ANSI/NFPA 70”, of no less than 115 percent of the maximum current that the circuit carries during rated conditions. All conductors shall be rated 90° C (194° F) or greater.

Installation Access:

This stationary engine generator assembly shall be installed so that access is restricted to only qualified service personnel who have been instructed of the reasons for the restrictions applied to the location, and about any precautions that must be taken. Access shall be by using a special tool, or lock and key, or other means of security and shall be controlled by the authority responsible for the location.

Batteries and Servicing:

This stationary engine generator assembly utilizes one battery to produce a nominal 12V DC power supply.

Battery servicing is to be performed or supervised by qualified personnel knowledgeable of batteries and the required precautions. Keep unauthorized and unqualified personnel away from batteries.

When replacing batteries, use the same number and the following type batteries: lead-acid, vented type.

Table 2

Engine	Number of Batteries	Battery Voltage	Connected In:	Minimum CCA Battery
C4.4	1	12 VDC	N/A	500

⚠ WARNING

Do not dispose of battery or batteries in a fire. The battery is capable of exploding.

⚠ WARNING

Do not open or mutilate the battery or batteries. Released electrolyte has been known to be harmful to the skin and eyes and to be toxic.

⚠ WARNING

A battery presents a risk of electrical shock and high short circuit current. The following precautions are to be observed when working on batteries:

- **Remove watches, rings, or other metal objects**
- **Use tools with insulated handles**
- **Wear rubber gloves and boots**
- **Do not lay tools or metal parts on top of batteries**
- **Disconnect charging source prior to connecting or disconnecting battery terminals**
- **Determine the battery is not inadvertently grounded. When inadvertently grounded, remove the source of ground. Contact with any part of a grounded battery is capable of resulting in electrical shock. The risk of such shock is reduced when such grounds are removed during installation and maintenance (applicable to a generator not having a grounded supply circuit)**

Vented Batteries

The installation of the engine generator shall provide enough ventilation to ensure that gases generated by vented batteries during charging or caused by equipment malfunction are removed.

⚠ WARNING

The electrolyte is a dilute sulfuric acid that is harmful to the skin and eyes. The electrolyte is electrically conductive and corrosive. The following procedures are to be observed:

- **Wear full eye protection and protective clothing**
- **Where electrolyte contacts the skin, wash electrolyte off immediately with water**
- **Where electrolyte contacts the eyes, flush thoroughly and immediately with water and seek medical attention**
- **Spilled electrolyte is to be washed down with an acid neutralizing agent. A common practice is to use a solution of 500 gram (1 lb) bicarbonate of soda to 4 L (1 US gal) of water. The bicarbonate of soda solution is to be added until the evidence of reaction (foaming) has ceased. The resulting liquid is to be flushed with water and the area dried.**

⚠ WARNING

Lead-acid batteries present a risk of fire because lead-acid batteries generate hydrogen gas.

- **DO NOT SMOKE when near batteries**
- **DO NOT cause flame or spark in battery area**
- **Discharge static electricity from body before touching batteries by first touching a grounded metal surface.**

Exhaust System (Shipped Loose or Not Complete)

Exhaust piping and chimneys shall be designed, constructed, and installed in accordance with the “Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines, NFPA 37”.

Output Circuit Breaker Requirement

Installation of a UL 2200 Listed stationary engine generator assembly shipped without an installed output circuit breaker requires a UL Listed Circuit Breaker to be installed in the output circuit within 7.6 m (25 feet) of the stationary engine generator assembly.

Field Wiring – EMCP 4 Controller Interface

Installer shall use Class 1 wiring methods for all controller (customer) connections with following exception. Class 2 wiring methods shall be allowed for Class 2 controller interface wiring when Class 2 conductors are shielded with UL Listed/Recognized insulation sleeve or conduit rated to 600V for each individual circuit.

Features and Controls

i03646563

Battery Disconnect Switch
(If Equipped)

SMCS Code: 1411

The battery disconnect switch and the engine start switch perform different functions. Turn off the battery disconnect switch in order to disable the entire electrical system. The battery remains connected to the electrical system when you turn off the engine start switch.

Turn the battery disconnect switch to the OFF position and remove the key when you service the electrical system or any other components.

Also turn the battery disconnect switch to the OFF position and remove the key when the engine will not be used for an extended period of a month or more. This will prevent drainage of the battery.

NOTICE
Never move the battery disconnect switch to the OFF position while the engine is operating. Serious damage to the electrical system could result.

To ensure that no damage to the engine occurs, verify that the engine is fully operational before cranking the engine. Do not crank an engine that is not fully operational.

Perform the following procedure in order to check the battery disconnect switch for proper operation:

1. With the battery disconnect switch in the ON position, verify that electrical components are functioning. Verify that the hour meter is displaying information. Verify that the engine will crank.
2. Turn the battery disconnect switch to the OFF position.
3. Verify that the following items are not functioning: electrical components, hour meter and engine cranking. If any of the items continue to function with the battery disconnect switch in the OFF position, consult your Caterpillar dealer.

i05294014

Control Panel

SMCS Code: 7451

Electronic Modular Control Panel

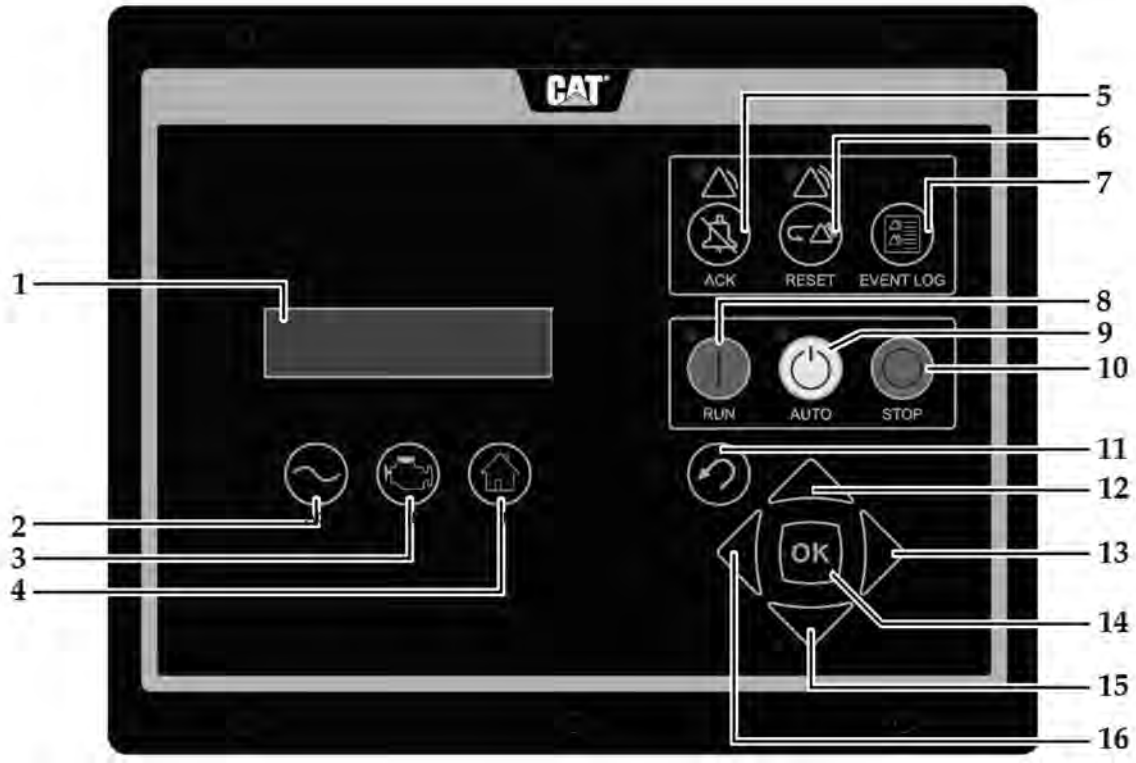


Illustration 33 g02082653

EMCP 4 Control System Panel

(1) Display screen
(2) AC overview key
(3) Engine overview key
(4) Main menu key
(5) Alarms acknowledge key
(6) Reset shut down Key
(7) Event log
(8) Run key
(9) Auto key
(10) Stop key
(11) Escape key
(12) Up key
(13) Right key
(14) OK key
(15) Down key
(16) Left key

Navigation Keys

AC Overview (2) – The “AC OVERVIEW” key will navigate the display to the first screen of AC information. The “AC OVERVIEW” information contains various AC parameters that summarize the electrical operation of the generator set.

Engine Overview (3) – The “ENGINE OVERVIEW” key will navigate the display to the first screen of engine information. The “ENGINE OVERVIEW” information contains various engine parameters that summarize the operation of the generator set.

Main Menu Key (4) – The “MAIN MENU” key will navigate the display to the main menu directly without having to navigate out of menus.

Acknowledge Key(5) – Pressing the “ACKNOWLEDGE” key will cause the horn relay to turn off. The horn relay being turned off will silence the horn. Pressing the “ACKNOWLEDGE” key will also cause any red or yellow flashing lights to either turn off or to come on continuously. The “ACKNOWLEDGE” key may also be configured to send out a global alarm silence signal on the J1939 Data Link. Sending out a global alarm silence signal on the J1939 Data Link will silence the horns on the annunciators.

Reset Key (6) – Pressing the “RESET” key will reset various events.

Event Log Key (7) – Pressing the “EVENT LOG” key will navigate the display to the event log.

RUN Key (8) – Pressing the “RUN” key will start the engine.

AUTO Key (9) – Pressing the “AUTO” key will cause the engine to enter the “AUTO” mode. The engine will start if the module receives a start command from a remote source.

STOP Key (10) – Pressing the “STOP” key will stop the engine.

Escape Key (11) – The “ESCAPE” key is used in order to navigate through the menus. When the key is pressed, the user moves backward or the user moves upward through the menus. The “ESCAPE” key is also used to exit out of entering data when the user is programming the setpoints. If the “ESCAPE” key is pressed while the user is programming the setpoints, changes made on the screen will not be saved to memory.

Up Key (12) – The “UP” key is used to navigate through the various menus and monitoring screens. The “UP” key is also used when a setpoint is entered. When entering numeric data, the “UP” key is used in order to increment the digits (0-9). If the setpoint requires selection from a list, the “UP” key is used to navigate UP through the list.

Right Key (13) – The “RIGHT” key is used during setpoint adjustment. The “RIGHT” key is used to select which digit is edited while entering numeric data. The “RIGHT” key is also used during some setpoint adjustments in order to select or to unselect a check box. If a check box has a check mark, the function has been enabled. Pressing the “RIGHT” key will disable the function. Pressing the “RIGHT” key will also cause the check mark to disappear. If the check box does not have a check mark, the function is disabled. Pressing the “RIGHT” key will enable the function. Pressing the “RIGHT” key will also cause a check mark to appear.

Enter Key (14) – The “ENTER” key is used in order to navigate through the menus. When the key is pressed, the user moves forward or the user moves downward through the menus. The “ENTER” key is also used to save any changes while the setpoints are being programmed. Pressing the “OK” key during programming the setpoints causes the changes to be saved to memory.

Down Key (15) – The “DOWN” key is used to navigate downward through the various menus or screens. The “DOWN” key is also used to program the setpoints. The “DOWN” key is used to decrease the digits when entering numeric data. If the setpoint requires selection from a list, the “DOWN” key is used to navigate DOWN through the list.

Left Key (16) – The “LEFT” key is used during setpoint adjustment. The “LEFT” key is used to select the digit that is edited during the entry of numeric data. The “LEFT” key is also used during some of the setpoint adjustments to select a check box. The key is also used to unselect a check box. If a check box has a check mark, pressing the “LEFT” key will disable the function. Pressing the key will also remove the check mark. Pressing the “LEFT” key will also cause the check mark to disappear. If the check box does not have a check mark, pressing the “LEFT” key will enable the function. Pressing the “LEFT” key will also cause a check mark to appear.

Alarm Indicators

Yellow Warning Lamp – A yellow warning lamp is located above the “ACKNOWLEDGE” key. A flashing yellow light indicates that there are active warnings that have not been acknowledged. A continuous yellow light indicates that there are acknowledged warnings that are active. If there are any active warnings, the yellow light will change from flashing yellow to continuous yellow after the “ACKNOWLEDGE” key is pressed. If there are no longer any active warnings, the yellow light will turn off after the “ACKNOWLEDGE” key is pressed.

Red Shutdown Lamp – A red shutdown lamp is located above the “RESET” key. A flashing red light indicates that there are active shutdowns that have not been acknowledged. A continuous red light indicates that there are active shutdowns that have been acknowledged. If there are any active shutdowns, the red light will change from flashing red to continuous red after the “ACKNOWLEDGE” key is pressed. Any condition that has caused a shutdown must be manually reset. If there are no longer any active shutdowns, the red light will turn off.

Digital Inputs

There are several digital inputs and outputs on “EMCP 4.1” and “EMCP 4.2” . For detailed information about the inputs on this electronic control module, see Systems Operation, Troubleshooting, Testing, and Adjusting, UENR1209, “EMCP4.1/4.2”.

Control Panel

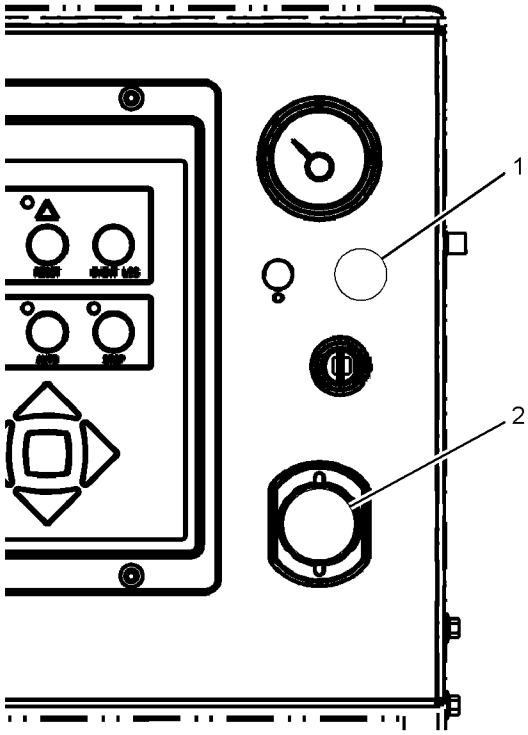


Illustration 34 g03361519

(1) Speed potentiometer (if equipped)
(2) Emergency stop push button

Speed Potentiometer (1) – The speed potentiometer is optional. The speed potentiometer can be used with the generator set that has an electronic governor.

Emergency Stop Push Button (2) – The emergency stop push button (ESPB) is used to shut down the engine during an emergency situation.

Voltage Potentiometer – The voltage potentiometer is located inside the control panel, and must only be adjusted by qualified personnel.

Annunciator Module

Illustration 35 g02111119

(20) Alarm acknowledge button

General Information

The annunciator module is used to indicate various system events and conditions. The annunciator module uses indicator lights and an audible horn to give the operator information about the status of the system. The annunciator module can be used to announce faults and/or status signals to the operator. The annunciator module allows the operator to silence the horn. The annunciator module also allows the operator to acknowledge faults to the system.

There are 17 pairs of LED indicators on the front panel of the annunciator. The 16 pairs of LED indicators are used to announce events, diagnostics, and ready signals. The 17th pair of LED indicators is used as a combined network/module status LED. The 17th pair of LED indicators can tell the operator if there is a problem with the J1939 data link connection.

Basic Operation

Each pair of LED indicators on the annunciator consists of two of the following three colors: green, yellow and red. For example, a pair of red and yellow LED indicators may be configured for engine oil pressure. If a low engine oil pressure warning is read over the data link, the annunciator will flash the yellow LED. The audible horn will then sound. If the low engine oil pressure shutdown is read over the data link, the annunciator will flash the red LED. The audible horn will then sound.

To acknowledge the shutdown and alarm conditions or to silence the horn, press the “Alarm Acknowledge” button (20).

To test the LED indicators or the horn when the data link is either connected or disconnected, hold the “Lamp Test” button in.

Configuration

The annunciator module can be customized in order to signal many different conditions that are related to the system. Each pair of LEDs must be configured by using the appropriate service tool. Once the service tool has been connected to the annunciator, the user must enter the “Configuration” screen. Each pair of LEDs has four settings: SPN, Trigger Type, Trigger Severity Level and Failure Mode Identifier (FMI).

For detailed information about the annunciator module, see Systems Operation, Troubleshooting, Testing, and Adjusting, UENR1209, “EMCP4.1/4.2”.

RS-485 Annunciator

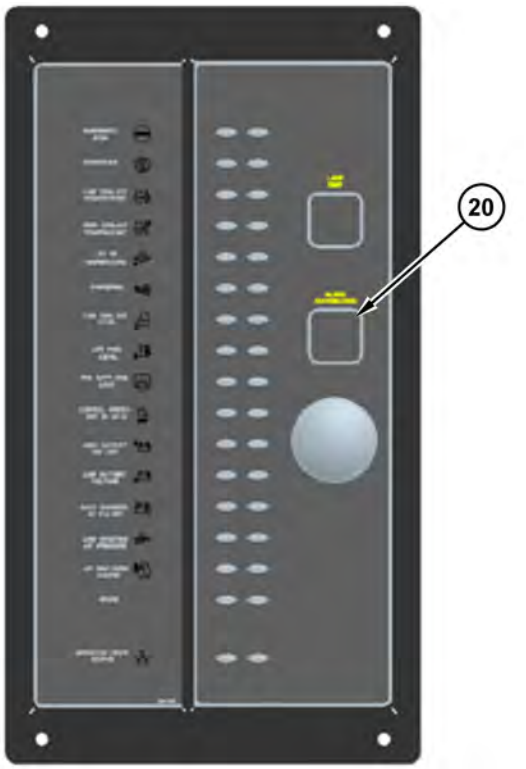


Illustration 36 g03361691

General Information

The annunciator module is used to indicate various system events and conditions. The annunciator module uses indicator lights and an audible horn to give the operator information about the status of the system. The annunciator module can be used to announce faults and/or status signals to the operator. The annunciator module allows the operator to silence the horn. The annunciator module also allows the operator to acknowledge faults to the system.

There are 17 pairs of LED indicators on the front panel of the annunciator. The 16 pairs of LED indicators are used to announce events, diagnostics, and ready signals. The 17th pair of LED indicators is used as a combined network/module status LED. The 17th pair of LED indicators can tell the operator if there is a problem with the RS-485 annunciator network connection.

Basic Operation

Each pair of LED indicators on the annunciator consists of two of the following three colors: green, yellow and red. For example, a pair of red and yellow LED indicators may be configured for engine oil pressure. If a low engine oil pressure warning is read over the data link, the annunciator will flash the yellow LED. The audible horn will then sound. If the low engine oil pressure shutdown is read over the data link, the annunciator will flash the red LED. The audible horn will then sound.

To acknowledge the shutdown and alarm conditions or to silence the horn, press the “Alarm Acknowledge” button (20).

To test the LED indicators or the horn when the data link is either connected or disconnected, hold the “Lamp Test” button in.

Configuration

The annunciator module can be customized in order to signal many different conditions that are related to the system. Each pair of LEDs must be configured by using the appropriate service tool. Once the service tool has been connected to the annunciator, the user must enter the “Configuration” screen. Each pair of LEDs has four settings: SPN, Trigger Type, Trigger Severity Level and Failure Mode Identifier (FMI).

For detailed information about the annunciator module, see Systems Operation, Troubleshooting, Testing, and Adjusting, UENR1209, “EMCP4.1/4.2”.

Engine Starting

i05314112

Cold Weather Starting

SMCS Code: 1000; 1250; 1450; 1453; 1456; 1900

⚠ WARNING

Explosion hazard! Do not use ether! Using ether can create explosions or fires that can cause personal injury or death. Read and follow the starting procedure in the Operation and Maintenance Manual.

A jacket water heater is optional equipment on these models. Space heaters for the generator are optional equipment on these models. Use the jacket water heater and use the space heaters, as needed.

Note: Oil pan immersion heaters are not recommended for heating the engine oil. To ensure the compatibility of the components, only use equipment that is recommended by Caterpillar.

The heated water will help to keep the oil in the engine block warm enough to flow when the engine is started.

Maintain the proper level of electrolyte in the batteries. Keep the batteries fully charged.

To maximize the battery power, heat the battery compartment or store the batteries in a warm location. Typically, batteries only have 50 percent of the capability at −10 °C (14 °F) versus 27 °C (80 °F).

Extra battery capacity may be necessary for very cold temperatures.

Consult your Caterpillar dealer for more information on the starting aids that are available for cold weather starting.

i03907410

Starting the Engine

SMCS Code: 1000; 1450

⚠ WARNING

Engine exhaust contains products of combustion which may be harmful to your health. Always start and operate the engine in a well ventilated area and, if in an enclosed area, vent the exhaust to the outside.

⚠ WARNING

When the engine is in the AUTOMATIC mode, the engine can start at any moment. To avoid personal injury, always remain clear of the the engine when the engine is in the AUTOMATIC mode.

Before manually starting the engine, perform all of the procedures that are described in this Operation and Maintenance Manual, “Before Starting Engine”. Ensure that no one will be endangered before the engine is started and when the engine is started.

NOTICE
Do not engage the starting motor when flywheel is turning. Do not start the engine under load.

If the engine fails to start within 30 seconds, release the starter switch or button and wait two minutes to allow the starting motor to cool before attempting to start the engine again.

NOTICE
For initial start-up of a new or rebuilt engine, and for start-up of an engine that has been serviced, make provision to shut the engine off should an overspeed occur. This may be accomplished by shutting off the air and/or fuel supply to the engine.

1. Start the engine by one of these three methods.

- The operator presses the “RUN” Key.
- The control is in “AUTO” and the remote initiate contact (IC) becomes active.
- The operator presses the “AUTO” Key and a start command is sent via the RS-485 SCADA Data Link.

2. The EMCP checks the system prior to start of the crank cycle. The EMCP checks that no system faults are present. The EMCP checks that all previous shutdown faults have been reset. The EMCP also checks that the engine is not already running. If the engine is equipped with prelube, the EMCP checks the status of the prelube. If the prelube is not complete, the EMCP will not crank the engine.

3. The EMCP begins the crank cycle.

4. The EMCP cranks the engine until the crank cycle time reaches the setpoint for total crank time or until the engine starts.

5. The EMCP deactivates the starting motor relay (SMR) when the engine speed reaches the setpoint for crank terminate speed.

i03640789

Starting with Jump Start Cables

SMCS Code: 1000; 1401; 1402; 1900

⚠ WARNING

Improper jump start cable connections can cause an explosion resulting in personal injury.

Prevent sparks near the batteries. Sparks could cause vapors to explode. Do not allow jump start cable ends to contact each other or the engine.

If the installation is not equipped with a backup battery system, it may be necessary to start the engine from an external electrical source.

For information on troubleshooting the charging system, refer to Special Instruction, REHS0354, “Charging System Troubleshooting”.

Many batteries which are considered unusable are still rechargeable. After jump starting, the alternator may not be able to fully recharge batteries that are severely discharged. The batteries must be charged to the proper voltage with a battery charger. For information on testing and charging, refer to the Special Instruction, SEHS7633, “Battery Test Procedure”.

NOTICE
Use a battery that is sourced with the same voltage as the electric starting motor. Use ONLY equal voltage for jump starting. The use of higher voltage will damage the electrical system.

Do not reverse the battery cables. The alternator can be damaged. Attach the negative battery cable last and remove the negative battery cable first.

When an external electrical source is used to start the engine, turn the control switch on the generator set to the “OFF” position. Turn all electrical accessories OFF before attaching the jump start cables.

Ensure that the main power switch is in the OFF position before jump start cables are attached to the engine that is being started.

1. Turn the start switch on the stalled engine to the OFF position. Turn off all accessories.
2. Connect one positive end of the jump start cable to the positive cable terminal of the discharged battery. Connect the other positive end of the jump start cable to the positive cable terminal of the charging or starting source.
3. Connect one negative end of the jump start cable to the negative cable terminal of the charging or starting source. Connect the other negative end of the jump start cable to the stalled engine block or to the chassis ground. This procedure helps to prevent potential sparks from igniting combustible gases that are produced by some batteries.
4. Charge the batteries. The engine will not continue to run after starting if the batteries have not been charged.
5. Start the engine.
6. Immediately after the stalled engine is started, disconnect the jump start cables in reverse order.

Refer to the Electrical Schematic for your engine. Consult your Caterpillar dealer for more information.

i02386850

After Starting Engine

SMCS Code: 1000

After the engine has been installed or rebuilt, carefully monitor the engine in order to detect any unusual engine performance.

1. Ensure that the indicators are in the normal ranges.
2. Adjust the voltage and the frequency, if necessary.
3. Close the main circuit breaker in order to apply the load.
4. Continue to check the indicators and the generator.

Engine Operation

i06545704

Engine Operation

SMCS Code: 1000

Proper operation and maintenance are key factors in obtaining the maximum life and economy of the engine. If the directions in the Operation and Maintenance Manual are followed, costs can be minimized and engine service life can be maximized.

The time that is needed for the engine to reach normal operating temperature can be less than the time needed for a walk-around inspection of the engine.

After the engine is started and after the engine reaches normal operating temperature, the engine can be operated at the rated rpm. The engine will reach normal operating temperature faster when the engine is at rated speed. The engine will reach normal operating temperature faster when the engine is at low-power demand. This procedure is more effective than idling the engine at no load. The engine should reach operating temperature in a few minutes.

Gauge readings should be observed and the data should be recorded frequently while the engine is operating. Comparing the data over time will help to determine normal readings for each gauge. Comparing data over time will also help detect abnormal operating developments. Significant changes in the readings should be investigated.

Engines rated for constant speed use are allowed to complete a starting sequence, an operation at a single constant speed, and a shutdown sequence. Every time the engine is run, each of these operations should occur only once. The starting sequence and shutdown sequence can include a short period of operation at the low idle speed for purposes of warming up and cooling down the engine or driven equipment. The emissions type approval is not valid for operation of a constant speed engine in a manner different from that described above.

i01432412

Fuel Conservation Practices

SMCS Code: 1000; 1250

The efficiency of the engine can affect the fuel economy. Caterpillar's design and technology in manufacturing provides maximum fuel efficiency in all applications. Follow the recommended procedures in order to attain optimum performance for the life of the engine.

- Avoid spilling fuel.

Fuel expands when the fuel is warmed up. The fuel may overflow from the fuel tank. Inspect fuel lines for leaks. Repair the fuel lines, as needed.

- Be aware of the properties of the different fuels. Use only the recommended fuels.
- Avoid unnecessary idling.

Shut off the engine rather than idle for long periods of time.

- Observe the service indicator frequently. Keep the air cleaner elements clean.
- Maintain a good electrical system.

One bad battery cell will overwork the alternator. This will consume excess power and excess fuel.

- Ensure that the belts are properly adjusted. The belts should be in good condition.
- Ensure that all of the connections of the hoses are tight. The connections should not leak.
- Ensure that the driven equipment is in good working order.
- Cold engines consume excess fuel. Utilize heat from the jacket water system and the exhaust system, when possible. Keep cooling system components clean and keep cooling system components in good repair. Never operate the engine without water temperature regulators. All of these items will help maintain operating temperatures.
- Settings for the fuel system and the limits for the operating altitude are stamped on the Engine Information Plate. If an engine is moved to a higher altitude, the settings must be changed by a Caterpillar dealer. Changing the settings will help to provide the maximum efficiency for the engine. Engines can be operated safely at higher altitudes, but the engines will deliver less horsepower. The fuel settings should be changed by a Caterpillar dealer in order to obtain the rated horsepower.

Generator Operation

i06075229

Generator Operation

SMCS Code: 4450

Loading of the Generator

When a generator is installed or reconnected, be sure that the total current in one phase does not exceed the nameplate rating. Each phase should carry the same load, thus allowing the engine to work at the rated capacity. An electrical unbalance can result in an electrical overload and overheating if one phase current exceeds the nameplate amperage.

Allowable combinations of unbalanced loads are shown in Illustration 37 . When you operate with significant single-phase loads, the combinations of single-phase load and three-phase load may be used. Such combinations should be located below the line on the graph.

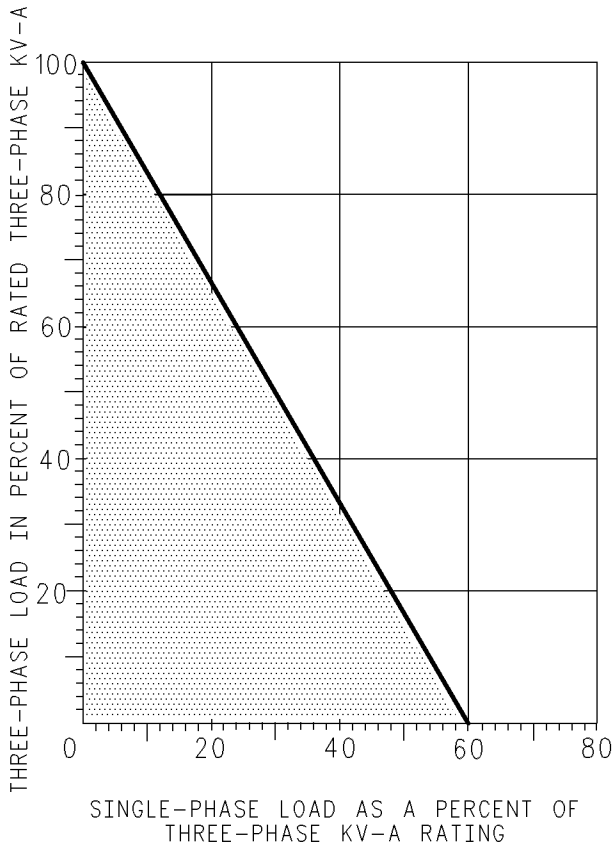


Illustration 37 g00627416

Allowable Combinations of Unbalanced Loads

Block Loading

The block loading is the instantaneous application of an electrical load to a generator set. This load may be anywhere from a moderate percentage of the rated load up to the rated load.

The block loading capability of a generator set depends on the following factors.

- Engine transient response
- Voltage regulator response
- Type of the voltage regulator
- Altitude of operation of the generator set
- Type of load
- The amount of load

If derating is required in order to block load, refer to ISO 3046 or SAE J1349 Standards. Also, reference Engine Data Sheet, LEKX4066, “Loading Transient Response” and Engine Data Sheet, LEKX4067, “Block and Transient Response”.

Note: ISO stands for International Standards Organization.

Power Factor

The power factor is the ratio of apparent power to total power. The power factor is expressed as a decimal. The power factor represents that portion of the current which is doing useful work. The portion of current which is not doing useful work is absorbed in maintaining the magnetic field in motors or other devices. This current is called the reactive load. This current does not require engine power to be maintained.

In most applications, electric motors and transformers determine the power factor of the system. Induction motors usually have a power factor of 0.8 lagging. Incandescent lighting is a resistive load of about 1.0 power factor, or unity.

The power factor of a system may be determined by a power factor meter or by calculations. Determine the power requirement in kW by multiplying the power factor by the kVA that is supplied to the system. As the power factor goes up, the total current that is supplied to a constant power demand will go down. A 100 kW load that is at 0.8 power factor will draw more current than a 100 kW load that is at 0.9 power factor. A high-power factor will result in a full engine load at less than the generator rated amperage. A lower power factor increases the possibility of overloading the generator.

Note: The Caterpillar generators are rated at a power factor of 0.8 lagging unless the generator is specified otherwise.

Standby Generator Sets

Most standby units are automatic. Without an operator in attendance, standby units will perform the following functions: start, pick up the load, run and stop.

Standby units will not change the governor speed control or voltage level settings automatically. The governor speed and voltage level must be preset for the proper operation of that unit. Whenever the set is operated manually, ensure that the governor speed and the voltage level settings are set correctly for automatic operation. Check all switches for the proper setting. The Engine Control Switch should be in the AUTOMATIC position. Emergency Stop Switches should be in RUN position.

Excitation Systems

Refer to this Operation and Maintenance Manual, “Voltage Regulators” for information on excitation systems.

Low Idle Adjustment

The low idle is typically 900 rpm. On 60 Hz units, low idle will be approximately 83 percent of the full load speed. On 50 Hz units, low idle will be approximately 70 percent of full load speed.

The low idle is set at the factory on generator sets with mechanical governors. The low idle should only be adjusted by your Caterpillar dealer if adjustment is required.

Note: Operating the electric set at low idle speed for an extended time will cause some voltage regulators to shut off. The electric set must be completely shut down. Then, the electric set must be restarted allowing the voltage regulator to resume output.

Generator Options

Space Heaters

The generator can be equipped with space heaters. The space heater is installed for operation in high humidity conditions. 120 V space heaters are available.

i06107877

Single Unit Operation

SMCS Code: 4450

Initial Start-Up

Measure the insulation resistance of each winding if the generator was exposed to the following conditions:

- Rapid changes in temperature
- Freezing
- Wet climate during shipment

- Wet climate during storage

Refer to this Operation and Maintenance Manual, “Insulation - Test”.

Note: These tests should be conducted prior to any power connections or control connections that are being made.

Starting

1. Make all preliminary engine starting checks.

2. Be sure that the main circuit breaker or the line circuit breaker is open.

3. Start the engine. Allow the engine to warm up.

4. Adjust to the full load engine speed.

5. Close the main circuit breaker.

6. Apply the load. Do not try to apply the full load. Apply the load in increments in order to maintain system frequency at a constant level.

7. Readjust the governor for rated frequency.

Stopping

1. Remove the load in increments.

2. Open the circuit breaker.

3. Allow the engine to run for 5 minutes in order to cool.

4. Stop the engine.

i06889750

Voltage Regulators

SMCS Code: 4467

⚠ DANGER

DANGER: Shock/Electrocution Hazard-Do not operate this equipment or work on this equipment unless you have read and understand the instructions and warnings in the Operation and Maintenance Manual. Failure to follow the instructions or heed the warnings will result in serious injury or death.

⚠ WARNING

Personal injury or death can result from high voltage.

When power generation equipment must be in operation to make tests and/or adjustments, high voltage and current are present.

Improper test equipment can fail and present a high voltage shock hazard to its user.

Make sure the testing equipment is designed for and correctly operated for high voltage and current tests being made.

When servicing or repairing electric power generation equipment:

- **Make sure the unit is off-line (disconnected from utility and/or other generators power service) , and either locked out or tagged DO NOT OPERATE.**
- **Remove all fuses.**
- **Make sure the generator engine is stopped.**
- **Make sure all batteries are disconnected.**
- **Make sure all capacitors are discharged.**

Failure to do so could result in personal injury or death. Make sure residual voltage in the rotor, stator and the generator is discharged.

⚠ WARNING

Accidental engine starting can cause injury or death to personnel working on the equipment.

To avoid accidental engine starting, disconnect the battery cable from the negative (−) battery terminal. Completely tape all metal surfaces of the disconnected battery cable end in order to prevent contact with other metal surfaces which could activate the engine electrical system.

Place a Do Not Operate tag at the Start/Stop switch location to inform personnel that the equipment is being worked on.

The voltage regulator is located in the enclosure for the control panel or in the terminal box on the generator.

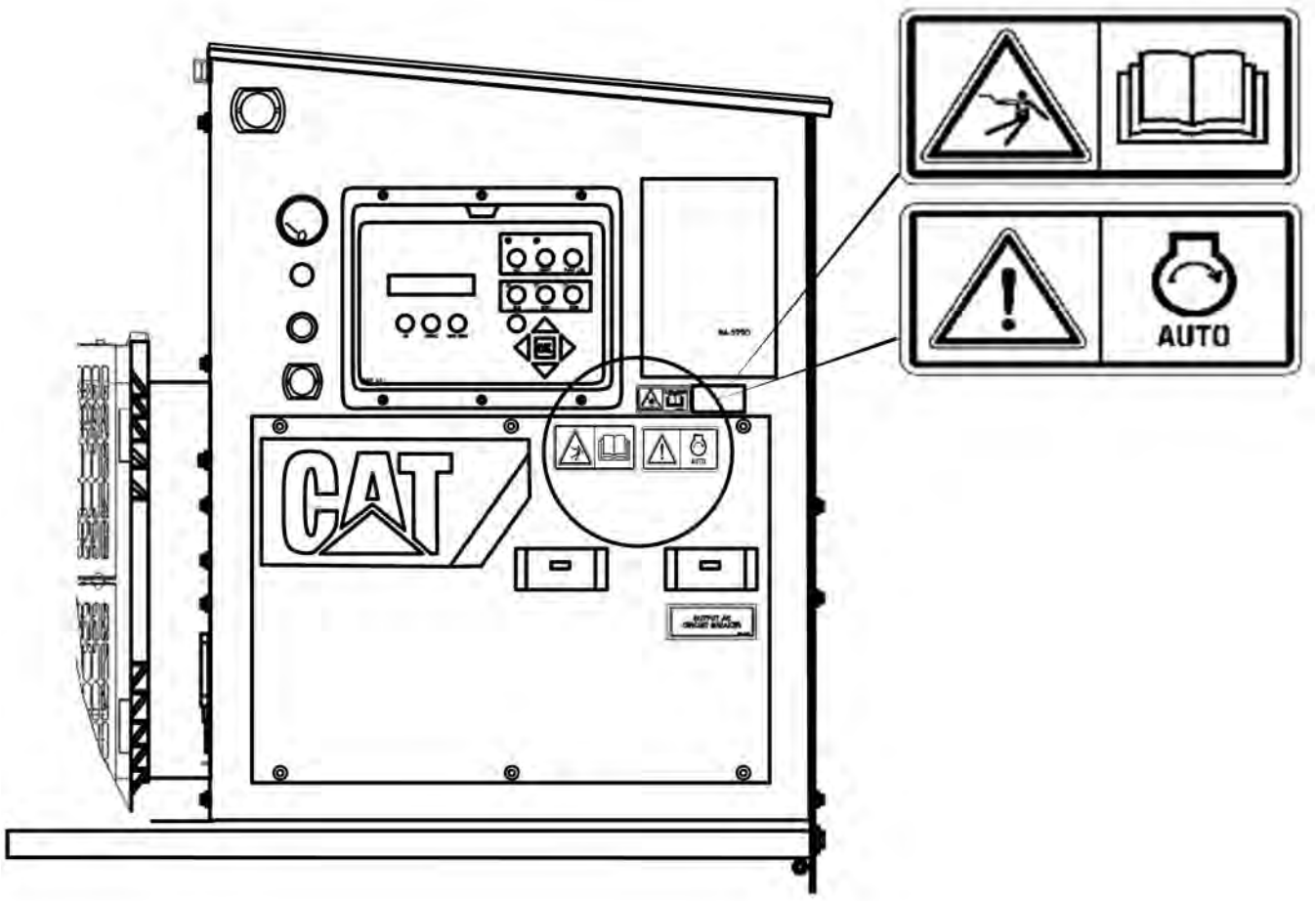


Illustration 38 g03827032

The voltage regulator is located in the terminal box on the generator or in the enclosure for the control panel.

Illustration 39 g06156843

The generator set may include one of the following voltage regulators.

Integrated Voltage Regulator (IVR)

The Integrated Voltage Regulator (IVR) provides excitation current to the generator. The IVR is controlled by the IVR function in the EMCP4. The IVR function allows the EMCP4 to control the generator voltage, optimize transient performance, and provide feature specification.

The excitation module may interface with any of the following excitation systems: Self-Excitation (SE), Internal Excitation (IE), and Permanent Magnet (PMG) excitation systems.

For additional information about the IVR, see Application and Installation, LEBE0006, and Special Instruction, REHS9106.

Illustration 40 g06157009

Excitation Module 10 (EM10–A)

(1) Connector P3 (2) Connector P2 (3) Connector P4

EMCP IVR Connection

To regulate the generator terminal voltage, the EMCP communicates the desired excitation command to the excitation module through a pulse width modulation (PWM) signal. A twisted pair of shielded cable must be used for the communication link. Table 3 details the connections to be made between the EMCP and Excitation Module.

Table 3

EMCP 4.1 and EMCP 4.2 Connections to Excitation Module (70-pin connector)			
EMCP 4.1 and EMCP 4.2 70-Pin Connector		Excitation Module 3-Pin Connector	
Digital Output #2 / IVR CS+	68	CS+	P3-2
Battery negative splice	60 or 65	CS-	P3-3
Battery negative splice	60 or 65	Shield	P3-1
EMCP 4.3 and EMCP 4.4 Connections to Excitation Module (120-pin connector)			
EMCP 4.3 and EMCP 4.4 120-Pin Connector		Excitation Module 3-Pin Connector	
PWM Output #2 Positive	28	CS+	P3-2
PWM Output #2 Negative	8	CS-	P3-3
Shield	19	Shield	P3-1

(continued)

Table 4 provides information on the technical specification of the EM10 and EM15 modules. Selection of the appropriate module must be determined by the following:

- Nominal and maximum generator excitation current at full load (standby 0.8 PF).
- The maximum AC voltage input.

Table 4

EM10 and EM15 Technical Specifications		
	EM10–A	**EM15–A**
Compatible Generator Excitation Types	Permanent Magnet (PM) Self-Excitation (SE) Internal Excitation (IE/AREP)(1)	
Nominal Field Current Output	6A	7A
Maximum (forcing) Field Current Output	10A	15A
Maximum AC Voltage Input	240Vms	300Vms

(1) Internal Excitation (IE is also referred to as “Auxiliary Regulation Excitation Principle”(AREP)

IVR Excitation Module Connections

The EM10 and EM15 excitation modules have three plug type multiple-pin connectors. The connectors are labeled P2, P3, and P4 as shown in illustration 40 . Table 5 describes the signal and function of each connector pin.

Table 5

Excitation Module Connections		
Terminal	**Label**	**Signal/Function**
P2-1	F+	Exciter Field Positive
P2-2	F-	Exciter Field Negative
P3-1	Shield	Excitation Command Control Signal Shield
P3-2	CS+	Excitation Command Control Signal Positive
P3-3	CS-	Excitation Command Control Signal Negative
P4-1	ZB	Excitation Power Supply Input X2
P4-2	XA	Excitation Power Supply Input Z1
P4-3	ZA	Excitation Power Supply Input X1
P4-4	XB	Excitation Power Supply Input Z2

Note: The ZB and XA connections are internally linked within the excitation module. The link provides a point of common connection for the auxiliary windings where an AREP or IE excitation supply is available. Also, the ZB and XA connections may be linked externally to the excitation module. Only three connections (ZA, ZB, and XB) are needed for the EM. Refer to Systems Operation/Test and Adjust/ Troubleshooting, UENR1209, “Integrated Voltage Regulator Connections” for excitation module wiring connections. The wiring diagrams are for self-excitation (shunt), auxiliary windings (AREP/IE), and permanent magnet (PM) configurations.

The voltage regulator knee frequency must be configured for your specific package requirements. The knee frequency for 50 Hz operation will usually be between 48.0 and 49.8 Hz. For 60 Hz operation, the parameter must be set between 58.0 to 59.8 Hz.

Refer to Illustration 39 for an example under-frequency roll-off (loading) profile.

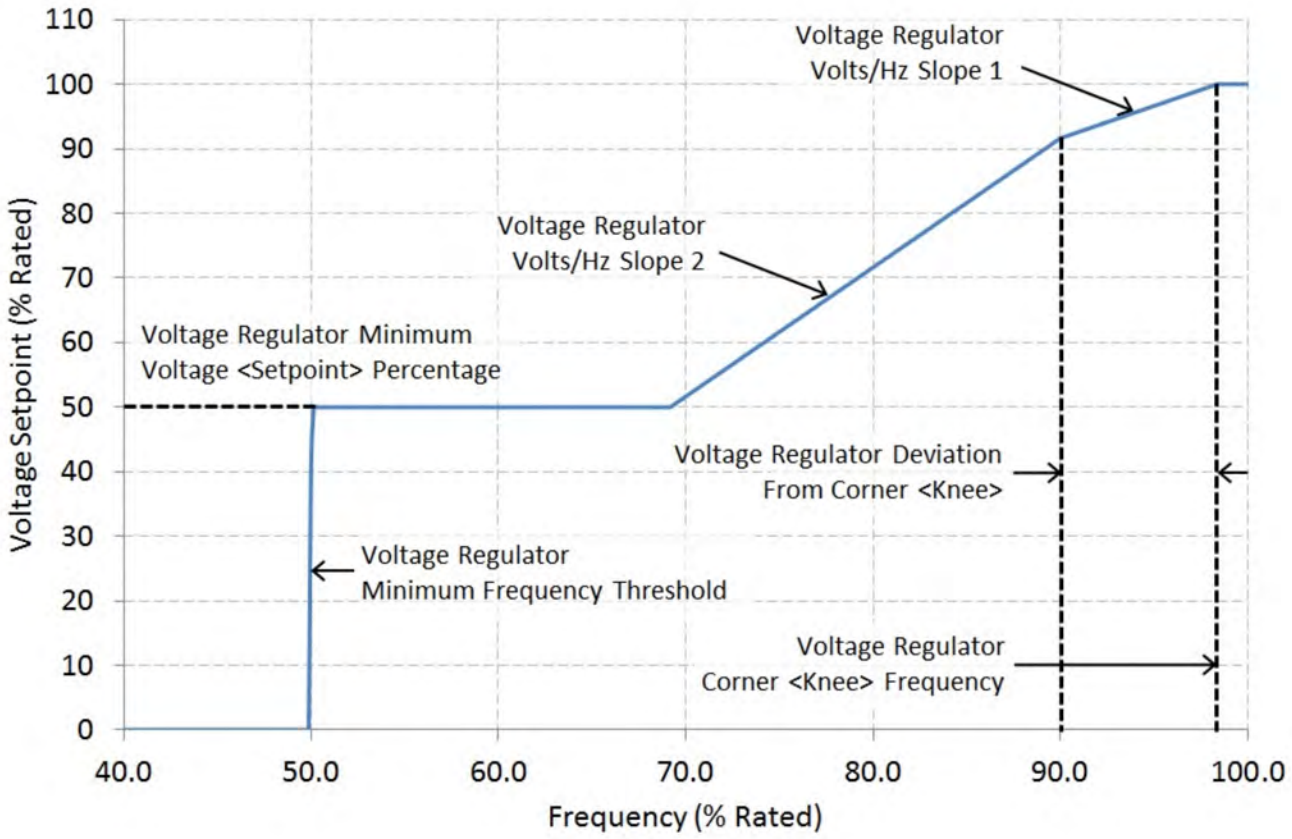


Illustration 41 g03487998

Under-frequency (loading) profile slope1 = 1.0 V/Hz, slope2 = 2.0 V/Hz

Cold Weather Operation

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Fuel and the Effect from Cold Weather

SMCS Code: 1000; 1250; 1280

The following fuels are the grades that are available for Cat engines:

- No. 1
- No. 2
- Blend of No. 1 and No. 2

No. 2 diesel fuel is the most commonly used fuel. Either No. 1 diesel fuel or a blend of No. 1 and No. 2 is best suited for cold-weather operation.

Quantities of No. 1 diesel fuel are limited. No. 1 diesel fuels are usually available during the months of the winter in the colder climates. During cold-weather operation, if No. 1 diesel fuel is not available, use No. 2 diesel fuel, if necessary.

There are three major differences between No. 1 and No. 2 diesel fuel. No. 1 diesel fuel has the following properties:

- Lower cloud point
- Lower pour point
- Lower rating of kJ (BTU) per unit volume of fuel

When No. 1 diesel fuel is used, a decrease in power and in fuel efficiency may be noticed. Other operating effects should not be experienced.

The cloud point is the temperature when a cloud of wax crystals begins to form in the fuel. These crystals can cause the fuel filters to plug. The pour point is the temperature when diesel fuel will thicken. The diesel fuel becomes more resistant to flow through fuel pumps and through fuel lines.

Be aware of these values when diesel fuel is purchased. Anticipate the average ambient temperature of the area. Engines that are fueled in one climate may not operate well if the engines are moved to another climate. Problems can result due to changes in temperature.

Before troubleshooting for low power or for poor performance in the winter, check the type of fuel that is being used.

When No. 2 diesel fuel is used the following components provide a means of minimizing problems in cold weather:

- Starting aids
- Engine oil pan heaters
- Engine coolant heaters
- Fuel heaters
- Fuel line insulation

For more information on cold-weather operation, see Special Publication, SEBU5898, “Cold Weather Recommendations”.

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Fuel Related Components in Cold Weather

SMCS Code: 1000; 1250; 1280

Fuel Tanks

Condensation can form in partially filled fuel tanks. Top off the fuel tanks after operating the engine.

Fuel tanks should contain some provision for draining water and sediment from the bottom of the tanks. Some fuel tanks use supply pipes that allow water and sediment to settle below the end of the fuel supply pipe.

Some fuel tanks use supply lines that take fuel directly from the bottom of the tank. If the engine is equipped with this system, regular maintenance of the fuel system filter is important.

Draining the fuel tank will help prevent water and/or sediment from being pumped from the fuel storage tank and into the engine fuel tank. Drain the water and sediment from any fuel storage tank at the following intervals:

- Weekly
- Oil changes
- Refueling of the fuel tank

Fuel Filters

NOTICE
Do not fill the fuel filters with fuel before installing them. The fuel would not be filtered and could be contaminated. Contaminated fuel will cause accelerated wear to fuel system parts.

NOTICE
Caterpillar requires the use of a 4 micron (c) secondary fuel filter for the following reasons: to maximize fuel system life and to prevent premature wear out from abrasive particles in the fuel. Cat high efficiency fuel filters meet these requirements. Consult your Cat dealer for the proper part numbers.

When the engine is equipped with a primary filter/water separator, the primary filter/water separator must use a 10 micron filter to a 15 micron filter. The filters are becoming more critical as fuel injection pressures increase to 209 MPa (30000 psi) and higher psi. For more information on priming the fuel system, see the Operation and Maintenance Manual, “Fuel System - Prime” topic.

Fuel Heaters

Fuel heaters help to prevent fuel filters from plugging in cold weather due to waxing. A fuel heater should be installed in order for the fuel to be heated before the fuel enters the primary fuel filter.

Select a fuel heater that is mechanically simple, yet adequate for the application. The fuel heater should also help to prevent overheating of the fuel. High fuel temperatures reduce engine performance and the availability of engine power. Choose a fuel heater with a large heating surface. The fuel heater should be practical in size. Small heaters can be too hot due to the limited surface area.

Disconnect the fuel heater in warm weather.

Note: Only use fuel heaters that are controlled by the water temperature regulator or fuel heaters that are self-regulating. Fuel heaters that are not controlled by the water temperature regulator can heat the fuel in excess of 65° C (149° F). A loss of engine power can occur if the fuel supply temperature exceeds 37° C (100° F).

Note: Heat exchanger type fuel heaters should have a bypass provision in order to prevent overheating of the fuel when the engine operates in warm weather.

For further information on fuel heaters, consult your Cat dealer.

Engine Stopping

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Stopping the Engine

SMCS Code: 1000

NOTICE
Stopping the engine immediately after it has been working under load can result in overheating and accelerated wear of engine components.

Excessive temperatures in the turbocharger centerhousing will cause oil coking problems. Excessive temperatures in the turbocharger centerhousing may damage the turbocharger bearing/shaft system and significantly shorten the life of the turbocharger.

Allow the engine to gradually cool before stopping the engine

1. Use one of the following methods to stop the engine:
   - Press the “STOP” Key.
   - Press the “AUTO” Key. A stop command will be sent via the RS-485 SCADA Data Link.
2. After receiving the engine stop signal, the EMCP 4 checks that there are no present system faults.
3. The EMCP 4 begins the cooldown period. In order to bypass the cooldown, the operator must hold down the “STOP” Key. “PRESS ENTER TO BYPASS” or “PRESS ENTER TO CONTINUE” will be shown on the display. Press the “ENTER” Key in order to bypass the cooldown sequence or press the “ESCAPE” Key in order to continue the cooldown sequence.

After the cooling cycle is completed, the EMCP 4 initiates an engine shutdown by turning off the fuel supply.

The engine will coast to a stop. Ensure that any system that provides external support to the engine is secured after the engine is stopped.

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Emergency Stopping

SMCS Code: 1000; 7418

NOTICE
Emergency shutoff controls are for EMERGENCY use ONLY. DO NOT use emergency shutoff devices or controls for normal stopping procedure.

Ensure that any components for the external system that support the engine operation are secured after the engine is stopped.

NOTICE
Do not start the engine until the problem necessitating the emergency stop has been located and corrected.

Emergency Stop Button

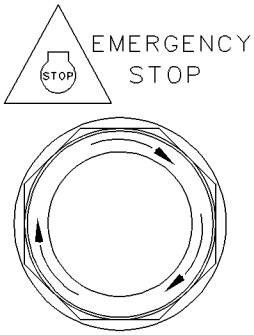

Illustration 42 g00104303
Typical emergency stop button

The emergency stop button is in the OUT position for normal engine operation. Push the emergency stop button. The engine will not start when the button is locked. Turn the button clockwise in order to reset.

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After Stopping Engine

SMCS Code: 1000

- Check the engine crankcase oil level. Maintain the oil level between the “ADD” and “FULL” marks on the “ENGINE STOPPED” side of the oil level gauge. Complete all of the lubrication recommendations that are listed in Special Publication, SEBU6251, “Caterpillar Commercial Diesel Engine Fluids Recommendations”.
- If necessary, perform minor adjustments. Repair any leaks and tighten loose bolts.
- Note the service hour meter reading. Perform the maintenance that is in the Operation and Maintenance Manual, “Maintenance Interval Schedule”.
- Fill the fuel tank in order to help prevent accumulation of moisture in the fuel. Do not overfill the fuel tank.

Note: Only use the antifreeze coolant solutions that are recommended in Special Publication, SEBU6251, “Caterpillar Commercial Diesel Engine Fluids Recommendations”. Failure to follow the recommendations in Special Publication, SEBU6251, “Caterpillar Commercial Diesel Engine Fluids Recommendations” can cause engine damage.

- Allow the engine to cool. Check the coolant level. Maintain the cooling system at 13 mm (0.5 inch) from the bottom of the pipe for filling.
- If freezing temperatures are expected, check the coolant for proper antifreeze protection. The cooling system must be protected against freezing to the lowest expected outside temperature. See Special Publication, SEBU6251, “Caterpillar Commercial Diesel Engine Fluids Recommendations”. Add the proper coolant/water mixture, if necessary.

Maintenance Section

Refill Capacities

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Refill Capacities

SMCS Code: 1000; 1348; 1395; 7560

Lubrication System

The refill capacities for the engine crankcase reflect the approximate capacity of the crankcase or sump plus standard oil filters. Auxiliary oil filter systems will require additional oil. Refer to the OEM specifications for the capacity of the auxiliary oil filter.

Table 6

C4.4 Engine Naturally Aspirated Engines and Turbocharged Engines Without an Aftercooler		
Compartment or System	**Liters**	**Quarts**
Standard Oil Sump for the Engine Crankcase (1)	7.0	(7.4)

(1) These values are the approximate capacities for the crankcase oil sump which include the standard factory installed oil filters. Engines with auxiliary oil filters will require additional oil. Refer to the OEM specifications for the capacity of the auxiliary oil filter.

Table 7

C4.4 Engine Turbocharged Engines With an Aftercooler		
Compartment or System	**Liters**	**Quarts**
Standard Oil Sump for the Engine Crankcase (1)	8.4	(8.9)

(1) These values are the approximate capacities for the crankcase oil sump which include the standard factory installed oil filters. Engines with auxiliary oil filters will require additional oil. Refer to the OEM specifications for the capacity of the auxiliary oil filter.

Cooling System

The capacities in Table8 and Table 9 are approximate refill capacities for the total cooling system. Always follow the procedure in this Operation and Maintenance Manual, “Cooling System Coolant (ELC) - Change” when you refill the cooling system.

Table 8

C4.4 Naturally Aspirated and Turbocharged Engines Without Aftercoolers		
Compartment or System	**Liters**	**US Gal**
Total Cooling System	9	(2.4)

Table 9

C4.4 Turbocharged Engines With Aftercoolers		
Compartment or System	**Liters**	**US Gal**
Total Cooling System	18.9 L	(5)

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Fluid Recommendations

SMCS Code: 1280; 1348; 1395; 7560

Engine Oil

NOTICE
These recommendations are subject to change without notice. Contact your local Caterpillar dealer for the most up to date recommendations.

API Oils

The Engine Oil Licensing and Certification System by the American Petroleum Institute (API) is recognized by Caterpillar. For detailed information about this system, see the latest edition of the “API publication No. 1509”. Engine oils that bear the API symbol are authorized by API.

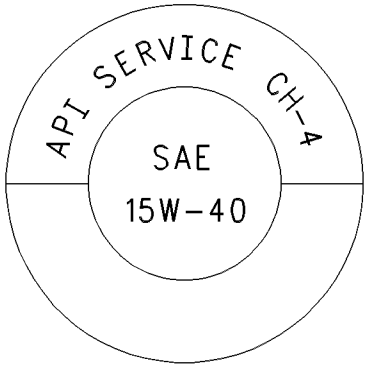

Illustration 43 g00546535
Typical API symbol

Diesel engine oils CC, CD, CD-2, and CE have not been API authorized classifications since January 1, 1996. Table 10 summarizes the status of the classifications.

Table 10

API Classifications	
Current	**Obsolete**
CI-4(1). CH-4(1) . CG-4(2). CF-4(3)	CE

(continued)

(Table 10, contd)

CF[4]	CC, CD
CF-2[5]	CD-2[5]

(1) **API CH-4 and CI-4 oils are acceptable if the requirements of Caterpillar's ECF-1 (Engine Crankcase Fluid specification-1) are met. CH-4 and CI-4 oils that have not met the requirements of Caterpillar's ECF-1 Specification may cause reduced engine life.**
(2) API CG-4 oils are acceptable for all Caterpillar diesel engines. When the API CG-4 oils are used, the oil drain interval should not exceed the standard oil drain interval for your engine.
(3) API CF-4 oils are not recommended for this series of Caterpillar diesel engines. For all other commercial diesel engines, the oil drain interval should not exceed 50 percent of the standard oil drain interval for your engine with a maximum of 125 hours.
(4) API CF oils are not recommended for this series of Caterpillar engines and smaller Direct Injection (DI) diesel engines.
(5) API CF-2 and CD-2 oils are classifications for two-cycle diesel engines. Caterpillar does not sell engines that utilize the CD-2 and the API CF-2 oils.

Note: When oil meets more than one API classification, the applicable footnote is determined by the highest API classification that is met.

Example – An oil meets both the API CH-4 and the API CF oil classifications. In this case, the API CH-4 applies.

Cat DEO (Diesel Engine Oil)

Caterpillar Oils have been developed and tested in order to provide the full performance and service life that has been designed and built into Caterpillar Engines. Caterpillar Oils are currently used to fill diesel engines at the factory. These oils are offered by Caterpillar dealers for continued use when the engine oil is changed. Consult your Caterpillar dealer for more information on these oils.

Due to significant variations in the quality and in the performance of commercially available oils, Caterpillar makes the following recommendations:

- **Cat DEO (Diesel Engine Oil) (10W-30)**
- **Cat DEO (Diesel Engine Oil) (15W-40)**

Caterpillar multigrade DEO is formulated with the correct amounts of detergents, dispersants, and alkalinity in order to provide superior performance in Caterpillar Diesel Engines.

Caterpillar multigrade DEO is available in various viscosity grades that include SAE 10W-30 and SAE 15W-40. To choose the correct viscosity grade for the ambient temperature, see Table 11 . Multigrade oils provide the correct viscosity for a broad range of operating temperatures.

Multigrade oils are effective in maintaining low oil consumption and low levels of piston deposits.

Caterpillar multigrade DEO can be used in other diesel engines and in gasoline engines. See the engine manufacturer's guide for the recommended specifications. Compare the specifications to the specifications of Caterpillar multigrade DEO. The current industry standards for Caterpillar DEO are listed on the product label and on the data sheets for the product.

Consult your Caterpillar dealer for part numbers and for available sizes of containers.

Note: Caterpillar SAE 15W-40 multigrade DEO exceeds the performance requirements for the following API classifications: CI-4, CH-4, CG-4, CF-4 and CF. The Caterpillar multigrade DEO exceeds the requirements of the Caterpillar specification that is ECF-1 (Engine Crankcase Fluid-1). The Caterpillar SAE 15W-40 multigrade DEO passes the following proprietary tests: sticking of the piston ring, oil control tests, wear tests and soot tests. Proprietary tests help ensure that Caterpillar multigrade oil provides superior performance in Caterpillar Diesel Engines. In addition, Caterpillar multigrade oil exceeds many of the performance requirements of other manufacturers of diesel engines. Therefore, this oil is an excellent choice for many mixed fleets. **True high performance oil is produced with a combination of the following factors: industry standard tests, proprietary tests, field tests and prior experience with similar formulations. The design and the development of Caterpillar lubricants that are both high performance and high quality are based on these factors.**

Note: Non-Caterpillar commercial oils are second choice oils.

Commercial Oils

Note: If Caterpillar Multigrade DEO is not used, use only commercial oils that meet the following classifications.

- API CH-4 multigrade oils and API CI-4 multigrade oils are acceptable if the requirements of Caterpillar's ECF-1 (Engine Crankcase Fluid specification-1) are met. CH-4 oils and CI-4 oils that have not met the requirements of Caterpillar's ECF-1 Specification may cause reduced engine life.
- API CG-4 multigrade oils are acceptable for all Caterpillar diesel engines. When the API CG-4 oils are used, the oil drain interval should not exceed the standard oil drain interval for your engine.

- API CF-4 multigrade oils are not recommended for this series of diesel engines. For all other smaller commercial diesel engines, the oil drain interval should not exceed 50 percent of the standard oil drain interval for your engine.

NOTICE
In selecting oil for any engine application, both the oil viscosity and oil performance classification/specification as specified by the engine manufacturer must be defined and satisfied. Using only one of these parameters will not sufficiently define oil for an engine application.

In order to make the proper choice of a commercial oil, refer to the following explanations:

API CI-4 – API CI-4 oils were developed in order to meet the requirements of high performance diesel engines that use cooled Exhaust Gas Recirculation (EGR). API CI-4 oils are acceptable if the requirements of Caterpillar's ECF-1 (Engine Crankcase Fluid specification-1) are met.

API CH-4 – API CH-4 oils were developed in order to protect low emissions diesel engines that use a 0.05 percent level of fuel sulfur. However, API CH-4 oils may be used with higher sulfur fuels. API CH-4 oils are acceptable if the requirements of Caterpillar's ECF-1 (Engine Crankcase Fluid specification-1) are met.

Note: CH-4 oils and CI-4 oils that have not met the requirements of Caterpillar's ECF-1 Specification may cause reduced engine life.

NOTICE
Failure to follow these oil recommendations can cause shortened engine service life due to deposits and/or excessive wear.

Note: Refer to Special Publication, SEBU6251, “Caterpillar Commercial Diesel Engine Fluids Recommendations” for additional information that relates to lubrication for your engine.

Lubricant Viscosity Recommendations

The proper SAE viscosity grade of oil is determined by the minimum ambient temperature during cold engine start-up, and the maximum ambient temperature during engine operation.

Refer to Table 11 (minimum temperature) in order to determine the required oil viscosity for starting a cold engine.

Refer to Table 11 (maximum temperature) in order to select the oil viscosity for engine operation at the highest ambient temperature that is anticipated.

Note: Generally, use the highest oil viscosity that is available to meet the requirement for the temperature at start-up.

If ambient temperature conditions at engine start-up require the use of multigrade SAE 0W oil, SAE 0W-40 viscosity grade is preferred over SAE 0W-20 or SAE 0W-30.

Table 11

Engine Oil Viscosities for Ambient Temperatures		
	Ambient Temperature	
Viscosity Grade	Minimum	Maximum
SAE 0W-20	−40 °C (−40 °F)	10 °C (50 °F)
SAE 0W-30	−40 °C (−40 °F)	30 °C (86 °F)
SAE 0W-40	−40 °C (−40 °F)	40 °C (104 °F)
SAE 5W-30	−30 °C (−22 °F)	30 °C (86 °F)
SAE 5W-40	−30 °C (−22 °F)	50 °C (122 °F)
SAE 10W-30	−18 °C (0 °F)	40 °C (104 °F)
SAE 10W-40	−18 °C (0 °F)	50 °C (122 °F)
SAE 15W-40	−9.5 °C (15 °F)	50 °C (122 °F)

Note: Supplemental heat is recommended below the minimum recommended ambient temperature.

S·O·S Oil Analysis

Caterpillar has developed a tool for maintenance management that evaluates oil degradation and the tool also detects the early signs of wear on internal components. The Caterpillar tool for oil analysis is called S·O·S Oil Analysis and the tool is part of the S·O·S Services program. S·O·S Oil Analysis divides oil analysis into three categories:

- Wear Analysis
- Oil condition
- Additional tests

The wear analysis monitors metal particles, some oil additives, and some contaminants.

Oil condition uses infrared (IR) analysis to evaluate the chemistry of the oil. Infrared analysis is also used to detect certain types of contamination.

Additional tests are used to measure contamination levels from water, fuel, or coolant. Oil viscosity and corrosion protection can be evaluated, as needed.

Refer to Special Publication, SEBU6251, “Caterpillar Commercial Diesel Engine Fluids Recommendations” or contact your local Caterpillar dealer for additional information concerning the S·O·S Oil Analysis program.

Lubricating Grease

Caterpillar provides a range of moderate greases to extremely high performance greases in order to service the entire line of Caterpillar products that operate throughout the wide variety of climates. From this variety of Caterpillar grease products, you will find at least one of the Caterpillar greases that will satisfy the performance requirements for any machine or equipment application.

Before selecting a grease for any application, the performance requirements must be determined. Consult the grease recommendations that are made by the OEM for the equipment when the equipment is operated in the expected conditions. Then, consult with your Caterpillar dealer for a list of greases and the following related characteristics.

- Performance specifications
- Available sizes of containers
- Part numbers

Always choose a grease that satisfies the recommendations that are specified by the equipment manufacturer for the application.

Note: If it is necessary to choose a single grease to use for all of the equipment at one site, always choose a grease that satisfies the requirements of the most demanding application.

Do not use the cost per pound as the only factor when you choose a grease. Use the grease that yields the lowest total cost of operation. The cost analysis should include the following factors:

- Parts
- Labor
- Downtime
- Cost of the grease

Greases that barely meet the minimum performance requirements can be expected to barely produce the minimum life of the parts.

Note: Take care when you change the type of grease. Take care when you change to a different supplier of grease. Some greases are not chemically compatible. Some brands of grease can not be interchanged. **If you are in doubt about the compatibility of the old grease and the new grease, purge all of the old grease from the joint.** Consult your supplier in order to determine if the greases are compatible.

Note: All Caterpillar brand of greases are compatible with each other.

Note: Refer to Special Publication, SEBU6251, “Caterpillar Commercial Diesel Engine Fluids Recommendations” for additional information that relates to lubrication for your engine.

General Fuel Information

Diesel fuels that meet the Caterpillar Specification for Distillate Diesel Fuel are recommended. These fuels will help to provide maximum engine service life and performance. In North America, diesel fuel that is identified as No. 1-D or No. 2-D in “ASTM D975” generally meet the specifications. Diesel fuels from other sources could exhibit detrimental properties that are not defined or controlled by this specification.

NOTICE
Operating with fuels that do not meet Caterpillar's recommendations can cause the following effects: starting difficulty, poor combustion, deposits in the fuel injectors, reduced service life of the fuel system, deposits in the combustion chamber and reduced service life of the engine.

Note: Refer to Special Publication, SEBU6251, “Caterpillar Commercial Diesel Engine Fluids Recommendations” for the Caterpillar Specification for distillate fuel and for additional information that relates to fuel for your engine.

General Coolant Information

NOTICE
These recommendations are subject to change without notice. Contact your local Caterpillar dealer for the most up to date fluids recommendations.

NOTICE
Never add coolant to an overheated engine. Engine damage could result. Allow the engine to cool first.

NOTICE
If the engine is to be stored in, or shipped to an area with below freezing temperatures, the cooling system must be either protected to the lowest outside temperature or drained completely to prevent damage.

NOTICE
Frequently check the specific gravity of the coolant for proper freeze protection or for anti-boil protection.

Clean the cooling system for the following reasons:

- Contamination of the cooling system
- Overheating of the engine
- Foaming of the coolant

Note: Air pockets can form in the cooling system if the cooling system is filled at a rate that is greater than 5 L (1.3 US gal) per minute.

After you drain the cooling system and after you refill the cooling system, operate the engine. Operate the engine without the filler cap until the coolant reaches normal operating temperature and the coolant level stabilizes. Ensure that the coolant is maintained to the proper level.

NOTICE
Never operate an engine without water temperature regulators in the cooling system. Water temperature regulators help to maintain the engine coolant at the proper operating temperature. Cooling system problems can develop without water temperature regulators.

Refer to Special Instruction, SEBD0518, “Know Your Cooling System” and Special Instruction, SEBD0970, “Coolant and Your Engine” for more detailed information.

Many engine failures are related to the cooling system. The following problems are related to cooling system failures: overheating, leakage of the water pump, plugged radiators or heat exchangers and pitting of the cylinder liners.

These failures can be avoided with proper cooling system maintenance. Cooling system maintenance is as important as maintenance of the fuel system and the lubrication system. Quality of the coolant is as important as the quality of the fuel and the lubricating oil.

Coolant is normally composed of three elements: water, additives and glycol.

Water

NOTICE
Never use water alone without Supplemental Coolant Additives (SCA) or without inhibited coolant. Water alone is corrosive at engine operating temperatures. Water alone does not provide adequate protection against boiling or freezing.

Water is used in the cooling system in order to transfer heat.

Distilled water or deionized water is recommended for use in engine cooling systems.

DO NOT use the following types of water in cooling systems: hard water, softened water that has been conditioned with salt and sea water.

If distilled water or deionized water is not available, use water with the properties that are listed in Table 12 .

Table 12

Caterpillar Minimum Acceptable Water Requirements		
Property	**Maximum Limit**	**ASTM Test**
Chloride (Cl)	40 mg/L (2.4 grains/US gal)	“D512”, “D4327”
Sulfate (SO_4)	100 mg/L (5.9 grains/US gal)	“D516”
Total Hardness	170 mg/L (10 grains/US gal)	“D1126”
Total Solids	340 mg/L (20 grain/US gal)	“D1888”
Acidity	pH of 5.5 to 9.0	“D1293”

For a water analysis, consult one of the following sources:

- Caterpillar dealer
- Local water utility company
- Agricultural agent
- Independent laboratory

Additives

Additives help to protect the metal surfaces of the cooling system. A lack of coolant additives or insufficient amounts of additives enable the following conditions to occur:

- Corrosion
- Formation of mineral deposits
- Rust
- Scale

- Pitting and erosion from cavitation of the cylinder liner
- Foaming of the coolant

Many additives are depleted during engine operation. These additives must be replaced periodically. This can be done by adding Supplemental Coolant Additives (SCA) to Diesel Engine Antifreeze/Coolant (DEAC) or by adding ELC Extender to Extended Life Coolant (ELC).

Additives must be added at the proper concentration. Overconcentration of additives can cause the inhibitors to drop out-of-solution. The deposits can enable the following problems to occur:

- Formation of gel compounds
- Reduction of heat transfer
- Leakage of the water pump seal
- Plugging of radiators, coolers, and small passages

Glycol

Glycol in the coolant helps to provide protection against the following conditions:

- Boiling
- Freezing
- Cavitation of the water pump and the cylinder liner

For optimum performance, Caterpillar recommends a 1:1 mixture of a water/glycol solution.

Note: Use a mixture that will provide protection against the lowest ambient temperature.

Note: 100 percent pure glycol will freeze at a temperature of −23 °C (−9 °F).

Most conventional heavy-duty coolants use ethylene glycol. Propylene glycol may also be used. In a 1:1 mixture with water, ethylene and propylene glycol provide similar protection against freezing and boiling. See Tables 13 and 14 .

Table 13

Ethylene Glycol		
Concentration	**Freeze Protection**	**Boil Protection**
50 Percent	−36 °C (−33 °F)	106 °C (223 °F)
60 Percent	−51 °C (−60 °F)	111 °C (232 °F)

NOTICE
Do not use propylene glycol in concentrations that exceed 50 percent glycol because of propylene glycol's reduced heat transfer capability. Use ethylene glycol in conditions that require additional protection against boiling or freezing.

Table 14

Propylene Glycol		
Concentration	**Freeze Protection**	**Anti-Boil Protection**
50 Percent	−29 °C (−20 °F)	106 °C (223 °F)

To check the concentration of glycol, use the 1U-7298 Coolant/Battery Tester (Degrees Celsius) or use the 1U-7297 Coolant/Battery Tester (Degrees Fahrenheit). The testers give readings that are immediate and accurate. The testers can be used with ethylene or propylene glycol.

Coolant Recommendations

NOTICE
Do not use a commercial coolant/antifreeze that only meets the ASTM D3306 specification. This type of coolant/antifreeze is made for light duty automotive applications.

The following two coolants are used in Caterpillar diesel engines:

Preferred – Caterpillar Extended Life Coolant (ELC) or a commercial extended life coolant that meets the Caterpillar EC-1 specification

Acceptable – Caterpillar Diesel Engine Antifreeze/Coolant (DEAC) or a commercial heavy-duty antifreeze/coolant that meets “ASTM D4985”, or “ASTM D6210” specifications

Caterpillar recommends a 1:1 mixture of water and glycol. This mixture of water and glycol will provide optimum heavy-duty performance as an antifreeze/coolant.

Note: Caterpillar DEAC does not require a treatment with an SCA at the initial fill. A commercial heavy-duty antifreeze/coolant that meets “ASTM D4985” or “ASTM D6210” specifications MAY require a treatment with an SCA at the initial fill. These coolants WILL require a treatment with an SCA on a maintenance basis.

Refer to Special Publication, SEBU6251, “Caterpillar Commercial Diesel Engine Fluids Recommendations” for additional information that relates to coolant.

S·O·S Coolant Analysis

Table 15

Recommended Interval		
Type of Coolant	**Level 1**	**Level 2**
DEAC	Every 250 Hours	Yearly(1)
ELC	Not Required	Yearly

(1) The Level 2 Coolant Analysis should be performed sooner if a problem is identified by a Level 1 Coolant Analysis.

S·O·S Coolant Analysis (Level 1)

A coolant analysis (Level 1) is a test of the properties of the coolant.

The following properties of the coolant are tested:

- Glycol concentration for freeze protection and boil protection
- Ability to protect from erosion and corrosion
- pH
- Conductivity
- Visual analysis
- Odor analysis

The results are reported, and appropriate recommendations are made.

Refer to the Maintenance Interval Schedule in this Operation and Maintenance Manual, “Cooling System Coolant Sample (Level 1) - Obtain” for a sampling location and the maintenance interval for collecting the coolant samples.

S·O·S Coolant Analysis (Level 2)

A coolant analysis (Level 2) is a comprehensive chemical evaluation of the coolant. This analysis is also a check of the overall condition of the inside of the cooling system.

The S·O·S Coolant Analysis has the following features:

- Full coolant analysis (Level 1)
- Identification of the source of metal corrosion and of contaminants
- Water hardness
- Identification of buildup of the impurities that cause corrosion
- Identification of buildup of the impurities that cause scaling

The results are reported, and appropriate recommendations are made.

Refer to the Maintenance Interval Schedule in this Operation and Maintenance Manual, “Cooling System Coolant Sample (Level 2) - Obtain” for a sampling location and the maintenance interval for collecting the coolant samples.

Testing the engine coolant is important to ensure that the engine is protected from internal cavitation and from corrosion. The analysis also tests the ability of the coolant to protect the engine from boiling and from freezing. The S·O·S Coolant Analysis can be done at your Caterpillar dealer. Caterpillar S·O·S Coolant Analysis is the best way to monitor the condition of your coolant and your cooling system. S·O·S Coolant Analysis is a program that is based on periodic samples.

Refer to Special Publication, SEBU6251, “Caterpillar Commercial Diesel Engine Fluids Recommendations” for additional information.

Maintenance Recommendations

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General Maintenance Information

SMCS Code: 4450; 7000

Note: Read the warnings and read the instructions that are contained in the Safety Section of this manual. These warnings and instructions must be understood before you perform any operation or any maintenance procedures.

Rotating electric machines are complex structures that are exposed to the following forms of stress:

- mechanical
- electrical
- thermal
- environmental

These stresses may be of varying magnitudes. The electrical insulation systems are susceptible to damage that is caused by the stresses that are listed above. Exposure to these stresses may shorten the effective life of the electrical insulation system. Therefore, the service life of an electric machine will largely depend on the serviceability of the electrical insulation systems. An inspection program and a testing procedure are recommended. An inspection program and a testing procedure will ensure that the equipment is maintained in satisfactory condition. This will increase field reliability.

A regular maintenance and inspection program can provide an evaluation of the present condition of the equipment. A regular maintenance program and a regular inspection program can also reveal future problems. The frequency of this maintenance program will depend on the following factors:

- application
- environmental conditions
- experience level of the operator
- philosophy of the operator

A regular maintenance program is strongly recommended. This program would involve the following steps:

- periodic disassembly
- knowledgeable visual examination of the equipment
- the application of electrical tests

Never perform a test over the rated potential. These tests can damage insulation that is contaminated or insulation that is in marginal condition. For more information, refer to “I.E.E.E. Standard 432-1992” or consult a Cat dealer.

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System Pressure Release

SMCS Code: 1250; 1300; 1350; 5050

Coolant System

⚠ WARNING

Pressurized system: Hot coolant can cause serious burn. To open cap, stop engine, wait until radiator is cool. Then loosen cap slowly to relieve the pressure.

To relieve the pressure from the coolant system, turn off the engine. Allow the cooling system pressure cap to cool. Remove the cooling system pressure cap slowly in order to relieve pressure.

Fuel System

To relieve the pressure from the fuel system, turn off the engine.

High Pressure Fuel Lines (If Equipped)

⚠ WARNING

Contact with high pressure fuel may cause fluid penetration and burn hazards. High pressure fuel spray may cause a fire hazard. Failure to follow these inspection, maintenance and service instructions may cause personal injury or death.

The high pressure fuel lines are the fuel lines that are between the high pressure fuel pump and the high pressure fuel manifold and the fuel lines that are between the fuel manifold and cylinder head. These fuel lines are different from fuel lines on other fuel systems.

This is because of the following differences:

- The high pressure fuel lines are constantly charged with high pressure.
- The internal pressures of the high pressure fuel lines are higher than other types of fuel system.

Before any service or repair is performed on the engine fuel lines, perform the following tasks:

1. Stop the engine.

2. Wait for ten minutes.

Do not loosen the high pressure fuel lines in order to remove air pressure from the fuel system.

Engine Oil

To relieve pressure from the lubricating system, turn off the engine.

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Welding on Engines with Electronic Controls

SMCS Code: 1000

NOTICE
Because the strength of the frame may decrease, some manufacturers do not recommend welding onto a chassis frame or rail. Consult the OEM of the equipment or your Cat dealer regarding welding on a chassis frame or rail.

Proper welding procedures are necessary in order to avoid damage to the engine ECM, sensors, and associated components. When possible, remove the component from the unit and then weld the component. If removal of the component is not possible, the correct procedure must be followed. When welding on a unit that is equipped with a Cat Electronic Engine, the following is considered to be the safest procedure:

NOTICE
Do not ground the welder to electrical components such as the ECM or sensors. Improper grounding can cause damage to the drive train, the bearings, hydraulic components, electrical components, and other components.

Do not ground the welder across the centerline of the package. Improper grounding could cause damage to the bearings, the crankshaft, the rotor shaft, and other components.

Clamp the ground cable from the welder to the component that will be welded. Place the clamp as close as possible to the weld. This will help reduce the possibility of damage.

Note: Perform the welding in areas that are free from explosive hazards.

1. Stop the engine. Turn the switched power to the OFF position.

2. Disconnect the negative battery cable from the battery. If a battery disconnect switch is provided, open the switch.

3. Disconnect the J1/P1 and J2/P2 connectors from the ECM. Move the harness to a position that will not allow the harness to move back accidentally, and contact any of the ECM pins.

4. Disconnect any component with a microprocessor from the engine harness, such as:

- Engine ECM
- Product Link
- Cell/Sat Radio
- DOC Identity Modules

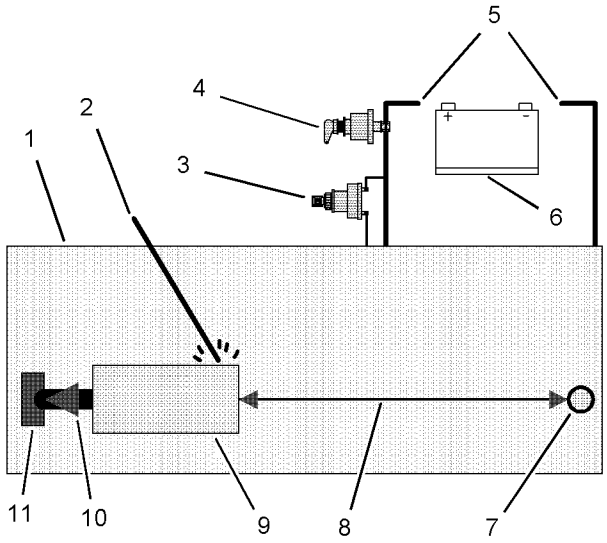

Illustration 44 g01075639

Use the example above. The current flow from the welder to the ground clamp of the welder will not damage any associated components.

(1) Engine
(2) Welding electrode
(3) Keyswitch in the OFF position
(4) Battery disconnect switch in the open position
(5) Disconnected battery cables
(6) Battery
(7) Electrical/Electronic component
(8) Minimum distance between the component that is being welded and any electrical/electronic component
(9) The component that is being welded
(10) Current path of the welder
(11) Ground clamp for the welder

5. Connect the welding ground cable directly to the part that will be welded. Place the ground cable as close as possible to the weld. This location will reduce the possibility of welding current damage to bearings, hydraulic components, electrical components, and ground straps.

Note: If electrical/electronic components are used as a ground for the welder, current flow from the welder could severely damage the component. Current flow from the welder could also severely damage electrical/electronic components that are located between the welder ground and the weld.

6. Protect the wiring harness from welding debris and spatter.

7. Use standard welding practices to weld the materials.

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Maintenance Interval Schedule (Prime Power)

SMCS Code: 1000; 4450; 7500

Ensure that all safety information, warnings, and instructions are read and understood before any operation or any maintenance procedures are performed.

The user is responsible for the performance of maintenance, including all adjustments, the use of proper lubricants, fluids, filters, and the replacement of components due to normal wear and aging. Failure to adhere to proper maintenance intervals and procedures may result in diminished performance of the product and/or accelerated wear of components.

Use mileage, fuel consumption, service hours, or calendar time, WHICH EVER OCCURS FIRST, in order to determine the maintenance intervals. Products that operate in severe operating conditions may require more frequent maintenance.

Note: Before each consecutive interval is performed, all maintenance from the previous interval must be performed.

When Required

Daily

Every Week

Every 50 Service Hours or Weekly

Every 250 Service Hours

Every 500 Service Hours

After Harvest

Every Year

Every 500 Service Hours or 1 Year

Every 1000 Service Hours or 1 Year

Every 2000 Service Hours

Every 2000 Service Hours or 6 Months

Every 3000 Service Hours

Every 3000 Service Hours or 2 Years

Every 6000 Service Hours or 3 Years

Every 12 000 Service Hours or 6 Years

Overhaul

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Maintenance Interval Schedule (Standby)

SMCS Code: 1000; 4450; 7500

Ensure that all safety information, warnings, and instructions are read and understood before any operation or any maintenance procedures are performed.

The user is responsible for the performance of maintenance, including all adjustments, the use of proper lubricants, fluids, filters, and the replacement of components due to normal wear and aging. Failure to adhere to proper maintenance intervals and procedures may result in diminished performance of the product and/or accelerated wear of components.

Use mileage, fuel consumption, service hours, or calendar time, WHICH EVER OCCURS FIRST, in order to determine the maintenance intervals. Products that operate in severe operating conditions may require more frequent maintenance.

Note: Before each consecutive interval is performed, all maintenance from the previous interval must be performed.

When Required

Every Week

Every 500 Service Hours or 1 Year

Every Year

Every 3000 Service Hours or 2 Years

Every 3 Years

Every 6 Years

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Alternator - Inspect

SMCS Code: 1405-040

Caterpillar recommends a scheduled inspection of the alternator. Inspect the alternator for loose connections and proper battery charging. Inspect the ammeter (if equipped) during engine operation in order to ensure proper battery performance and/or proper performance of the electrical system. Make repairs, as required. Refer to the Service Manual.

Check the alternator and the battery charger for proper operation. If the batteries are properly charged, the ammeter reading should be very near zero. All batteries should be kept charged. The batteries should be kept warm because temperature affects the cranking power. If the battery is too cold, the battery will not crank the engine. The battery will not crank the engine, even if the engine is warm. When the engine is not run for long periods of time or if the engine is run for short periods, the batteries may not fully charge. A battery with a low charge will freeze more easily than a battery with a full charge.

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Battery - Recycle

SMCS Code: 1401-561; 1401; 1401-510; 1401-005; 1401-535

Always recycle a battery. Never discard a battery. Return used batteries to one of the following locations:

- A battery supplier
- An authorized battery collection facility
- A recycling facility

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Battery - Replace

SMCS Code: 1401-510

⚠ WARNING

Batteries give off combustible gases which can explode. A spark can cause the combustible gases to ignite. This can result in severe personal injury or death.

Ensure proper ventilation for batteries that are in an enclosure. Follow the proper procedures in order to help prevent electrical arcs and/or sparks near batteries. Do not smoke when batteries are serviced.

⚠ WARNING

The battery cables or the batteries should not be removed with the battery cover in place. The battery cover should be removed before any servicing is attempted.

Removing the battery cables or the batteries with the cover in place may cause a battery explosion resulting in personal injury.

Note: Always recycle a battery. Never discard a battery. Return used batteries to an appropriate recycling facility.

1. Turn the key start switch to the OFF position. Remove the key and all electrical loads.
2. Turn OFF the battery charger. Disconnect the charger.
3. Turn battery isolator switch to OFF position.
4. The NEGATIVE “-” cable connects the NEGATIVE “-” battery terminal to the ground plane. Disconnect the cable from the NEGATIVE “-” battery terminal.
5. The POSITIVE “+” cable connects the POSITIVE “+” battery terminal to the starting motor. Disconnect the cable from the POSITIVE “+” battery terminal.

Note: Always recycle a battery. Never discard a battery. Return used batteries to an appropriate recycling facility.

6. Remove the used battery.
7. Install the new battery.

Note: Before the cables are connected, ensure that the key start switch is OFF.

8. Connect the cable from the starting motor to the POSITIVE “+” battery terminal.
9. Connect the cable from the ground plane to the NEGATIVE “-” battery terminal.

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Battery Electrolyte Level - Check

SMCS Code: 1401-535-FLV

When the engine has not run for long or short periods of time, the batteries may not fully recharge. Ensure a full charge to help prevent the battery from freezing.

In warmer climates, check the electrolyte level more frequently.

Ensure that the electrolyte level is 13 mm (0.5 inch) above the top of the separators.

⚠ WARNING

All lead-acid batteries contain sulfuric acid which can burn the skin and clothing. Always wear a face shield and protective clothing when working on or near batteries.

1. Remove the filler caps. Maintain the electrolyte level to the “FULL” mark on the battery.

   If the addition of water is necessary, use distilled water. If distilled water is not available, use clean water that is low in minerals. Do not use artificially softened water.

2. Check the condition of the electrolyte with the 245-5829 Coolant Battery Tester Refractometer.

3. Keep the batteries clean.

   Clean the battery case with one of the following cleaning solutions:

   - A mixture of 0.1 kg (0.2 lb) of baking soda and 1 L (1 qt) of clean water
   - A mixture of 0.1 L (0.11 qt) of ammonia and 1 L (1 qt) of clean water

   Thoroughly rinse the battery case with clean water.

   Use the 1U-9921 Battery Service Tool to clean the battery terminals. Use a wire brush to clean the cable clamps. Clean the items until the surfaces are bright or shiny. DO NOT remove material excessively. Excessive removal of material can cause the clamps to fit improperly. Coat the clamps and the terminals with the Loctite® product listed below, petroleum jelly or MPGM.

   - For Americas North - Loctite LB8632
   - For Europe and Africa, Middle East, CIS (AMEC) - Loctite LB8104
   - For Asia Pacific - Loctite LB8801
   - For Americas South - Loctite LB Superlube

   For ordering the products listed above, go to the following address.

   http://www.loctite.com/en/meta/meta-nav/location-selector.html

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Battery or Battery Cable - Disconnect

SMCS Code: 1401; 1402-029

⚠ WARNING

The battery cables or the batteries should not be removed with the battery cover in place. The battery cover should be removed before any servicing is attempted.

Removing the battery cables or the batteries with the cover in place may cause a battery explosion resulting in personal injury.

1. Turn the start switch to the OFF position. Turn the ignition switch (if equipped) to the OFF position and remove the key and all electrical loads.
2. Disconnect the negative battery terminal at the battery that goes to the start switch. Ensure that the cable cannot contact the terminal. When four 12 volt batteries are involved, the negative side of two batteries must be disconnected.
3. Tape the leads in order to help prevent accidental starting.
4. Proceed with necessary system repairs. Reverse the steps in order to reconnect all of the cables.

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Belts - Inspect/Adjust/Replace

SMCS Code: 1357-510; 1357-040; 1357-025

Inspection

To maximize the engine performance, inspect the belts for wear and for cracking. Replace belts that are worn or damaged.

For applications that require multiple drive belts, replace the belts in matched sets. Replacing only one belt of a matched set will cause the new belt to carry more load because the older belt is stretched. The additional load on the new belt could cause the new belt to break.

If the belts are too loose, vibration causes unnecessary wear on the belts and pulleys. Loose belts may slip enough to cause overheating.

To check the belt tension accurately, Gauge 144-0235 Belt Tension Gauge should be used.

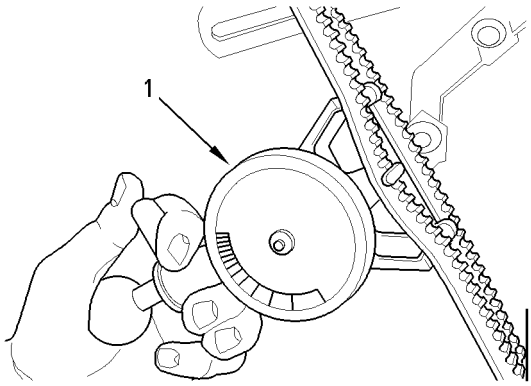

Illustration 45 g01003936

Typical example

(1) 144-0235 Belt Tension Gauge

Install the gauge (1) at the center of the belt between the alternator and the crankshaft pulley and check the belt tension. The correct tension for a new belt is 400 N (90 lb) to 489 N (110 lb). The correct tension for a used belt that has been in operation for 30 minutes or more at the rated speed is 267 N (60 lb) to 356 N (80 lb).

If twin belts are installed, check and adjust the tension on both belts.

Adjustment

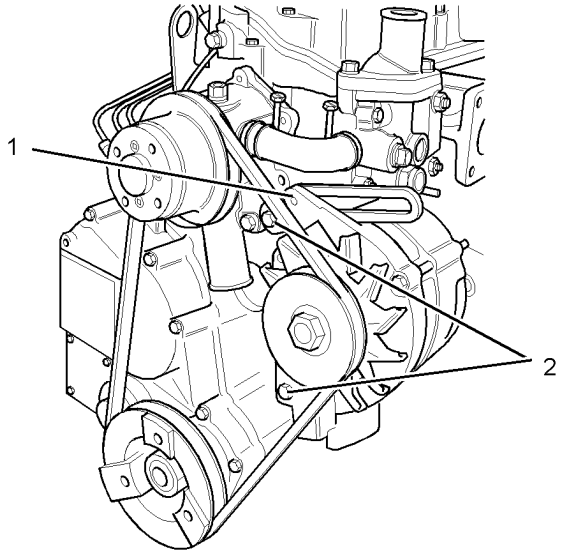

Illustration 46 g01091158

Typical example

(1) Adjusting bolt
(2) Mounting bolts

1. Loosen the mounting bolts (2) and the adjusting bolt (1).

2. Move the alternator in order to increase or decrease the belt tension.

3. Tighten the adjusting bolt (1). Tighten the mounting bolts (2). Refer to the Specifications Manual for the correct torque settings.

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Coolant (ELC) - Change

SMCS Code: 1350-070; 1395-044

Clean the cooling system and flush the cooling system before the recommended maintenance interval if the following conditions exist:

- The engine overheats frequently.
- Foaming is observed.
- The oil has entered the cooling system and the coolant is contaminated.
- The fuel has entered the cooling system and the coolant is contaminated.

Note: When the cooling system is cleaned, only clean water is needed when the ELC is drained and replaced.

Note: Inspect the water pump and the water temperature regulator after the cooling system has been drained.

Drain

⚠ WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

1. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap.

2. Open the cooling system drain valve (if equipped). If the cooling system is not equipped with a drain valve, remove the cooling system drain plugs.

Allow the coolant to drain.

NOTICE
Dispose of used engine coolant properly or recycle. Various methods have been proposed to reclaim used coolant for reuse in engine cooling systems. The full distillation procedure is the only method acceptable by Caterpillar to reclaim the used coolant.

For information regarding the disposal and the recycling of used coolant, consult your Cat dealer or consult Cat Dealer Service Tool Group:

Outside Illinois 1-800-542-TOOL
Inside Illinois 1-800-541-TOOL
Canada 1-800-523-TOOL

Flush

1. Flush the cooling system with clean water in order to remove any debris.
2. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Specifications Manual, SENR3130, “Torque Specifications” for more information on the proper torques.

NOTICE
Fill the cooling system no faster than 19 L (5 US gal) per minute to avoid air locks.

3. Fill the cooling system with clean water. Install the cooling system filler cap.
4. Start and run the engine at low idle until the temperature reaches 49 to 66 °C (120 to 150 °F).
5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Open the drain valve (if equipped) or remove the cooling system drain plugs. Allow the water to drain. Flush the cooling system with clean water. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Specifications Manual, SENR3130, “Torque Specifications” for more information on the proper torques.

Fill

Note: Do not step on the roof of the enclosure to fill the radiator with coolant from outside of the enclosure. Use a funnel of adequate length and a safe platform to stand on while filling the radiator with coolant. Refer to this Operation and Maintenance Manual, “Mounting and Dismounting” for additional information to mount and dismount the enclosure safely. Filling the radiator with coolant from inside the enclosure is an alternative to filling the radiator from outside of the enclosure.

NOTICE
Fill the cooling system no faster than 19 L (5 US gal) per minute to avoid air locks.

1. Fill the cooling system with Extended Life Coolant (ELC). Refer to the Operation and Maintenance Manual, “Refill Capacities and Recommendations” topic (Maintenance Section) for more information on cooling system specifications. Do not install the cooling system filler cap.
2. Start and run the engine at low idle. Increase the engine rpm to high idle. Run the engine at high idle for 1 minute in order to purge the air from the cavities of the engine block. Stop the engine.
3. Check the coolant level. Maintain the coolant level within 13 mm (0.5 inch) below the bottom of the pipe for filling. Maintain the coolant level within 13 mm (0.5 inch) to the proper level on the sight glass (if equipped).

4. Clean the cooling system filler cap. Inspect the gasket that is on the cooling system filler cap. If the gasket that is on the cooling system filler cap is damaged, discard the old filler cap and install a new filler cap. If the gasket that is on the filler cap is not damaged, use a 9S-8140 Pressurizing Pump in order to pressure test the filler cap. The correct pressure for the cooling system filler cap is stamped on the face of the cooling system filler cap. If the cooling system filler cap does not retain the correct pressure, install a new cooling system filler cap.
5. Start the engine. Inspect the cooling system for leaks and for proper operating temperature.

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Coolant Extender (ELC) - Add

SMCS Code: 1352-544-NL

Cat ELC (Extended Life Coolant) does not require the frequent additions of any supplemental cooling additives which are associated with the present conventional coolants. The Cat ELC Extender will only be added one time.

NOTICE
Use only Cat Extended Life Coolant (ELC) Extender with Cat ELC.

Do NOT use conventional supplemental coolant additive (SCA) with Cat ELC. Mixing Cat ELC with conventional coolants and/or conventional SCA reduces the Cat ELC service life.

Check the cooling system only when the engine is stopped and cool.

⚠ WARNING

Personal injury can result from hot coolant, steam and alkali.

At operating temperature, engine coolant is hot and under pressure. The radiator and all lines to heaters or the engine contain hot coolant or steam. Any contact can cause severe burns.

Remove cooling system pressure cap slowly to relieve pressure only when engine is stopped and cooling system pressure cap is cool enough to touch with your bare hand.

Do not attempt to tighten hose connections when the coolant is hot, the hose can come off causing burns.

Cooling System Coolant Additive contains alkali. Avoid contact with skin and eyes.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Cat Dealer Service Tool Catalog” or refer to Special Publication, PECJ0003, “Cat Shop Supplies and Tools Catalog” for tools and supplies suitable to collect and contain fluids on Cat products.

Dispose of all fluids according to local regulations and mandates.

1. Loosen the cooling system filler cap slowly in order to relieve pressure. Remove the cooling system filler cap.
2. If necessary, drain enough coolant from the cooling system in order to add the Cat ELC Extender.
3. Add Cat ELC Extender according to the requirements for the cooling system capacity. Refer to this Operation and Maintenance Manual, “Refill Capacities” or to this Operation and Maintenance Manual, “Fluid Recommendations” for more information.
4. Clean the cooling system filler cap. Inspect the gaskets on the cooling system filler cap. Replace the cooling system filler cap if the gaskets are damaged. Install the cooling system filler cap.

i05262731

Coolant Sample (Level 1) - Obtain

SMCS Code: 1350-008; 1395-554; 1395-008; 7542

Note: Obtaining a Coolant Sample (Level 1) is optional if the cooling system is filled with Cat ELC (Extended Life Coolant). Cooling systems that are filled with Cat ELC should have a Coolant Sample (Level 2) that is obtained at the recommended interval that is stated in the Maintenance Interval Schedule.

Note: Obtain a Coolant Sample (Level 1) if the cooling system is filled with any other coolant instead of Cat ELC. A Coolant Sample (Level 1) includes the following types of coolants:

- Commercial long life coolants that meet the Caterpillar Engine Coolant Specification -1 (Caterpillar EC-1)

- Cat DEAC (Diesel Engine Antifreeze/Coolant)
- Commercial heavy-duty coolant/antifreeze

Table 16

Recommended Interval		
Type of Coolant	**Level 1**	**Level 2**
Cat DEAC	Every 250 Hours(1)	Yearly(1) (2)
Cat ELC	Optional(2)	Yearly(2)

(1) This is the recommended interval for coolant samples for all conventional heavy-duty coolant/antifreeze. This is also the recommended interval for coolant samples of commercial coolants that meet the Cat EC-1 specification for engine coolant.
(2) The Level 2 Coolant Analysis should be performed sooner if a problem is suspected or identified.

NOTICE
Always use a designated pump for oil sampling, and use a separate designated pump for coolant sampling. Using the same pump for both types of samples may contaminate the samples that are being drawn. This contaminate may cause a false analysis and an incorrect interpretation that could lead to concerns by both dealers and customers.

Note: Level 1 results may indicate a need for Level 2 Analysis.

Obtain the sample of the coolant as close as possible to the recommended sampling interval. In order to receive the full effect of S·O·S analysis, a consistent trend of data must be established. In order to establish a pertinent history of data, perform consistent samplings that are evenly spaced. Supplies for collecting samples can be obtained from your Caterpillar dealer.

Use the following guidelines for proper sampling of the coolant:

- Complete the information on the label for the sampling bottle before you begin to take the samples.
- Keep the unused sampling bottles stored in plastic bags.
- Obtain coolant samples directly from the coolant sample port. You should not obtain the samples from any other location.
- Keep the lids on empty sampling bottles until you are ready to collect the sample.
- Place the sample in the mailing tube immediately after obtaining the sample in order to avoid contamination.
- Never collect samples from expansion bottles.
- Never collect samples from the drain for a system.

Submit the sample for Level 1 analysis.

For additional information about coolant analysis, see this Operation and Maintenance Manual, “Fluid Recommendations” or consult your Caterpillar dealer.

i05378320

Coolant Sample (Level 2) - Obtain

SMCS Code: 1350-008; 1395-554; 1395-008; 7542

NOTICE
Always use a designated pump for oil sampling, and use a separate designated pump for coolant sampling. Using the same pump for both types of samples may contaminate the samples that are being drawn. This contaminate may cause a false analysis and an incorrect interpretation that could lead to concerns by both dealers and customers.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Cat Dealer Service Tool Catalog” or refer to Special Publication, PECJ0003, “Cat Shop Supplies and Tools Catalog” for tools and supplies suitable to collect and contain fluids on Cat products.

Dispose of all fluids according to local regulations and mandates.

Refer to Operation and Maintenance Manual, “Cooling System Coolant Sample (Level 1) - Obtain” for the guidelines for a proper sampling of the coolant.

Submit the sample for Level 2 analysis.

For additional information about coolant analysis, see Special Publication, SEBU7003, “Cat 3600 Series and C280 Series Diesel Engine Fluids Recommendations” or consult your Cat dealer.

i06071309

Coolant Temperature Regulator - Replace

SMCS Code: 1355-510

This replacement is a recommended preventive maintenance practice. Replacing the water temperature regulator reduces the chances for unscheduled downtime.

A water temperature regulator that fails in a partially opened position can cause overheating or overcooling of the engine.

A water temperature regulator that fails in the closed position can cause excessive overheating. Excessive overheating could result in cracking of the cylinder head or piston seizure problems.

A water temperature regulator that fails in the open position will cause the engine operating temperature to be too low during partial load operation. Low engine operating temperatures during partial loads could cause an excessive carbon buildup inside the cylinders. This excessive carbon buildup could result in an accelerated wear of the piston rings and wear of the cylinder liner.

NOTICE
Failure to replace your water temperature regulator on a regularly scheduled basis could cause severe engine damage.

Caterpillar engines incorporate a shunt design cooling system and require operating the engine with a water temperature regulator installed.

If the water temperature regulator is installed incorrectly, the engine may overheat, causing cylinder head damage. Ensure that the new water temperature regulator is installed in the original position. Ensure that the water temperature regulator vent hole is open.

Do not use liquid gasket material on the gasket or cylinder head surface.

Refer to Disassembly and Assembly, “Water Temperature Regulator - Remove and Install”. Consult your Cat dealer for more information.

Note: If only the water temperature regulators are replaced, drain the coolant from the cooling system to a level that is below the water temperature regulator housing.

i02398768

Electrical Connections - Check

SMCS Code: 4459-535

DANGER

DANGER: Shock/Electrocution Hazard-Do not operate this equipment or work on this equipment unless you have read and understand the instructions and warnings in the Operation and Maintenance Manual. Failure to follow the instructions or heed the warnings will result in serious injury or death.

Checking the electrical connections is an important part of the maintenance for the generator set. Improper connections may cause the generator set to malfunction.

Check all exposed electrical connections for tightness.

Check the following devices for loose mounting or for physical damage:

- Transformers
- Fuses
- Capacitors
- Lightning arresters

Check the connections for the following components:

- Load cables
- Cables for the generator
- Potential transformers
- Current transformers

Check all lead wires and electrical connections for proper clearance. Inspect all cables for chafing, abrasion and corrosion.

i02293096

Engine - Clean

SMCS Code: 1000-070

⚠ WARNING

Personal injury or death can result from high voltage.

Moisture could create paths of electrical conductivity.

Make sure the unit is off line (disconnected from utility and/or other generators), locked out and tagged "Do Not Operate".

NOTICE
Accumulated grease and oil on an engine is a fire hazard. Keep the engine clean. Remove debris and fluid spills whenever a significant quantity accumulates on the engine.

NOTICE
Water or condensation can cause damage to generator components. Protect all electrical components from exposure to water.

Periodic cleaning of the engine is recommended. Steam cleaning the engine will remove accumulated oil and grease. A clean engine provides the following benefits:

- Easy detection of fluid leaks
- Maximum heat transfer characteristics
- Ease of maintenance

Note: Caution must be used in order to prevent electrical components from being damaged by excessive water when you clean the engine. Avoid electrical components such as the alternator, the starter, and the ECM.

i02456872

Engine Mounts - Inspect

SMCS Code: 1152; 1152-040

Inspect the engine mounts for deterioration and for proper bolt torque. Engine vibration can be caused by the following conditions:

- Improper mounting of the engine
- Deterioration of the engine mounts

Any engine mount that shows deterioration should be replaced. Refer to Special Publication, SENR3130, “Torque Specifications” for the recommended torques. Refer to the OEM recommendations for more information.

i00623423

Engine Oil Level - Check

SMCS Code: 1348-535-FLV

⚠ WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

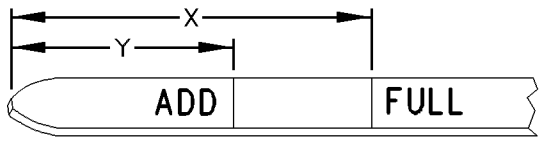

Illustration 47 g00110310

(Y) “ADD” mark. (X) “FULL” mark.

NOTICE
Perform this maintenance with the engine stopped.

1. Maintain the oil level between “ADD” mark (Y) and “FULL” mark (X) on oil level gauge (1). Do not fill the crankcase above “FULL” mark (X).

NOTICE
Operating your engine when the oil level is above the “FULL” mark could cause your crankshaft to dip into the oil. The air bubbles created from the crankshaft dipping into the oil reduces the oil's lubricating characteristics and could result in the loss of power.

2. Remove the oil filler cap and add oil, if necessary. Clean the oil filler cap. Install the oil filler cap.

i04237495

Engine Oil Sample - Obtain

SMCS Code: 1348-554-SM

In addition to a good preventive maintenance program, Caterpillar recommends using S·O·S oil analysis at regularly scheduled intervals. S·O·S oil analysis provides infrared analysis, which is required for determining nitration and oxidation levels.

Obtain the Sample and the Analysis

⚠ WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

Before you take the oil sample, complete the Label, PEEP5031 for identification of the sample. In order to help obtain the most accurate analysis, provide the following information:

- Engine model
- Service hours on the engine
- The number of hours that have accumulated since the last oil change
- The amount of oil that has been added since the last oil change

To ensure that the sample is representative of the oil in the crankcase, obtain a warm, mixed oil sample.

To avoid contamination of the oil samples, the tools and the supplies that are used for obtaining oil samples must be clean.

Caterpillar recommends using the sampling valve in order to obtain oil samples. The quality and the consistency of the samples are better when the sampling valve is used. The location of the sampling valve allows oil that is flowing under pressure to be obtained during normal engine operation.

The 169-8373 Fluid Sampling Bottle is recommended for use with the sampling valve. The fluid sampling bottle includes the parts that are needed for obtaining oil samples. Instructions are also provided.

NOTICE
Always use a designated pump for oil sampling, and use a separate designated pump for coolant sampling. Using the same pump for both types of samples may contaminate the samples that are being drawn. This contaminate may cause a false analysis and an incorrect interpretation that could lead to concerns by both dealers and customers.

If the engine is not equipped with a sampling valve, use the 1U-5718 Vacuum Pump. The pump is designed to accept sampling bottles. Disposable tubing must be attached to the pump for insertion into the sump.

For instructions, see Special Publication, PEGJ0047, “How To Take A Good S·O·S Oil Sample”. Consult your Cat dealer for complete information and assistance in establishing an S·O·S program for your engine.

i06075344

Engine Oil and Filter - Change

SMCS Code: 1318-510

⚠ WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Do not drain the oil when the engine is cold. As the oil cools, suspended waste particles settle on the bottom of the oil pan. The waste particles are not removed with the draining cold oil. Drain the crankcase with the engine stopped. Drain the crankcase with the oil warm. This draining method allows the waste particles that are suspended in the oil to be drained correctly.

Failure to follow this recommended procedure will cause the waste particles to be recirculated through the engine lubrication system with the new oil.

Drain the Engine Oil

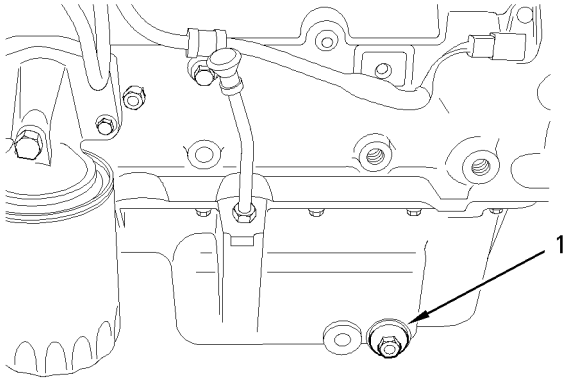

Illustration 48 g01003623
Oil drain plug

After the engine has been run at the normal operating temperature, stop the engine. Use one of the following methods to drain the engine crankcase oil:

- If the engine is equipped with a drain valve, turn the drain valve knob counterclockwise in order to drain the oil. After the oil has drained, turn the drain valve knob clockwise in order to close the drain valve.
- If the engine is not equipped with a drain valve, remove the oil drain plug (1) in order to allow the oil to drain. If the engine is equipped with a shallow sump, remove the bottom oil drain plugs from both ends of the oil pan.

After the oil has drained, the oil drain plugs should be cleaned and installed. If necessary, renew the O ring seal on the drain plug.

Some types of oil pans have oil drain plugs that are on both sides of the oil pan, because of the shape of the pan. This type of oil pan requires the engine oil to be drained from both plugs.

Replace the Spin-on Oil Filter

NOTICE
Caterpillar oil filters are built to Caterpillar specifications. Use of an oil filter not recommended by Caterpillar could result in severe engine damage to the engine bearings, crankshaft, etc., as a result of the larger waste particles from unfiltered oil entering the engine lubricating system. Only use oil filters recommended by Caterpillar.

1. Remove the oil filter with a 1U-8760 Chain Wrench.

Note: The following actions can be carried out as part of the preventive maintenance program.

2. Cut the oil filter open with a 175-7546 Oil Filter Cutter Gp. Break apart the pleats and inspect the oil filter for metal debris. An excessive amount of metal debris in the oil filter may indicate early wear or a pending failure.

Use a magnet to differentiate between the ferrous metals and the nonferrous metals that are found in the oil filter element. Ferrous metals may indicate wear on the steel and cast iron parts of the engine.

Nonferrous metals may indicate wear on the aluminum parts, brass parts, or bronze parts of the engine. Parts that may be affected include the following items: main bearings, rod bearings, turbocharger bearings and cylinder heads.

Due to normal wear and friction, finding small amounts of debris in the oil filter is not uncommon. Consult your Caterpillar dealer in order to arrange for a further analysis if an excessive amount of debris is found in the oil filter.

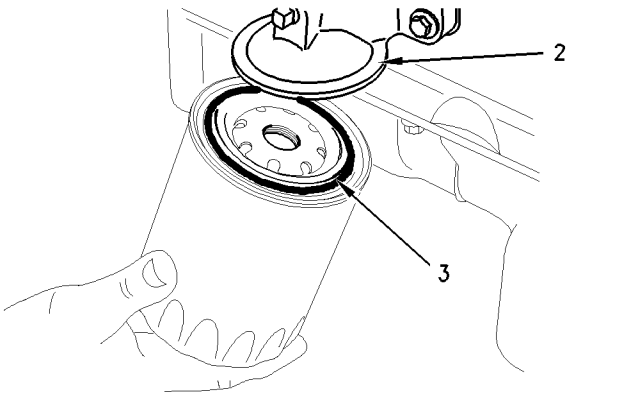

Illustration 49 g01003628
(2) Filter head
(3) O ring seal

3. Clean the sealing surface of the oil filter head (2). Ensure that the union (not shown) in the oil filter head is secure.

4. Apply clean engine oil to the new oil filter seal (3).

NOTICE
Do not fill the oil filters with oil before installing them. This oil would not be filtered and could be contaminated. Contaminated oil can cause accelerated wear to engine components.

5. Install the oil filter. Tighten the oil filter until the oil filter seal contacts the cylinder block or the oil cooler. Tighten the oil filter by hand according to the instructions that are shown on the oil filter. Do not overtighten the oil filter.

Fill the Engine Crankcase

1. Remove the oil filler cap. Refer to this Operation and Maintenance Manual , “Refill Capacities and Recommendations” for more information on lubricant specifications. Fill the crankcase with the correct amount of oil. Refer to this Operation and Maintenance Manual , “Refill Capacities” for more information on refill capacities.

NOTICE
If equipped with an auxiliary oil filter system or a remote oil filter system, follow the OEM or filter manufacturer's recommendations. Under filling or overfilling the crankcase with oil can cause engine damage.

NOTICE
To prevent crankshaft bearing damage, crank the engine with the fuel OFF. This will fill the oil filters before starting the engine. Do not crank the engine for more than 30 seconds.

2. Start the engine and run the engine at “LOW IDLE” for two minutes. Perform this procedure in order to ensure that the lubrication system has oil and that the oil filters are filled. Inspect the oil filter for oil leaks.

3. Stop the engine and allow the oil to drain back to the sump for a minimum of ten minutes.

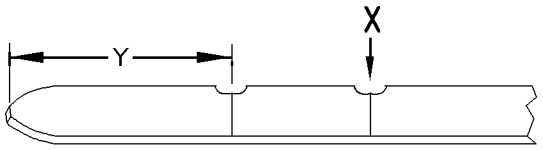

Illustration 50 g00998024

(Y) “ADD” mark. (X) “FULL” mark.

4. Remove the oil level gauge in order to check the oil level. Maintain the oil level between the “ADD” and “FULL” marks on the oil level gauge.

i06621306

Fuel Injector - Replace

SMCS Code: 1290-510

⚠ WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire.

NOTICE
Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over disconnected fuel system component.

NOTICE
If a fuel injector is suspected of operating outside of normal parameters it should be removed by a qualified technician. The suspect fuel injector should be taken to an authorised agent for inspection.

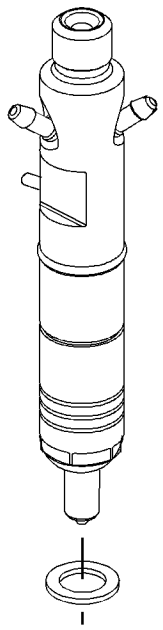

Illustration 51 g01347499

Typical fuel Injector

The fuel injectors should not be cleaned as cleaning with incorrect tools can damage the nozzle. The fuel injectors should be renewed only if a fault with the fuel injectors occurs. Some of the problems that may indicate that new fuel injectors are needed are listed below:

- The engine will not start or the engine is difficult to start.
- Not enough power
- The engine misfires or the engine runs erratically.
- High fuel consumption
- Black exhaust smoke
- The engine knocks or there is vibration in the engine.
- Excessive engine temperature

Refer to the appropriate Disassembly and Assembly manual for the removal and installation procedure.

i05323032

Fuel System - Prime

SMCS Code: 1250-548; 1258-548

⚠ WARNING

Contact with high pressure fuel may cause fluid penetration and burn hazards. High pressure fuel spray may cause a fire hazard. Failure to follow these inspection, maintenance and service instructions may cause personal injury or death.

Refer to Operation and Maintenance Manual , “General Hazard Information and High Pressure Fuel Lines” before adjustments and repairs are performed.

Note: Refer to Systems Operation,Testing and Adjusting, “Cleanliness of Fuel System Components” for detailed information on the standards of cleanliness that must be observed during ALL work on the fuel system.

Ensure that all adjustments and repairs are performed by authorized personnel that have had the correct training.

NOTICE
Do not crank the engine continuously for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking the engine again.

If air enters the fuel system, the air must be purged from the fuel system before the engine can be started. Air can enter the fuel system when the following events occur:

- The fuel tank is empty or the fuel tank has been partially drained.
- The low-pressure fuel lines are disconnected.
- A leak exists in the low-pressure fuel system.
- The fuel filter has been replaced.

Hand Fuel Priming Pump

Use the following procedures in order to remove air from the fuel system:

1. Ensure that the fuel system is in working order. Restore the fuel supply.

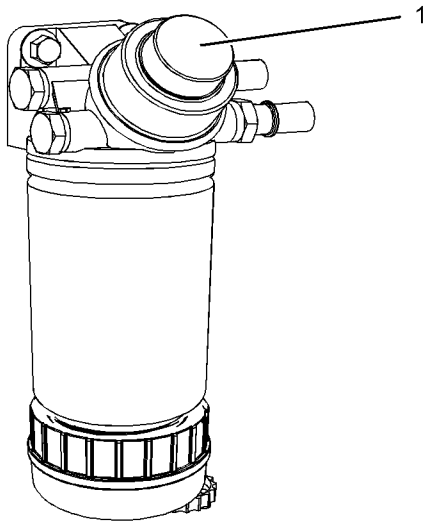

Illustration 52 g01448339
Typical example

2. Operate the fuel priming pump (1). Count the number of operations of the fuel priming pump. After 100 depressions of the fuel priming pump stop.

3. The engine fuel system should now be primed and the engine should now be able to start.

Note: Do not loosen the high-pressure fuel line in order to purge air from the fuel system. This procedure is not required.

4. Operate the engine starter and crank the engine. After the engine has started, operate the engine at low idle for a minimum of 5 minutes, immediately after air has been removed from the fuel system.

Note: Operating the engine for this time will help ensure that the fuel system is free of air.

After the engine has stopped, wait for 10 minutes in order to allow the fuel pressure to be purged from the high-pressure fuel lines before any service or repair is performed on the engine fuel lines. If necessary, perform minor adjustments. Repair any leaks from the low-pressure fuel system and from the cooling, lubrication, or air systems. Replace any high-pressure fuel line that has leaked. Refer to Disassembly and Assembly, “Fuel Injection Lines - Install”.

If you inspect the engine in operation, always use the proper inspection procedure in order to avoid a fluid penetration hazard. Refer to Operation and Maintenance Manual, “General hazard Information”.

Electric Fuel Priming Pump

1. Ensure that the fuel system is in working order. Restore the fuel supply.

NOTICE
The electric fuel priming pump will operate for 90 seconds. If necessary the electric fuel priming pump can be stopped during the 90 seconds of operation, by operation of the switch.

2. Turn the keyswitch to the “RUN” position. Operate the switch for the electric priming pump. After 100 seconds of the electric fuel priming pump operation, the fuel system will be primed and the electric fuel priming pump will turn off.

3. The engine should now be able to start.

Note: Do not loosen the high-pressure fuel line in order to purge air from the fuel system. This procedure is not required.

4. Operate the engine starter and crank the engine. After the engine has started, operate the engine at low idle for a minimum of 5 minutes, immediately after air has been removed from the fuel system.

Note: Operating the engine for this time will help ensure that the fuel system is free of air.

After the engine has stopped, wait for 10 minutes in order to allow the fuel pressure to be purged from the high-pressure fuel lines before any service or repair is performed on the engine fuel lines. If necessary, perform minor adjustments. Repair any leaks from the low-pressure fuel system and from the cooling, lubrication, or air systems. Replace any high-pressure fuel line that has leaked. Refer to Disassembly and Assembly, “Fuel Injection Lines - Install”.

If you inspect the engine in operation, always use the proper inspection procedure in order to avoid a fluid penetration hazard. Refer to Operation and Maintenance Manual, “General hazard Information”.

i05323036

Fuel System Primary Filter (Water Separator) Element - Replace

SMCS Code: 1260-510-FQ; 1263-510-FQ

⚠ WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.

Note: Refer to Testing and Adjusting Manual , “Cleanliness of Fuel System Components” for detailed information on the standards of cleanliness that must be observed during ALL work on the fuel system.

NOTICE
Ensure that the engine is stopped before any servicing or repair is performed.

If your engine is equipped with high-pressure fuel lines you must wait for 10 minutes after the engine has stopped, in order to allow the fuel pressure to be purged from the high-pressure fuel lines before any service or repair is performed on the engine fuel lines. If necessary, perform minor adjustments. Repair any leaks from the low-pressure fuel system and from the cooling, lubrication, or air systems. Replace any high-pressure fuel line that has leaked. Refer to Disassembly and assembly Manual, “Fuel Injection Lines - Install”.

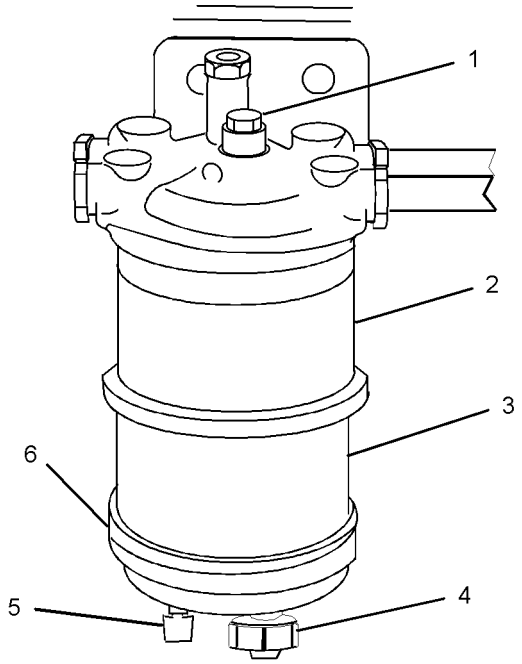

Illustration 53 g01118416

(1) Screw
(2) Element
(3) Glass bowl
(4) Sensor connection
(5) Drain
(6) Bottom cover

1. Turn the fuel supply valve (if equipped) to the OFF position.

2. Place a suitable container under the water separator. Clean the outside of the water separator.

3. Open the drain (5). Allow the fluid to drain into the container.

4. Tighten the drain (5) by hand pressure only.

5. Hold the element (2) and remove the screw (1). Remove the element and the glass bowl (3) from the base. Discard the old element.

6. Clean the glass bowl (4). Clean the bottom cover (6).

7. Install the new O ring seal. Install the bottom cover onto the new element. Install the assembly onto the base.

8. Install the screw (1) and tighten the screw to a torque of 8 N·m (6 lb ft).

9. Remove the container and dispose of the fuel safely.

10. Open the fuel supply valve.

11. Prime the fuel system. Refer to the Operation and Maintenance Manual, “Fuel System - Prime” for more information.

i05323045

Fuel System Primary Filter/ Water Separator - Drain

SMCS Code: 1260-543; 1263-543

⚠ WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.

NOTICE
The water separator is not a filter. The water separator separates water from the fuel. The engine should never be allowed to run with the water separator more than half full. Engine damage may result.

NOTICE
The water separator is under suction during normal engine operation. Ensure that the drain valve is tightened securely to help prevent air from entering the fuel system.

If your engine is equipped with high-pressure fuel lines you must wait for 10 minutes after the engine has stopped, in order to allow the fuel pressure to be purged from the high-pressure fuel lines before any service or repair is performed on the engine fuel lines. If necessary, perform minor adjustments. Repair any leaks from the low-pressure fuel system and from the cooling, lubrication, or air systems. Replace any high-pressure fuel line that has leaked. Refer to Disassembly and assembly Manual, “Fuel Injection Lines - Install”.

i06075409

Fuel System Secondary Filter - Replace

SMCS Code: 1261-510-SE

⚠ WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.

NOTICE
Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over disconnected fuel system component.

If your engine is equipped with high-pressure fuel lines you must wait for 60 seconds after the engine has stopped. Waiting 60 seconds after the engine has stopped allows the fuel pressure to be purged from the high-pressure fuel lines. Allow pressure to purge from the high-pressure fuel lines before any service or repair is performed on the engine fuel lines. If necessary, perform minor adjustments. Repair any leaks from the low-pressure fuel system and from the cooling, lubrication, or air systems. Replace any high-pressure fuel line that has leaked. Refer to Disassembly and assembly Manual, “Fuel Injection Lines - Install”.

Spin-on filter

Turn the valves for the fuel lines (if equipped) to the OFF position before performing this maintenance. Place a tray under the fuel filter in order to catch any fuel that might spill. Clean up any spilled fuel immediately.

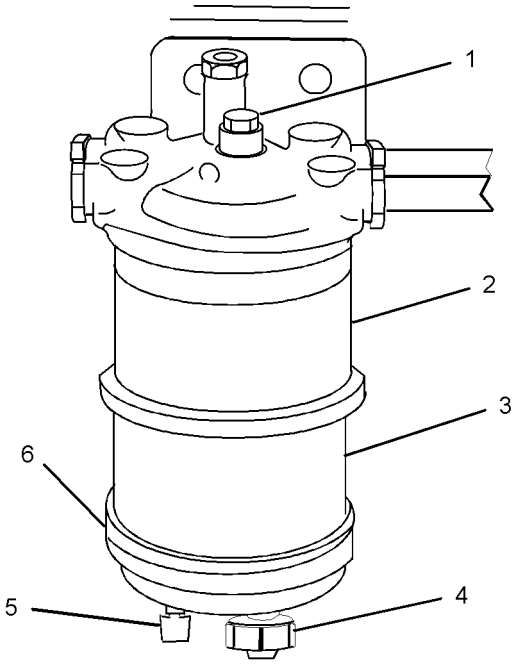

Illustration 54 g01118416

(1) Screw
(2) Element
(3) Glass bowl
(4) Sensor connection
(5) Drain
(6) Bottom cover

1. Place a suitable container below the water separator.

2. Open the drain (5). Allow the fluid to drain into the container.

3. When clean fuel drains from the water separator close the drain (5). Tighten the drain by hand pressure only. Dispose of the drained fluid correctly.

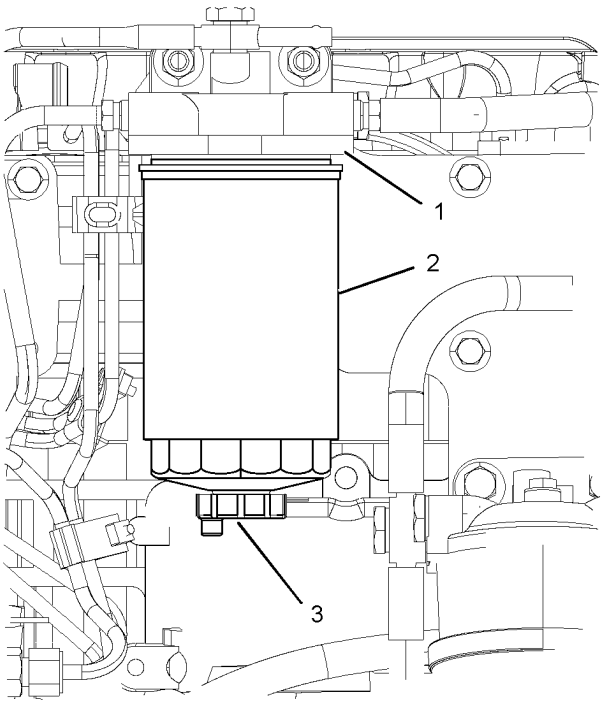

Illustration 55 g01121396

(1) Spin-on filter
(2) Drain

1. Clean the outside of the fuel filter assembly. Open the fuel drain (3) and drain the fuel into a suitable container.

2. Use a suitable tool in order to remove the spin-on filter (2) from the filter head (1).

3. Ensure that the fuel drain (3) on the new spin-on filter is closed.

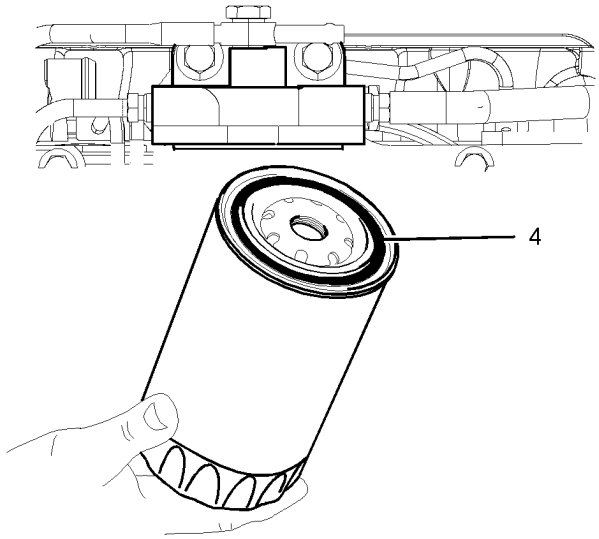

Illustration 56 g01121723

4. Lubricate the sealing ring (4) with clean fuel oil.

5. Install the spin-on filter (2) into the top of the filter head (1).

6. Tighten the spin-on filter by hand until the sealing ring contacts the filter head. Rotate the spin-on filter through 90 degrees.

7. Prime the fuel system. Refer to Operation and Maintenance Manual, “Fuel System - Prime”.

i05260766

Fuel Tank Water and Sediment - Drain

SMCS Code: 1273-543-M&S

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Cat Dealer Service Tool Catalog” or refer to Special Publication, PECJ0003, “Cat Shop Supplies and Tools Catalog” for tools and supplies suitable to collect and contain fluids on Cat products.

Dispose of all fluids according to local regulations and mandates.

Fuel Tank

Fuel quality is critical to the performance and to the service life of the engine. Water in the fuel can cause excessive wear to the fuel system. Condensation occurs during the heating and cooling of fuel. The condensation occurs as the fuel passes through the fuel system and the fuel returns to the fuel tank. This causes water to accumulate in fuel tanks. Draining the fuel tank regularly and obtaining fuel from reliable sources can help to eliminate water in the fuel.

Drain the Water and the Sediment

Fuel tanks should incorporate some provision for draining water and draining sediment from the tank.

Check the fuel daily. Drain the water and sediment from the fuel tank after operating the engine. Drain the water and sediment from the fuel tank after the fuel tank has been filled. Allow 5 to 10 minutes before performing this procedure.

Fill the fuel tank after operating the engine in order to drive out moist air. This will help prevent condensation. Do not fill the tank to the top. The fuel expands as the fuel gets warm. The tank may overflow.

Some fuel tanks use supply pipes that allow water and sediment to settle below the end of the fuel supply pipe. Some fuel tanks use supply lines that take fuel directly from the bottom of the tank. If the engine is equipped with this system, regular maintenance of the fuel system filter is important.

Fuel Storage Tanks

Drain the water and the sediment from the fuel storage tank during the following conditions:

- Weekly
- Oil change
- Refill of the tank

This will help prevent water or sediment from being pumped from the storage tank into the engine fuel tank. A four micron(c) absolute filter for the breather vent on the fuel tank is also recommended.

If a bulk storage tank has been refilled or moved recently, allow adequate time for the sediment to settle before filling the engine fuel tank. Internal baffles in the bulk storage tank will also help trap sediment. Filtering fuel that is pumped from the storage tank helps to ensure the quality of the fuel. When possible, water separators should be used.

i03642821

Generator - Dry

SMCS Code: 4450-569

NOTICE
Do not operate the generator if the windings are wet. If the generator is operated when the windings are wet, damage can occur due to insulation breakdown.

When moisture is present or when moisture is suspected in a generator, the generator must be dried before being energized.

If the drying procedure does not restore the insulation resistance to an acceptable value, the winding should be reconditioned.

Note: For additional information, refer to Special Instruction, SEHS9124 .

Drying Methods

The following methods can be used for drying a generator:

- Self-circulating air method
- Oven method

NOTICE
Do not allow the winding temperature to exceed 85 °C (185.0 °F). Temperatures that are greater than 85 °C (185.0 °F) will damage the winding insulation.

Self-Circulating Air Method

Note: Disable the excitation before using this method.

Run the engine and disconnect the generator load. This will help circulate air. Operate the generator space heaters.

Oven Method

Place the entire generator inside a forced air drying oven for four hours at 65 °C (149 °F).

NOTICE
Use a forced air type oven rather than a radiant type oven.

Radiant type ovens can cause localized overheating.

i06639212

Generator - Inspect

SMCS Code: 4450-040

⚠ WARNING

Personal injury or death can result from improper troubleshooting and repair procedures.

The following troubleshooting and repair procedures should only be performed by qualified personnel familiar with this equipment.

⚠ WARNING

The high voltage that is produced by an operating generator set can cause severe injury or death. Before performing any maintenance or repairs, ensure that the generator will not start.

Place the engine control switch in the "OFF" position. Attach "DO NOT OPERATE" tags to all starting controls. Disconnect the batteries or disable the starting system. Lock out all switchgear and automatic transfer switches that are associated with the generator.

Refer to Safety Section, "Generator Isolating for Maintenance" for information regarding the procedure to isolate the generator safely.

Proper maintenance of electrical equipment requires periodic visual examination of the generator and periodic visual examination of the windings. Proper maintenance of electrical equipment also requires appropriate electrical checks and appropriate thermal checks. Insulation material should be examined for cracks. The insulation material should be examined for accumulations of dirt and dust. If there is an insulation resistance value that is below normal, a conductive path may be present. This conductive path may be made of one of the following materials:

- Carbon
- Salt
- Metal dust
- Dirt that is saturated with moisture

These contaminants will develop a conductive path which may produce shorts. Cleaning is advisable if heavy accumulations of dirt can be seen or if heavy accumulations of dust can be seen. If excess dirt is the cause of a restriction in the ventilation, cleaning is also advisable. Restricted ventilation will cause excessive heating.

NOTICE
To avoid the possibility of deterioration to the generator windings, do not clean the generator unless there is visual, electrical, or thermal evidence that dirt is present.

If harmful dirt accumulations are present, various cleaning techniques are available. The cleaning procedure that is used may be determined by one of the items on the following list:

- The extent of the cleaning procedure that is being attempted
- The type of enclosure of the generator
- The voltage rating of the generator
- The type of dirt that is being removed

Cleaning (Assembled Generators)

NOTICE
Do not use water to clean the generator.

NOTICE
Do not use trichloroethane, perchloroethylene, trichloroethane, or any alkaline products to clean the generator.

Cleaning may be required at the point of installation. Complete disassembly of the generator may not be necessary or feasible. In this case, a vacuum cleaner should be used to pick up the following items: dry dirt, dust, and carbon. Cleaning the generator will prevent the spreading of these contaminants.

A small nonconductive tube may need to be connected to the vacuum cleaner. The small nonconductive tube will allow the vacuum cleaner to clean the surfaces that are not exposed. After dust is removed, use a small brush attached to the vacuum hose to remove dirt that is firmly attached to the surface.

After the initial cleaning with a vacuum, compressed air may be used to remove the remaining dust and dirt. Compressed air that is used for cleaning should be free of moisture and free of oil. Air pressure should be a maximum of 210 kPa (30 psi) to prevent mechanical damage to the insulation. If the above cleaning procedures are not effective, consult a Caterpillar dealer.

Cleaning (Disassembled Generators)

NOTICE
Do not use water to clean the generator.

NOTICE
Do not use trichloroethane, perchloroethylene, trichloroethane, or any alkaline products to clean the generator.

An initial insulation resistance check should be made on the generator to confirm electrical integrity. A minimum reading of 1megohm would be expected with severely contaminated generators. A zero megohm reading may indicate an insulation breakdown. An insulation breakdown requires more than cleaning. An insulation breakdown requires repair.

Use the following for cleaning the stator, the rotor, the exciter, and the diode bridge:

- Unleaded Gasoline
- Toluene
- Benzene
- Cyclohexane

Avoid permitting the solvent to run into the slots. Apply the solvent with a brush. Use a sponge on the windings frequently to remove the debris. Dry the winding with a dry cloth. Allow the solvent to evaporate before reassembling the generator.

Allow the generator to dry at room temperature. Check the insulation resistance. The insulation resistance should now be normal. If the insulation resistance is not normal, repeat the procedure.

Note: For more information on drying methods, refer to Special Instructions, SEHS9124, “Cleaning and Drying of Electric Set Generators”.

i05260763

Generator Bearing Temperature - Test/Record

SMCS Code: 4471-081-TA

The monitoring of bearing temperature may prevent premature bearing failure. A generator set should never operate above the recommended set points. Keep records in order to monitor the changes in the temperature of the bearing.

Note: Measure the bearing temperature after the generator reaches normal operating temperature.

Resistive Temperature Detectors (RTDs)

Caterpillar Generators may be equipped with resistance temperature detectors for generator bearings. These detectors are 100 ohm resistance temperature detectors. A resistance temperature detector may be monitored by the optional monitor for the Electronic Modular Control Panel (EMCP) resistance temperature detector. A resistance temperature detector may be monitored by equipment that is provided by the customer. Consult with your Caterpillar dealer about other methods of measuring the bearing temperature.

The EMCP may be configured to “ALARM” or the EMCP may be configured to “SHUTDOWN” . An alarm is activated if the temperature of the bearing reaches 85 °C (185 °F). A shutdown occurs if the temperature of the bearing reaches 95 °C (203 °F).

Infrared Thermometers

Bearing temperatures can also be recorded with the use of an infrared thermometer. Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tools Catalog” for various infrared thermometers. Follow the instructions that come with your infrared thermometer.

i01878834

Generator Load - Check

SMCS Code: 4450-535-LA

⚠ WARNING

Personal injury or death can result from high voltage.

When power generation equipment must be in operation to make tests and/or adjustments, high voltage and current are present.

Improper test equipment can fail and present a high voltage shock hazard to its user.

Make sure the testing equipment is designed for and correctly operated for high voltage and current tests being made.

During normal operation, monitor the power factor and monitor generator loading.

When a three-phase generator is installed or when a three-phase generator is reconnected, ensure that the total current in any one phase does not exceed the nameplate rating. Each phase should carry the same load. This allows the three-phase generator to work at the rated capacity. If one phase current exceeds the nameplate amperage, an electrical imbalance will occur. An electrical imbalance can result in an electrical overload and an electrical imbalance can result in overheating on three-phase generators. This is not applicable to single-phase generators.

The power factor can be referred to as the efficiency of the load. This can be expressed as the ratio of kVA to actual kW. The power factor can be calculated by dividing kW by kVA. Power factor is expressed as a decimal. Power factor is used to mean the portion of current that is supplied to a system that is doing useful work. The portion of the current that is not doing useful work is absorbed in maintaining the magnetic field in motors. This current (reactive load) can be maintained without engine power.

i05731121

Generator Set - Test

SMCS Code: 4450-081

⚠ WARNING

Personal injury or death can result from high voltage.

When power generation equipment must be in operation to make tests and/or adjustments, high voltage and current are present.

Improper test equipment can fail and present a high voltage shock hazard to its user.

Make sure the testing equipment is designed for and correctly operated for high voltage and current tests being made.

When servicing or repairing electric power generation equipment:

- **Make sure the unit is off-line (disconnected from utility and/or other generators power service), and either locked out or tagged DO NOT OPERATE.**
- **Make sure the generator engine is stopped.**
- **Make sure all batteries are disconnected.**
- **Make sure all capacitors are discharged.**

Table 17

Required Tools		
Part Number	**Part Description**	**Qty**
6V-7070	Digital Multimeter	1
-	12 VDC Battery	1
-	Potential Transformer	1

The generator set functional test is a simplified test that can be performed in order to determine if the generator is functional. The generator set functional test should be performed on a generator set that is under load.

The generator set functional test determines if the following statements happen:

- A phase voltage is being generated.
- The phase voltages are balanced.
- The phase voltages change relative to engine speed.

The generator set functional test consists of the following steps:

1. Stop the generator. Connect the potential transformer high voltage winding to the generator terminals (T1) and (T2). Connect the voltmeter to the low voltage winding. If two transformers are available, connect the high voltage winding of the second transformer to the generator terminals (T1) and (T3). Connect the secondary terminals that correspond to generator terminal (T2) of both transformers together.
2. Disconnect wires “E+” and “E-” from the voltage regulator. Disconnect the generator from the load.
3. Connect a 12 VDC automotive battery to wires “E +” and “E-” .
4. Measure the AC voltage across the low voltage terminals of the transformer that correspond to the following generator terminals: “T1” and “T2” , “T2” and “T3” and “T3” and “T1” . Record the voltages.

i07376415

Generator Set Alignment - Check

SMCS Code: 7002-024

Upon installation, or when moved, the generator set must be checked for proper alignment. If the generator set is run at the full continuous rating, the alignment of the generator to the engine must be checked annually.

Properly maintain the alignment between the engine and the driven equipment to minimize the following problems:

- Bearing problems
- Vibration of the engine crankshaft
- Vibration of the driven equipment

Refer to the following information for more information about the alignment of the generator set:

- Special Instruction, SEHS7654, “Alignment - General Instructions”
- Special Instruction, SEHS7259, “Alignment of Single Bearing Generators”
- Special Instruction, REHS0177, “Alignment of the Close Coupled Two Bearing Generators”

Keep a record of the measurement of the alignment. The record may be used to check the trend of the alignment. The record may be used to analyze the trend of the alignment.

i07459639

Generator Set Vibration - Test/ Record

SMCS Code: 4450-081-VI

NOTICE
Generator tests are to be performed by a trained Generator technician.

Check for vibration damage.

Vibration may cause the following problems:

- Coupling wear
- Loose fittings
- Fatigue of the metal components of the engine
- Cracks in the cabinet which surrounds the generator
- Cracks in welds
- Excessive noise
- Cracked insulation

The following areas are susceptible to vibration damage:

- Coupling for the generator set
- Generator bearings
- Stator output leads
- Protective sleeving
- Insulation
- Exposed electrical connections
- Transformers
- Fuses
- Capacitors
- Lightning arresters

When a generator set is installed, a vibration plot should be recorded to help in diagnosing potential problems. This vibration plot should be updated yearly. Update the vibration plot when the generator set is moved and when the engine is overhauled. This procedure will allow the trend of the vibration to be monitored and analyzed. A potential problem may be prevented by monitoring the trend of the vibration. If the vibration is approaching the limit of the specification of the component, the problem may be more imminent. Refer to Data Sheet, LEKQ4023, “Linear Vibration” for the allowable limits of vibration.

Caterpillar also recommends recording the vibration of the bearing at the generator bearing bracket.

If the vibration exceeds the EDS limits for vibration, check the alignment. Refer to this Operation and Maintenance Manual, “Generator Set Alignment - Check” for the alignment procedure.

Contact the Cat Dealer Service Tools group for information on ordering a vibration analyzer that will meet your needs.

i04863034

Generator Winding Insulation - Test

SMCS Code: 4453-081; 4454-081; 4457-081; 4470-081

⚠ WARNING

The high voltage that is produced by an operating generator set can cause severe injury or death. Before performing any maintenance or repairs, ensure that the generator will not start.

Place the engine control switch in the “OFF” position. Attach “DO NOT OPERATE” tags to all starting controls. Disconnect the batteries or disable the starting system. Lock out all switchgear and automatic transfer switches that are associated with the generator.

Table 18

TOOLS NEEDED		
Part Number	**Tool**	**Quantity**
142-5055	Insulation Tester Megohmmeter	1

⚠ WARNING

Personal injury or death can result from electrocution.

The megohmmeter is applying a high voltage to the circuit.

To avoid electrocution, do not touch the instrument leads without first discharging them. When finished testing also discharge the generator windings.

The following materials will cause the winding insulation to deteriorate:moisture, dust, grease and other foreign matter within the generator.

This deterioration reduces the resistance of the insulation. This test will measure the resistance of the winding insulation.

The insulation tester (megohmmeter) produces a high potential voltage between the test leads. During the test, a small amount of current flows. The tester converts this current to a resistance reading.

The insulation test is performed as part of periodic maintenance in order to detect the deterioration of the winding insulation. When there is a rapid decrease in the insulation resistance in a short amount of time, the generator needs to be cleaned.

Note: For information on generator cleaning, refer to Special Instruction, SEHS9124.

When generators have not been used recently, moisture can accumulate. Therefore, the insulation test should be performed on generators that have been idle. If moisture is known to exist, the windings must be dried prior to testing. Refer to Testing and Adjusting, “Generator - Dry”.

The insulation test should be performed on generators that are being used for the first time. The insulation test should be performed more frequently in the following cases:

- The generator set is operating in a humid environment.
- The generator set is not protected from the elements in an enclosed area.
- The generator set has not been run under load for 3 months.

Note: The use of space heaters may be needed around the generator set in the following cases:

- The generator set has not been run under load for 3 months.
- The generator set is exposed to a sea water environment.
- The humidity is above 75 percent.
- A test result was below 3 megohms.

Recondition or replace the winding in the following cases:

- The measured insulation resistance falls below the specified amount. The cleanup procedure does not correct the discrepancy.
- The measured insulation resistance falls below the specified amount. The drying procedure does not correct the discrepancy.

The specified insulation resistance is an approximate value. The generator may be operated with less than the specified value. However, a generator that has a low winding insulation resistance will be more likely to have a failure.

⚠ WARNING

Personal injury or death can result from improper troubleshooting and repair procedures.

The following troubleshooting and repair procedures should only be performed by qualified personnel familiar with this equipment.

The insulation test gives accurate results only when the generator windings are free of moisture and the generator windings are at room temperature.

Each winding must have a minimum insulation resistance of 1 megohm.

Main Armature (Stator L4)

1. Remove the load from the generator by either of the following:

- Open the line circuit breaker.
- Open the following load connections: T1, T2, T3 and T0.

Prevent these wires from coming into contact with each other and prevent these wires from contacting ground.

2. Isolate the main armature (L4) from the voltage regulator by disconnecting the wires for voltage sensing. If generator lead (T0) is connected to the generator frame or ground, open the connection.

3. Connect one test lead of the insulation tester (megohmmeter) to the generator enclosure (ground).

4. Connect the other test lead of the insulation tester (megohmmeter) to generator lead (T0).

5. The insulation resistance must be 1 megohm or more.

Exciter Field (Stator L1)

1. Isolate exciter field (L1) from the voltage regulator by disconnecting wires 5+ and 6-. Prevent these wires from coming into contact with each other and prevent these wires from contacting ground.

2. Connect one test lead of the insulation tester (megohmmeter) to the generator enclosure (ground).

3. Connect one test lead of the insulation tester (megohmmeter) to exciter field lead (5+ or 6-).

4. Measure the resistance of the exciter field winding insulation to ground. The insulation resistance must be a minimum of 0.25 megohm (250000 ohms).

Exciter Armature (Rotor L2)

1. Isolate exciter armature (L2) from the rectifier circuit. Disconnect the three wires of the exciter armature from the rectifier blocks.

2. Connect one test lead of the insulation tester (megohmmeter) to the rotor shaft.

3. Connect one test lead of the insulation tester (megohmmeter) to any one exciter field lead.

4. The insulation resistance must be a minimum of 0.25 megohm (250000 ohms).

i06825542

Hoses and Clamps - Inspect/ Replace

SMCS Code: 7554-510; 7554-040

Hoses and clamps must be inspected periodically and replaced at the recommended interval to ensure safe and continuous operation of the engine. Failure to replace a fuel hose at the recommended change interval may result in a hazardous situation. Take proper safety precautions before inspecting or replacing hoses and clamps.

Note: Always use a board or cardboard when the engine components are checked for leaks. Leaking fluid that is under pressure can cause serious injury or possible death. Leaks that are the size of a pin hole are included. Refer to Operation and Maintenance Manual, “General Hazard Information” for more information.

Note: Ensure that the hose is compatible with the application.

Inspect Tubes, Hoses, Bellows, and Clamps

Inspect all tubes and hoses for leaks that are caused by the following conditions. Replace any tube or hose which exhibits any of the following conditions. Failure to replace a tube or hose which exhibits any of the following conditions may result in a hazardous situation.

- Hoses which are cracked
- Hoses which are soft
- Outer covering that is chafed or cut

- Exposed wire that is used for reinforcement
- Outer covering that is ballooning locally
- Flexible part of the hose that is kinked or crushed
- Armoring that is embedded in the outer covering
- Exhaust bellows for leaks or damage
- Hoses which exhibit signs of leakage which are not the result of loose couplings or clamps

Inspect all clamps for the following conditions. Replace any clamp which exhibits signs of any of the following conditions.

- Cracking
- Looseness
- Damage

Inspect all couplings for leaks. Replace any coupling which exhibits signs of leaks.

Each installation application can be different. The differences depend on the following factors:

- Type of hose
- Type of fitting material
- Anticipated expansion and contraction of the hose
- Anticipated expansion and contraction of the fittings

Due to extreme temperature changes, the hose will heat set. Heat setting causes hose clamps to loosen which can result in leaks. A constant torque hose clamp will help to prevent loose hose clamps.

Replace hoses that are cracked or soft. Replace hoses that show signs of leakage. Replace hoses that show signs of damage. Replace hose clamps that are cracked or damaged. Tighten or replace hose clamps which are loose.

Replace the Hoses and the Clamps

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Cat Dealer Service Tool Catalog” or refer to Special Publication, PECJ0003, “Cat Shop Supplies and Tools Catalog” for tools and supplies suitable to collect and contain fluids on Cat products.

Dispose of all fluids according to local regulations and mandates.

Cooling System

⚠ WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

⚠ WARNING

Personal injury can result from removing hoses or fittings in a pressure system.

Failure to relieve pressure can cause personal injury.

Do not disconnect or remove hoses or fittings until all pressure in the system has been relieved.

1. Stop the engine.
2. Allow the engine to cool.
3. Before servicing a coolant hose, slowly loosen the filler cap for the cooling system to relieve any pressure.
4. Remove the filler cap for the cooling system.

5. Drain the coolant from the cooling system to a level that is below the hose that is being replaced. Drain the coolant into a suitable clean container. The coolant can be reused.

6. Remove the hose clamps.

7. Disconnect the old hose.

8. Replace the old hose with a new hose.

9. Install hose clamps which have been inspected or install new hose clamps. Refer to Specifications, SENR3130, “Torque Specifications” “Hose Clamps” for information about selecting and installing the proper hose clamps.

10. Refill the cooling system.

11. Clean the coolant filler cap. Inspect the gaskets on the filler cap. Inspect the gasket seat. Inspect the vacuum valve and seat for debris or damage. Replace the filler cap if the gaskets are damaged. Install the filler cap.

12. Start the engine. Inspect the cooling system for leaks.

Fuel System

⚠ WARNING

Personal injury can result from removing hoses or fittings in a pressure system.

Failure to relieve pressure can cause personal injury.

Do not disconnect or remove hoses or fittings until all pressure in the system has been relieved.

⚠ WARNING

Contact with high pressure fuel may cause fluid penetration and burn hazards. High pressure fuel spray may cause a fire hazard. Failure to follow these inspection, maintenance and service instructions may cause personal injury or death.

NOTICE
Do not bend or strike high pressure lines. Do not install bent or damaged lines, tubes or hoses. Repair any loose or damaged fuel and oil lines, tubes and hoses. Leaks can cause fires. Inspect all lines, tubes and hoses carefully. Tighten all connections to the recommended torque.

NOTICE
Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over any disconnected fuel system components.

Note: High-pressure fuel lines may be installed between the high-pressure fuel pump and the fuel injectors. High-pressure fuel lines are constantly charged with high pressure. Do not check the high-pressure fuel lines with the engine or the starting motor in operation. Wait for 10 minutes after the engine stops before you perform any service or repair on high-pressure fuel lines. Waiting for 10 minutes will allow the pressure to be purged.

1. Drain the fuel from the fuel system to a level that is below the hose that is being replaced.

2. Remove the hose clamps.

3. Disconnect the old hose.

Note: When servicing fuel system, use cap/s or cover/s as required to protect the system and maintain fuel system cleanliness.

4. Replace the old hose with a new hose.

5. Install hose clamps which have been inspected or install new hose clamps. Refer to Specifications, SENR3130, “Torque Specifications” “Hose Clamps” for information about selecting and installing the proper hose clamps.

6. Carefully inspect the engine for any spilled fuel. Make sure that no fuel remains on or close to the engine.

Note: Fuel must be added to the fuel system ahead of the fuel filter.

7. Refill the fuel system. Refer to this Operation and Maintenance Manual, “Fuel System - Prime” for information about priming the engine with fuel.

8. Start the engine. Inspect the fuel system for leaks.

Lubrication System

⚠ WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

1. Drain the oil from the lubrication system to a level that is below the hose that is being replaced.

2. Remove the hose clamps.

3. Disconnect the old hose.

4. Replace the old hose with a new hose.

5. Install hose clamps which have been inspected or install new hose clamps. Refer to Specifications, SENR3130, “Torque Specifications” “Hose Clamps” for information about selecting and installing the proper hose clamps.

6. Refill the lubrication system. Refer to this Operation and Maintenance Manual, “Engine Oil Level - Check” to ensure that the lubrication system is filled with the proper amount of engine oil.

7. Start the engine. Inspect the lubrication system for leaks.

Air System

1. Remove the hose clamps.

2. Disconnect the old hose.

3. Replace the old hose with a new hose.

4. Install hose clamps which have been inspected or install new hose clamps. Refer to Specifications, SENR3130, “Torque Specifications” “Hose Clamps” for information about selecting and installing the proper hose clamps.

Note: The bellows and the V-clamps that are used on the exhaust bellows should never be reused.

5. Start the engine. Inspect the air lines for leaks.

i02299454

Overhaul Considerations

SMCS Code: 7595-043

Reduced hours of operation at full load will result in a lower average power demand. A decreased average power demand should increase both the engine service life and the overhaul interval.

The need for an overhaul is generally indicated by increased fuel consumption and by reduced power.

The following factors are important when a decision is being made on the proper time for an engine overhaul:

- The need for preventive maintenance
- The quality of the fuel that is being used
- The operating conditions
- The results of the S·O·S analysis

Oil Consumption as an Overhaul Indicator

Oil consumption, fuel consumption, and maintenance information can be used to estimate the total operating cost for your Caterpillar engine. Oil consumption can also be used to estimate the required capacity of a makeup oil tank that is suitable for the maintenance intervals.

Oil consumption is in proportion to the percentage of the rated engine load. As the percentage of the engine load is increased, the amount of oil that is consumed per hour also increases.

The oil consumption rate (brake specific oil consumption) is measured in grams per kW/h (lb per bhp). The brake specific oil consumption (BSOC) depends on the engine load. Consult your Caterpillar dealer for assistance in determining the typical oil consumption rate for your engine.

When an engine's oil consumption has risen to three times the original oil consumption rate due to normal wear, an engine overhaul should be scheduled. There may be a corresponding increase in blowby and a slight increase in fuel consumption.

Overhaul Options

Before Failure Overhaul

A planned overhaul before failure may be the best value for the following reasons:

- Costly unplanned downtime can be avoided.
- Many original parts can be reused according to the standards for reusable parts.
- The engine's service life can be extended without the risk of a major catastrophe due to engine failure.
- The best cost/value relationship per hour of extended life can be attained.

After Failure Overhaul

Many options are available if a major engine failure occurs. An overhaul should be performed if the engine block or the crankshaft can be repaired.

If the engine block is repairable and/or the crankshaft is repairable, the overhaul cost should be less than the cost of a new engine with a similar exchange core.

This lower cost can be attributed to these aspects:

- Caterpillar dealer exchange components

- Caterpillar Inc. remanufactured exchange components

Overhaul Recommendation

To minimize downtime, Caterpillar Inc. recommends a scheduled engine overhaul by your Caterpillar dealer before the engine fails. This will provide you with the best cost/value relationship.

Note: Overhaul programs vary according to the engine application and according to the dealer that performs the overhaul. Consult your Caterpillar dealer for specific information about the available overhaul programs and about overhaul services for extending the engine life.

If an overhaul is performed without overhaul service from your Caterpillar dealer, be aware of the following maintenance recommendations.

Rebuild or Exchange

These components should be inspected according to the instructions that are found in various Caterpillar reusability publications. The Special Publication, SEBF8029 lists the reusability publications that are needed for inspecting the engine parts.

If the parts comply with the established inspection specifications that are expressed in the reusable parts guideline, the parts should be reused.

Parts that are not within the established inspection specifications should be dealt with in one of the following manners:

- Salvaging
- Repairing
- Replacing

Using out-of-spec parts can result in the following problems:

- Unscheduled downtime
- Costly repairs
- Damage to other engine parts
- Reduced engine efficiency
- Increased fuel consumption

Reduced engine efficiency and increased fuel consumption translates into higher operating costs. Therefore, Caterpillar Inc. recommends repairing out-of-spec parts or replacing out-of-spec parts.

Inspection and/or Replacement

The following components may not last until the second overhaul.

- Piston rings
- Thrust bearings
- Main bearings
- Connecting rod bearings
- Crankshaft seals
- Engine mounts
- Hoses

Caterpillar Inc. recommends the installation of new parts at each overhaul period.

Inspect these parts while the engine is disassembled for an overhaul.

Inspect the crankshaft for any of the following conditions:

- Deflection
- Damage to the journals
- Bearing material that has seized to the journals

Check the journal taper and the profile of the crankshaft journals. Check these components by interpreting the wear patterns on the following components:

- Rod bearing
- Main bearings

Note: If the crankshaft is removed for any reason, use the magnetic particle inspection process to check for cracks in the crankshaft.

Inspect the camshaft for damage to the journals and to the lobes.

Note: If the camshaft is removed for any reason, use the magnetic particle inspection process to check for cracks in the camshaft.

Inspect the following components for signs of wear or for signs of scuffing:

- Camshaft bearings
- Valve lifters

Testing

Test the following components during the overhaul.

- Fuel injection nozzles
- Fuel injection pump

Testing the fuel system during the overhaul will ensure that your engine operates at peak efficiency. Your Caterpillar dealer can provide these services and components in order to ensure that your fuel system is operating within the appropriate specifications.

Cleaning

Caterpillar Inc. recommends the use of Hydrosolv Liquid Cleaners. Table 19 lists the Hydrosolv Liquid Cleaners that are available from your Caterpillar dealer.

Table 19

HydrosolvLiquid Cleaners		
Part Number	**Description**	**Size**
1U-8812	Hydrosolv4165	4 L (1 US gallon)
1U-5490		19 L (5 US gallon)
8T-7570		208 L (55 US gallon)
1U-8804	Hydrosolv100	4 L (1 US gallon)
1U-5492		19 L (5 US gallon)
8T-5571		208 L (55 US gallon)

Obtain Coolant Analysis

The concentration of supplemental coolant additive (SCA) should be checked regularly with test kits or with S·O·S Coolant Analysis (Level I). Further coolant analysis is recommended when the engine is overhauled.

For example, considerable deposits are found in the water jacket areas on the external cooling system, but the concentrations of coolant additives were carefully maintained. The coolant water probably contained minerals that were deposited on the engine over time.

A coolant analysis can be conducted in order to verify the condition of the water that is being used in the cooling system. A full water analysis can be obtained by consulting your local water utility company or an agricultural agent. Private laboratories are also available for water analysis.

Caterpillar Inc. recommends an S·O·S Coolant Analysis (Level II).

S·O·S Coolant Analysis (Level II)

An S·O·S Coolant Analysis (Level II) is a comprehensive coolant analysis which completely analyzes the coolant and the effects on the cooling system. An S·O·S Coolant Analysis (Level II) provides the following information:

- Complete S·O·S Coolant Analysis (Level I)
- Visual inspection of properties
- Identification of metal corrosion
- Identification of contaminants
- Identification of built up impurities (corrosion and scale)

S·O·S Coolant Analysis (Level II) provides a report of the results of both the analysis and the maintenance recommendations.

For more information about coolant analysis, see your Caterpillar dealer.

i01880286

Rotating Rectifier - Check

SMCS Code: 4465-535

⚠ WARNING

The high voltage that is produced by an operating generator set can cause severe injury or death. Before performing any maintenance or repairs, ensure that the generator will not start.

Place the engine control switch in the “OFF” position. Attach “DO NOT OPERATE” tags to all starting controls. Disconnect the batteries or disable the starting system. Lock out all switchgear and automatic transfer switches that are associated with the generator.

Check the exciter armature. Ensure that the rotating rectifier is tight. If a failure of a rectifier is suspected, refer to Maintenance Procedure, “Rotating Rectifier - Test”.

i05072489

Rotating Rectifier - Check

SMCS Code: 4465-535

Check the exciter armature. Ensure that the rotating rectifier is tight. If a failure of a rectifier is suspected, proceed to the “Testing a Three-Diode Rectifier Block” section.

Testing a Three-Diode Rectifier Block

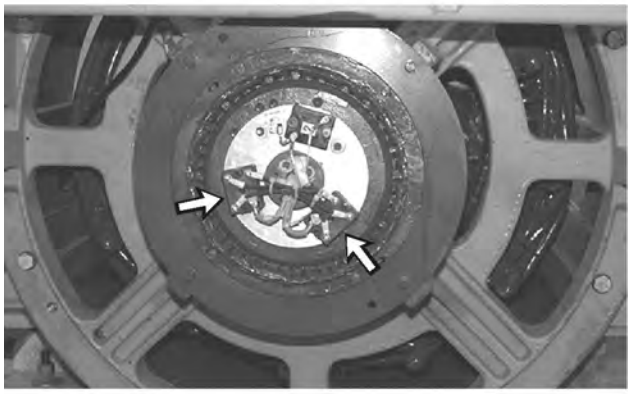

Illustration 57 g00610240

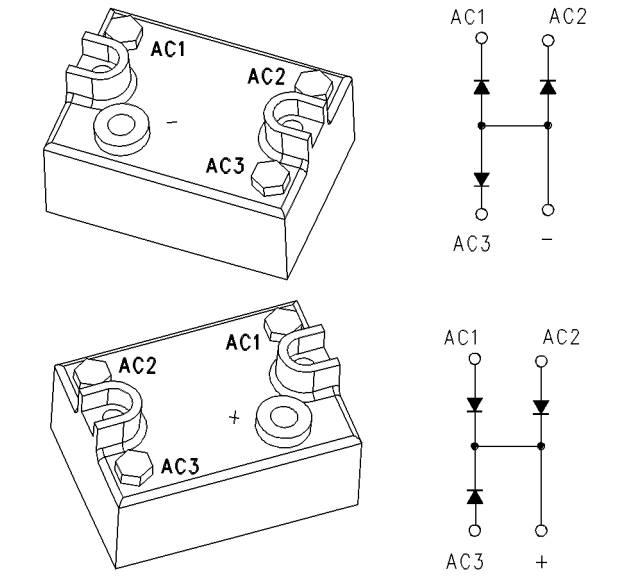

Illustration 58 g00613971

Three-Diode Rectifier Block (two pieces)

The following procedure tests all three diodes within a block. Check the positive rectifier block and the negative rectifier block. If any meter reading does not fall within the given ranges, replace the rectifier block.

1. Set the digital multimeter on the diode range. Remove all leads from the rectifier block.

2. To test the negative rectifier block, follow these steps:

a. Place the red test lead on the negative “-” terminal. Place the black test lead on the following rectifier terminals: “AC1” (3), “AC2” (4) and “AC3” (5). All readings on the meter should be between 0.4 and 1.0.

b. Place the black test lead on the negative “-” terminal. Place the red test lead on the following rectifier terminals: “AC1” (3), “AC2” (4) and “AC3” (5). In all cases, the meter should read “OL” (overload).

3. To test the positive rectifier block, follow these steps:

a. Place the red test lead on the positive “+” rectifier terminal. Place the black test lead on the following rectifier terminals: “AC1” (3), “AC2” (4) and “AC3” (5). In all cases, the meter should read “OL” (overload).

b. Place the black test lead on the positive “+” rectifier terminal. Place the red test lead on the following rectifier terminals: “AC1” (3), “AC2” (4) and “AC3” (5). All readings on the meter should be between 0.4 and 1.0.

Note: A shorted diode can damage the exciter rotor. If a diode is shorted, check the exciter rotor. Refer to the Testing and Adjusting, “Winding - Test” and Testing and Adjusting, “Insulation - Test”. Perform these tests.

Note: This rectifier block also contains varistor “CR7” . “CR7” can be checked by measuring the resistance between the positive “+” rectifier terminal and the negative “-” rectifier terminal. The resistance should be a minimum of 15000 ohms.

i04327496

Rotating Rectifier - Inspect/ Test

SMCS Code: 4465-081; 4465-040

⚠ WARNING

The high voltage that is produced by an operating generator set can cause severe injury or death. Before performing any maintenance or repairs, ensure that the generator will not start.

Place the engine control switch in the “OFF” position. Attach “DO NOT OPERATE” tags to all starting controls. Disconnect the batteries or disable the starting system. Lock out all switchgear and automatic transfer switches that are associated with the generator.

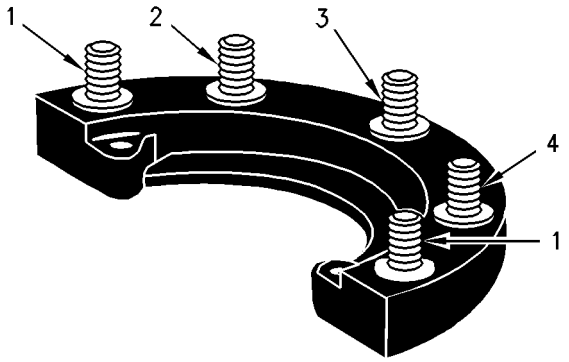

Illustration 59 g00992269

(1) Positive DC terminal or Negative DC terminal
(2) AC terminal
(3) AC terminal
(4) AC terminal

The following procedure tests all three diodes within a block. Check the positive rectifier block and the negative rectifier block. If any meter reading does not fall within the given ranges, replace the rectifier block.

1. Set the digital multimeter on the diode range. Remove all leads from the rectifier block.

2. To test the negative rectifier block, follow these steps:

a. Place the red test lead on the negative “-” terminal (1). Place the black test lead on the following rectifier terminals: AC terminal (2), AC terminal (3) and AC terminal (4). All readings on the meter should be between 0.4 and 1.0.

b. Place the black test lead on the negative “-” terminal (1). Place the red test lead on the following rectifier terminals: AC terminal (2), AC terminal (3) and AC terminal (4). In all cases, the meter should read “OL” (overload).

3. To test the positive rectifier block, follow these steps:

a. Place the red test lead on the positive “+” rectifier terminal (1). Place the black test lead on the following rectifier terminals: AC terminal (2), AC terminal (3) and AC terminal (4). In all cases, the meter should read “OL” (overload).

b. Place the black test lead on the positive “+” rectifier terminal (1). Place the red test lead on the following rectifier terminals: AC terminal (2), AC terminal (3) and AC terminal (4). All readings on the meter should be between 0.4 and 1.0.

Note: A shorted diode can damage the exciter rotor. If a diode is shorted, check the exciter rotor. Refer to the Testing and Adjusting, “Winding - Test” and Testing and Adjusting, “Insulation - Test”. Perform these tests.

i00651416

Starting Motor - Inspect

SMCS Code: 1451-040; 1453-040

Caterpillar Inc. recommends a scheduled inspection of the starting motor. If the starting motor fails, the engine may not start in an emergency situation.

Check the starting motor for proper operation. Check the electrical connections and clean the electrical connections. Refer to the Service Manual for more information on the checking procedure and for specifications or consult your Caterpillar dealer for assistance.

i00632301

Walk-Around Inspection

SMCS Code: 1000-040

Inspect the Engine for Leaks and for Loose Connections

A walk-around inspection should only take a few minutes. When the time is taken to perform these checks, costly repairs and accidents can be avoided.

For maximum engine service life, make a thorough inspection of the engine compartment before starting the engine. Look for items such as oil leaks or coolant leaks, loose bolts, worn belts, loose connections and trash buildup. Make repairs, as needed:

- The guards must be in the proper place. Repair damaged guards or replace missing guards.
- Wipe all caps and plugs before the engine is serviced in order to reduce the chance of system contamination.

NOTICE
For any type of leak (coolant, lube, or fuel) clean up the fluid. If leaking is observed, find the source and correct the leak. If leaking is suspected, check the fluid levels more often than recommended until the leak is found or fixed, or until the suspicion of a leak is proved to be unwarranted.

NOTICE
Accumulated grease and/or oil on an engine or deck is a fire hazard. Remove this debris with steam cleaning or high pressure water.

- Ensure that cooling lines are properly clamped and tight. Check for leaks. Check the condition of all pipes.
- Inspect the water pump for coolant leaks.

Note: The water pump seal is lubricated by coolant in the cooling system. It is normal for a small amount of leakage to occur as the engine cools down and the parts contract.

Excessive coolant leakage may indicate the need to replace the water pump seal. For the removal of water pump and the installation of water pump and/or seals, refer to the Service Manual for the engine or consult your Caterpillar dealer.

- Inspect the lubrication system for leaks at the front crankshaft seal, the rear crankshaft seal, the oil pan, the oil filters and the valve cover.
- Inspect the fuel system for leaks. Look for loose fuel line clamps.
- Inspect the piping for the air inlet system and the elbows for cracks and for loose clamps.
- Inspect the alternator belt and the accessory drive belts for cracks, breaks or other damage.

Belts for multiple groove pulleys must be replaced as matched sets. If only one belt is replaced, the belt will carry more load than the belts that are not replaced. The older belts are stretched. The additional load on the new belt could cause the belt to break.

- Drain the water and the sediment from fuel tanks on a daily basis in order to ensure that only clean fuel enters the fuel system.
- Inspect the wiring and the wiring harnesses for loose connections and for worn wires or frayed wires.
- Inspect the ground strap for a good connection and for good condition.
- Inspect the engine-to-frame ground strap for a good connection and for good condition.
- Disconnect any battery chargers that are not protected against the current drain of the starting motor. Check the condition and the electrolyte level of the batteries, unless the engine is equipped with a maintenance free battery.
- Check the condition of the gauges. Replace any gauges which are cracked or can not be calibrated.

i02226958

Water Pump - Inspect

SMCS Code: 1361-040

A failed water pump may cause severe engine overheating problems that could result in the following conditions:

- Cracks in the cylinder head
- A piston seizure
- Other potential damage to the engine

Note: The water pump seal is lubricated by the coolant in the cooling system. It is normal for a small amount of leakage to occur as the engine cools down and parts contract.

Visually inspect the water pump for leaks. Renew the water pump seal or the water pump if there is an excessive leakage of coolant. Refer to the Disassembly and Assembly Manual, “Water Pump - Remove and Install” for the disassembly and assembly procedure.

Reference Information Section

Customer Service

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Customer Assistance

SMCS Code: 1000; 4450

USA and Canada

If a problem arises concerning the operation or service of an engine, the problem will be managed by the dealer in your area.

Your satisfaction is a primary concern to Caterpillar and to Cat dealers. If you have a problem that has not been handled to your complete satisfaction, follow these steps:

1. Discuss your problem with a manager from the dealership.

2. If your problem cannot be resolved at the dealer without additional assistance, use the phone number below to talk with a Field Service Coordinator:

1-800-447-4986

The normal hours are from 8:00 to 4:30 Monday through Friday Central Standard Time.

3. If your needs have not been met still, submit the matter in writing to the following address:

Caterpillar Inc.
Electric Power North America
Attn: Product Support Manager
AC 6109
Mossville, Illinois 61552

Keep in mind: probably, your problem will ultimately be solved at the dealership, using the dealership facilities, equipment, and personnel. Therefore, follow the steps in sequence when a problem is experienced.

Outside of USA and of Canada

If a problem arises outside of USA and outside Canada, and if the problem cannot be resolved at the dealer level, consult the appropriate Caterpillar office.

Latin America, Mexico, Carribean
Caterpillar Americas Co.
701 Waterford Way, Suite 200
Miami, FL 33126-4670
USA
Phone: 305-476-6800
Fax: 305-476-6801

Europe, Africa, and Middle East
Caterpillar Overseas S.A.
76 Route de Frontenex
P.O. Box 6000
CH-1211 Geneva 6
Switzerland
Phone: 22-849-4444
Fax: 22-849-4544

Far East
Caterpillar Asia Pte. Ltd.
7 Tractor Road
Jurong, Singapore 627968
Republic of Singapore
Phone: 65-662-8333
Fax: 65-662-8302

China
Caterpillar China Ltd.
37/F., The Lee Gardens
33 Hysan Avenue
Causeway Bay
G.P.O. Box 3069
Hong Kong
Phone: 852-2848-0333
Fax: 852-2848-0440

Japan
Caterpillar Japan Ltd.
SBS Tower
10-1, Yoga 4-Chome
Setagaya-Ku, Tokyo 158-8530
Japan
Phone: 81-3-5717-1150
Fax: 81-3-5717-1177

Australia and New Zealand
Caterpillar of Australia Ltd.
1 Caterpillar Drive
Private Mail Bag 4
Tullamarine, Victoria 3043
Australia
Phone: 03-9953-9333
Fax: 03-9335-3366

i07254661

Ordering Replacement Parts

SMCS Code: 4450; 7567

⚠ WARNING

When replacement parts are required for this product Caterpillar recommends using Caterpillar replacement parts or parts with equivalent specifications including, but not limited to, physical dimensions, type, strength and material.

Failure to heed this warning can lead to premature failures, product damage, personal injury or death.

Quality Caterpillar replacement parts are available from Caterpillar dealers throughout the world. Caterpillar dealers' parts inventories are up-to-date. The parts stocks include all of the parts that are normally needed to protect your Caterpillar engine investment.

When you order parts, please specify the following information:

- Part number
- Part name
- Quantity

If there is a question concerning the part number, please provide your dealer with a complete description of the needed item.

When a Caterpillar engine requires maintenance and/or repair, provide the dealer with all the information that is stamped on the Information Plate. This information is described in this Operation and Maintenance Manual (Product Information Section).

Discuss the problem with the dealer. Inform the dealer about the conditions of the problem and the nature of the problem. Inform the dealer about when the problem occurs. This will help the dealer in troubleshooting the problem and solving the problem faster.

Reference Materials

i05264255

Maintenance Records

SMCS Code: 1000; 4450

Caterpillar Inc. recommends the retention of accurate maintenance records. Accurate maintenance records can be used for the following purposes:

- Determine operating costs.
- Establish maintenance schedules for other engines that are operated in the same environment.
- Show compliance with the required maintenance practices and maintenance intervals.

Maintenance records can be used for various other business decisions that are related to engine maintenance.

Maintenance records are a key element of a maintenance program that is managed. Accurate maintenance records can help your Cat dealer to fine-tune the recommended maintenance intervals in order to meet the specific operating situation. This should result in a lower engine operating cost.

Records should be kept for the following items:

Fuel Consumption – A record of fuel consumption is essential in order to determine when the load sensitive components should be inspected or repaired. Fuel consumption also determines overhaul intervals.

Service Hours – A record of service hours is essential to determine when the speed sensitive components should be inspected or repaired.

Documents – These items should be easy to obtain, and these items should be kept in the engine history file. All of the documents should show this information: date, service hours, fuel consumption, unit number and engine serial number. The following types of documents should be kept as proof of maintenance or repair for warranty:

Keep the following types of documents as proof of maintenance for warranty. Also, keep these types of documents as proof of repair for warranty:

- Dealer work orders and itemized bills
- Owner repair costs
- Owner receipts
- Maintenance log

i01176304

Maintenance Log

SMCS Code: 1000; 4450

Table 20

Engine Model		**Customer Identifier**		
Serial Number		**Arrangement Number**		
Service Hours	**Quantity Of Fuel**	**Service Item**	**Date**	**Authorization**

i07422648

Reference Material

SMCS Code: 1000; 4450

Additional literature regarding your product may be purchased from your local Cat dealer or by visiting publications.cat.com. Use the product name, sales model, and serial number to obtain the correct information for your product.

publications.cat.com

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Product and Dealer Information

Note: For product identification plate locations, see the section “Product Identification Information” in the Operation and Maintenance Manual.

Delivery Date: _____

Product Information

Model: _____

Product Identification Number: _____

Engine Serial Number: _____

Transmission Serial Number: _____

Generator Serial Number: _____

Attachment Serial Numbers: _____

Attachment Information: _____

Customer Equipment Number: _____

Dealer Equipment Number: _____

Dealer Information

Name: _____ Branch: _____

Address: _____

_____

_____

	Dealer Contact	Phone Number	Hours
Sales:	_____	_____	_____
Parts:	_____	_____	_____
Service:	_____	_____	_____

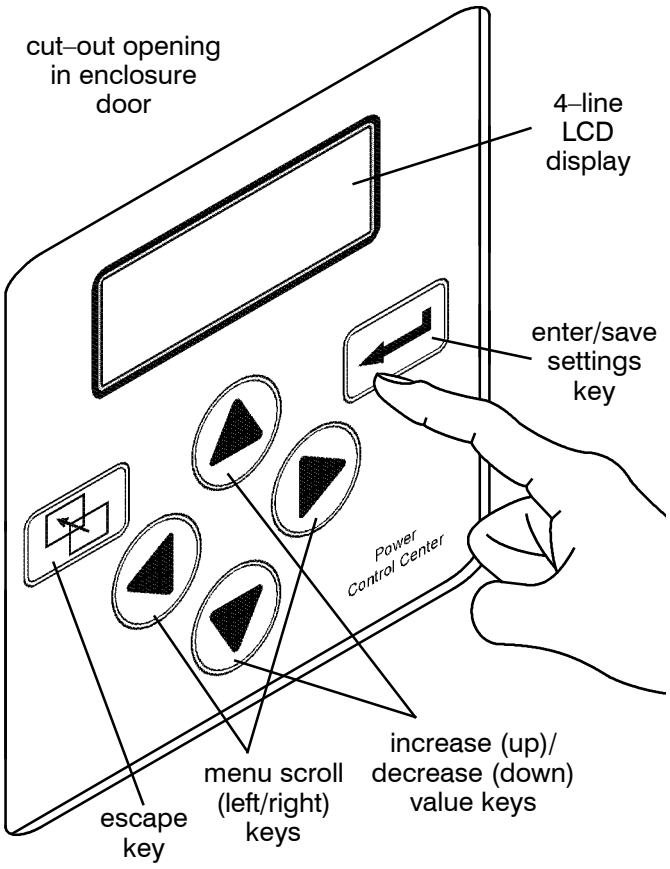
Transfer Switch Operation & Maintenance Manuals

Section 3.2

Transfer Switch Controller Manual

User's Guide

Group 5 Controller for ASCO® 4000 & 7000 Series Automatic Transfer Switch Products



Power Control Center keypad and display

⚠ DANGER

DANGER is used in this manual to warn of high voltages capable of causing shock, burns, or death.

⚠ WARNING

WARNING is used in this manual to warn of possible personal injury.

⚠ CAUTION

CAUTION is used in this manual to warn of possible equipment damage.

Refer to the outline and wiring drawings provided with the 4000 or 7000 Series ATS product for all installation and connection details and accessories.

Refer to the *Operator's Manual* for the ASCO 4000 or 7000 Series ATS product for installation, functional testing, sequence of operation,and troubleshooting.

Description

ASCO 4000 & 7000 Series Automatic Transfer Switch products utilize the Group 5 Controller for sensing, timing, and control functions. This state–of–the art microprocessor–based controller includes a built–in keypad and a four–line LCD display. All monitoring and control functions can be done with the enclosure door closed for greater convenience. In addition, all changes in voltage settings (except for nominal voltage) and time delays can be made through a system of menus.

TABLE OF CONTENTS

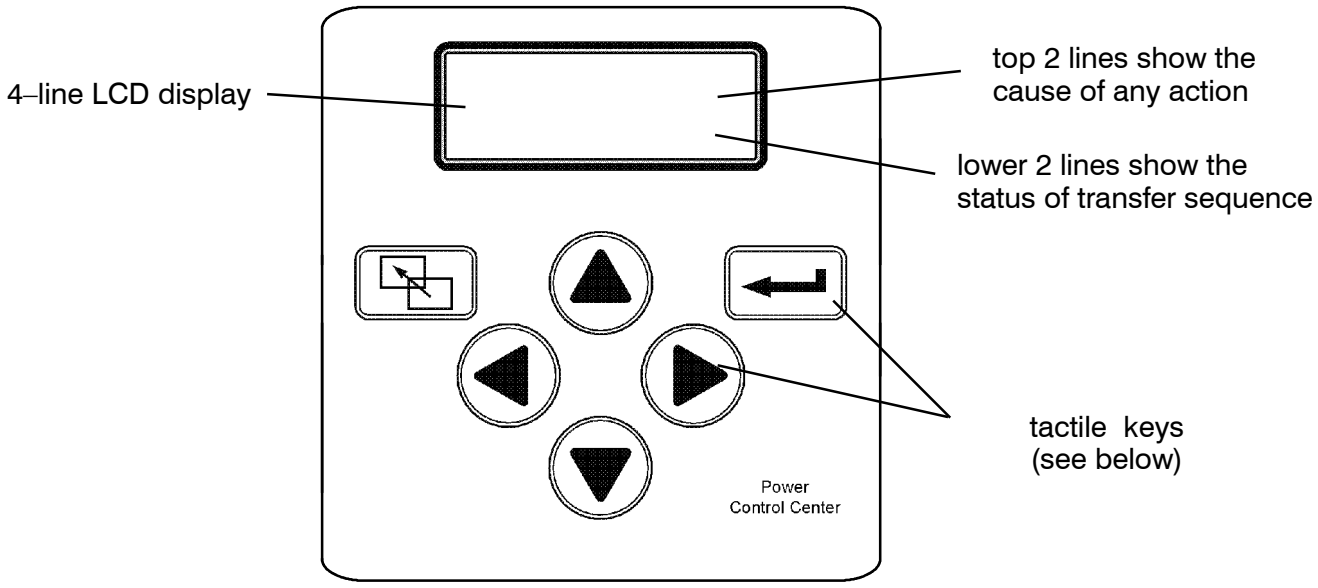
ASCO Power Technologies® 50 Hanover Road, Florham Park, New Jersey 07932–1591 USA
For sales or service call 1 800 800–2726 (ASCO) www.ascopower.com

381333–126 L

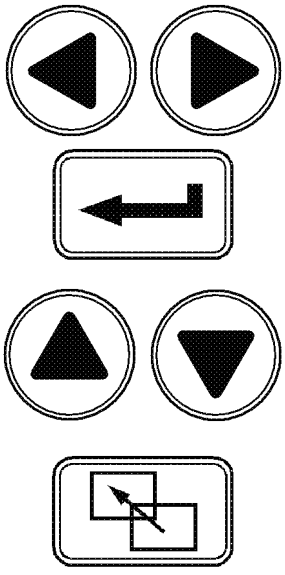
ASCO POWER TECHNOLOGIES CANADA PO Box 1238, 17 Airport Road, Brantford, Ontario, Canada N3T 5T3

Control Overview

On the Power Control Center, six keys allow access to all monitoring and setting functions. Two levels of screens are used. The *status level* provides information about the automatic transfer switch. The *settings level* allows configuration of the controller. Access to some settings may require entering a password (if the controller is set for one – see page 2–1 and Appendix A–3).



Power Control Center display and keypad.



Left–Right Arrows

The left and right arrow keys (menu scroll) navigate through the screens.

Enter/Save Settings key

The enter/save settings key move from the status level to the settings level screens. It also is used to enter a new setting.

Up–Down Arrows

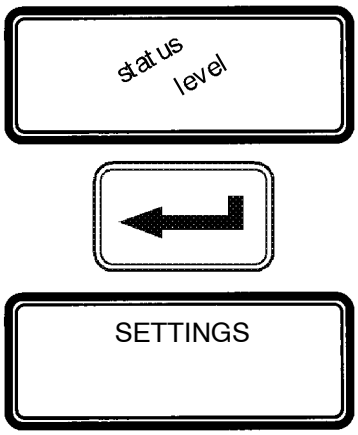
The up and down arrow keys (increase value and decrease value) modify a setting (setup parameter) while in the settings level screens.

Escape key

The escape key ignores a change and returns to the status level.

Settings Overview

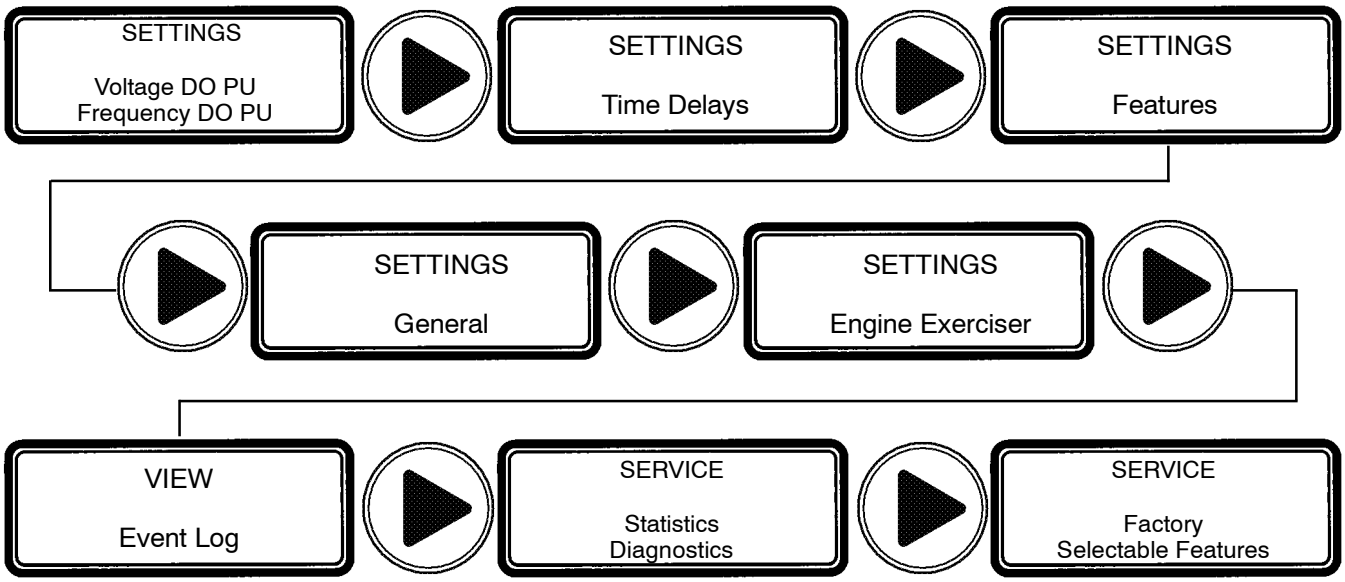
The controller settings can be displayed and changed from the keypad. Some settings may require a password (if the controller is set up for one).



From the **ATS Status** display, press the enter/save settings key to move to the **Settings** level of menus.

Press the right arrow key to see the eight parameter information headings (as shown below). An overview of each setting is listed below. The detailed menus for each setting are on the following pages.

8 Parameter Menus (loop back to beginning)



Voltage and Frequency Settings see page 2–2
CP settings and Normal & Emergency voltage and frequency pickup & dropout.

Time Delay Settings see page 2–4
Bypass running time delay, and settings for all standard time delays.

Features Settings see page 2–6
Commit on transfer, shed load, phase rotation, and inphase monitor settings.

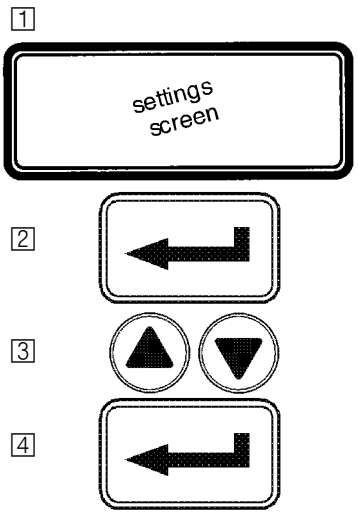
General Settings see page 2–8
Reset settings, language, communication, logging, and password.

Engine Exerciser Settings see page 2–10
Present date and time, seven exercise programs each with six parameters.

View Event Log see page 2–12
Last 99 events in date and time order; six types and seven reasons are logged.

Service Statistics/Diagnostics, Factory Selectable Features
For factory service use only. see pages 2–13

How to Change a Setting



To change a setting in the controller (CP):

1 Navigate to the settings screen that you want to change (see page 1–2).

2 Press the enter/save settings key to start the first field blinking. If the controller requires a password, see below.

3 Press up and down arrow keys to change flashing digit(s) or word and press the enter/save settings key to move to next field.

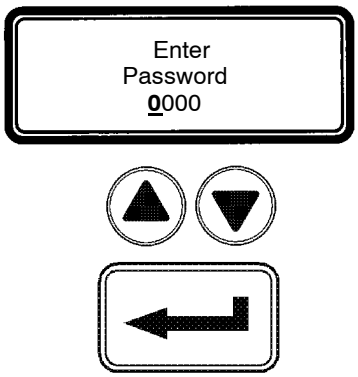
4 Repeat step 3 until all the fields have been entered.

Tips ☞ If a field is blinking, the CP is waiting for information to be entered.

The escape key will end the editing session.

Password

Tip ☞ **Default password is 1111** (see page 2–8)



If **Enter Password** displays, you must enter the correct password first.

Use the up and down arrow keys to change the flashing digit of the password. Press the enter/save settings key to move to next next digit (left to right). When the correct password is displayed, press the enter/save settings key.

If *WRONG PASSWORD !!!* displays, you are returned to the first flashing digit. When the correct password is displayed, press the enter/save settings key.

You can now change the settings on the selected screen.

Tip ☞ Once the password is entered it will stay *unlocked* for 5 minutes after last key is pushed so that you do not have to keep entering it. So, to save time, plan to make all your settings at one time.

Voltage & Frequency Settings

Unless otherwise specified on the order, the controller voltage and frequency settings are set at the factory to the default values. If a setting must be changed, carefully follow the procedure on the next page. Some settings may require a password (if the controller is set up for one).

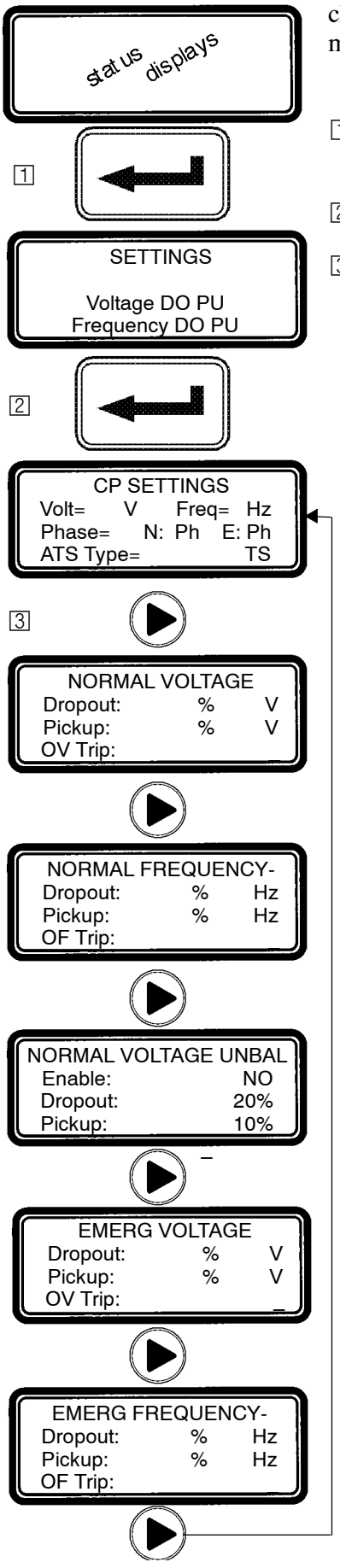
⚠ CAUTION

Any indiscriminate change in these settings may affect the normal operation of the Automatic Transfer Switch. This change could allow the load circuits to remain connected to an inadequate source.

Description	Settings	Default Setting % of nominal	Adjustment Range increments of 1%	Display Screen (see next page)
Normal Source Voltage	Dropout	85 %	70 to 98 %	NORMAL VOLTAGE Dropout
	Pickup	90 %	85 to 100 %	NORMAL VOLTAGE Pickup
	Over Voltage Trip *	off	102 to 115 %	NORMAL VOLTAGE OV Trip
	Unbalance Enable	no	yes or no	NORMAL VOLTAGE UNBAL Enable
	Unbalance Dropout	20 %	5 to 20 %	NORMAL VOLTAGE UNBAL Dropout
	Unbalance Pickup	10 %	3 to 18 %	NORMAL VOLTAGE UNBAL Pickup
Emergency Source Voltage	Dropout	75 %	70 to 98 %	EMERG VOLTAGE Dropout
	Pickup	90 %	85 to 100 %	EMERG VOLTAGE Pickup
	Over Voltage Trip *	off	102 to 115 %	EMERG VOLTAGE OV Trip
	Unbalance Enable	no	yes or no	EMERG VOLTAGE UNBAL Enable
	Unbalance Dropout	20 %	5 to 20 %	EMERG VOLTAGE UNBAL Dropout
	Unbalance Pickup	10 %	3 to 18 %	EMERG VOLTAGE UNBAL Pickup
Normal Source Frequency	Dropout	90 %	85 to 98 %	NORMAL FREQUENCY Dropout
	Pickup	95 %	90 to 100 %	NORMAL FREQUENCY Pickup
	Over Frequency Trip *	off	102 to 110 %	NORMAL FREQUENCY OF Trip
Emergency Source Frequency	Dropout	90 %	85 to 98 %	EMERG FREQUENCY Dropout
	Pickup	95 %	90 to 100 %	EMERG FREQUENCY Pickup
	Over Frequency Trip *	off	102 to 110 %	EMERG FREQUENCY OF Trip

* The Over Voltage and Over Frequency reset is fixed at 2% below the trip setting.

Voltage & Frequency Settings



The controller (CP) voltage and frequency setting can be displayed and changed from the keypad. See the table on the previous page. Some settings may require a password (if the controller is set up for one).

1 From any of the **Status** displays, press the enter/save settings key to move to the **Settings** level of menus.

2 Press the enter/save settings key to move to the **CP Settings** display.

3 Then you can press the right arrow key to see the other voltage and frequency displays (as shown below). An overview explanation of each setting is listed below.

5 Voltage & Frequency Menus (last menu loops back to first)

CP Settings see page 2–1

This display shows the base configuration of the controller. These settings are hardware activated and cannot be changed from the keypad:

Nominal source voltage — Normal and Emergency sources
Nominal source frequency — 50 or 60 Hz
Normal & Emergency source sensing — single or 3 phase
Switch type — open, closed, or delayed transition

Normal Voltage see page 2–1

This display shows pickup, dropout, and over–voltage trip settings for the Normal source. They are in percentage of nominal voltage and volts rms.

Normal Frequency see page 2–1

This display shows pickup, dropout, and over–frequency trip settings for the Normal source. They are in percentage of nominal frequency and Hz.

Normal Voltage Unbalance see page 2–1

This display appears only if the CP is set for 3 phase sensing on Normal. When enabled, the CP considers the Normal source unacceptable if the calculated voltage unbalance is greater than the specified dropout.

Emerg Voltage see page 2–1

This display shows pickup, dropout, and over–voltage trip settings for the Emergency source. They are in percent of nominal voltage and volts rms.

Emerg Frequency see page 2–1

This display shows pickup, dropout, and over–frequency trip settings for Emergency source. They are in percentage of nominal frequency and Hz.

Emerg Voltage Unbalance (not shown) see page 2–1

This display appears only if the CP is set for 3 phase sensing on Emergency. When enabled, the CP considers the Emergency source unacceptable if the calculated voltage unbalance is greater than the specified dropout.

Time Delay Settings

Unless otherwise specified on the order, the controller time delay settings are set at the factory to the default values. If a setting must be changed, follow the procedure on the next page. Some settings may require a password (if controller is set up for one).

⚠ CAUTION

Any indiscriminate change in these settings may affect the normal operation of the Automatic Transfer Switch. This change could allow the load circuits to remain connected to an inadequate source.

Feature	Time Delay	Default Setting	Adjustment Range 1 sec. increments	Display Screen (see next page)
1C ③	override momentary Normal source outages	1 second	0 to 6 sec see **CAUTION** below	TD NormFail
1F	override momentary Emergency source outages	0	0 to 60 min 59 sec	TD EmrgFail
2B	transfer to Emergency	0	0 to 60 min 59 sec	TD N>E
2E	unloaded running (engine cooldown)	5 minutes	0 to 60 min 59 sec	TD EngCool
3A	retransfer to Normal (if Normal fails)	30 minutes	0 to 60 min 59 sec	TD E>N if Normal Fail
	retransfer to Normal (if just a test)	30 seconds	0 to 9 hours 59 min 59 sec	TD E>N if Test Mode
31F ④	Normal to Emergency pre–transfer signal	0	0 to 5 min 59 sec	TD N>E Xfer Signal PreXfer
31M ④	Normal to Emergency post–transfer signal	0	0 to 5 min 59 sec	TD N>E Xfer Signal PostXfer
31F, 31M	bypass 31F & 31M if Normal fails	no	yes or no	TD N>E Xfer Signal BypassIfNFail
31G ④	Emergency to Normal pre–transfer signal	0	0 to 5 min 59 sec	TD E>N Xfer Signal PreXfer
31N ④	Emergency to Normal post–transfer signal	0	0 to 5 min 59 sec	TD E>N Xfer Signal PostXfer
31G, 31N	bypass 31G & 31N if Emergency fails	no	yes or no	TD E>N Xfer Signal BypassIfEFail
4ACTS, 7ACTS, 7ACTB only①	in sync	1.5 second	0 to 3.0 seconds 0.1 sec increments	CTTS TD SyncMonitorTD
	failure to synchronize	5 minutes	0 to 5 min 59 sec	CTTS TD FailToSyncTD
	extended parallel time	0.5 second	0.100 to 1.000 sec 0.01 sec increments	CTTS TD XtdParallelTD
4ADTS, 7ADTS/B only②	delay transition time	0	0 to 5 min 59 sec	DTTS TD LoadDisconnDelay

① These time delays appear only on the display for a 4ACTS, 7ACTS, or 7ACTB closed–transition transfer switch.

② This time delay appears only on the display for a 4ADTS, 7ADTS, or 7ADTB delayed–transition transfer switch.

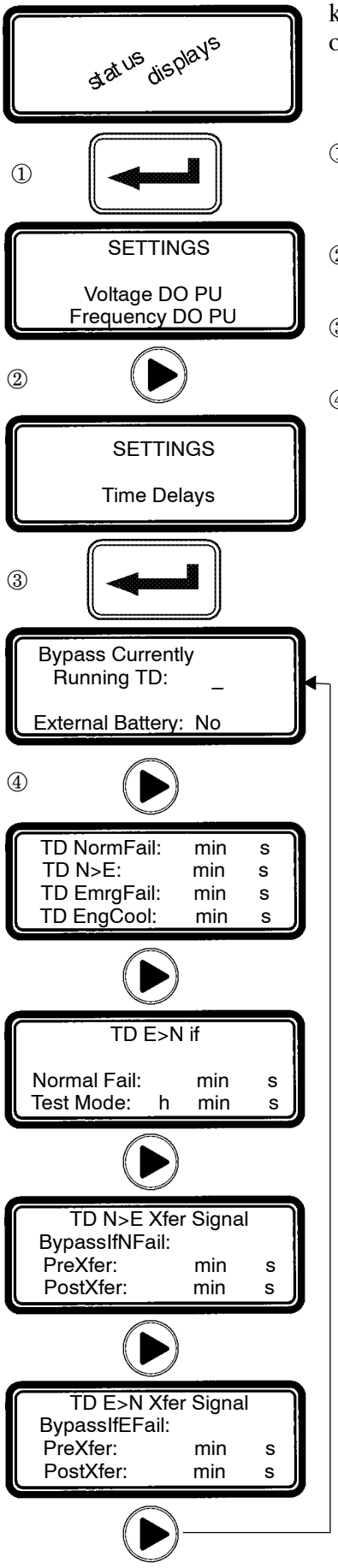
③ Standard adjustment up to 6 seconds (total power outage). For additional time delay contact ASI. **See CAUTION**.

④ If output contacts required, contact ASI at 1–800–800–2726.

⚠ CAUTION

Do not set Feature 1C TD longer than 6 sec. unless an external 24 V dc power supply is included. Contact ASI if longer than 6 sec. is required.

Time Delay Settings



The controller time delay (TD) settings can be displayed and changed from the keypad. Some settings may require a password (if the controller is set up for one).

① From any of the **Status** displays, press the enter/save settings key to move to the **Settings** level of menus.

② Press the right arrow key to move to the **Setting Time Delays** display.

③ Now press enter/save settings key to move to the first **Time Delay** menu.

④ You can press the right arrow key to see the other time delay menus (as shown below). An overview explanation of each setting is listed below.

5 Time Delay Menus (last menu loops back to first)

Bypass Currently Running TD see page 2–1

This display allows you to bypass some time delays. When the display is set to **Yes** the controller will bypass any of these time delays

Feature 1C — Momentary Normal failure time delay
Feature 2B — Normal to Emergency transfer time delay
Feature 3A — Emergency to Normal transfer time delay

External Battery: see CAUTION on bottom of page 2–4
Yes means external battery connected, Feat. 1C can be set longer than 6 sec
No mean there is no external battery, Feat. 1C can be set for 0–6 sec. only

Standard Time Delays see page 2–1

This display shows the settings for the following standard time delays:

Feature 1C — Momentary Normal source failure time delay
Feature 2B — Normal to Emergency transfer time delay
Feature 1F — Momentary Emergency source failure time delay
Feature 2E — Engine cooldown time delay

TD E>N if see page 2–1

This display shows the settings for Feature 3A retransfer to Normal time delay. There are two modes:

Normal source outage — retransfer TD if Normal fails
Transfer Test — retransfer TD if just a test

TD N>E Xfer Signal see page 2–1

This display shows the settings for the time delays used to signal external equipment before and after transfer from Normal to Emergency:

Feature 31F — Pre–transfer time delay signal
Feature 31M — Post–transfer time delay signal

TD E>N Xfer Signal see page 2–1

This display shows the settings for the time delays used to signal external equipment before and after retransfer from Emergency to Normal:

Feature 31G — Pre–transfer time delay signal
Feature 31N — Post–transfer time delay signal

CTTS TDs (not shown) see page 2–1

DTTS TD (not shown) see page 2–1

Features Settings

Unless otherwise specified on the order, the controller features settings are set at the factory to the default values. If a setting must be changed, follow the procedure on the next page. Some settings may require a password (if the controller is set up for one).

⚠ CAUTION

Any indiscriminate change in these settings may affect the normal operation of the Automatic Transfer Switch. This change could allow the load circuits to remain connected to an inadequate source.

Feature	Default Setting	Adjustment Range	Display Screen (see next page)
commit to transfer	no	yes or no	Commit to Xfer After TD Norm Fail
shed load direction	from E	from N or from E	SHED LOAD Direction
shed load in phase	no	yes or no	SHED LOAD InPhase
shed load in phase time delay	1.5 second	0 to 3.0 seconds 0.1 sec increments	SHED LOAD TD
shed load isolate load on source failure ②	yes	yes or no	SHED LOAD IsoLoadOnSrcFail
shed load isolate load on test 17 ②	no	yes or no	SHED LOAD IsoLoadOnTest17
phase rotation monitor enable ③	no	yes or no	PHASE ROTATION MONITOR Enable
phase rotation monitor reference ③	ABC	ABC or CBA	PHASE ROTATION MONITOR Reference
inphase monitor enable ④	no	yes or no	IN–PHASE MONITOR Enable
inphase monitor time delay ④	1.5 second	0 to 3.0 seconds 0.1 sec increments	IN–PHASE MONITOR Time Delay
failure to sync auto bypass ①	no	yes or no	CTTS BYPASS/SHED LD FailSyncAutoByps
bypass time delay ①	0 second	0 to 59 seconds 1 sec increments	CTTS BYPASS/SHED LD Bypass DT Delay
bypass in phase ①	no	yes or no	CTTS BYPASS/SHED LD Bypass InPhase
Y–Y primary failure detection enable	no	yes or no	Y–Y PRI FAIL DETECT Enable
Y–Y primary failure sensing time delay	1.0 second	0 to 9.9 seconds 0.1 sec increments	Y–Y PRI FAIL DETECT Sense Delay
Y–Y primary failure retransfer time delay	1.0 hour	0 to 23 hrs 59 min. 1 min. increments	Y–Y PRI FAIL DETECT TD E>N Y–Y

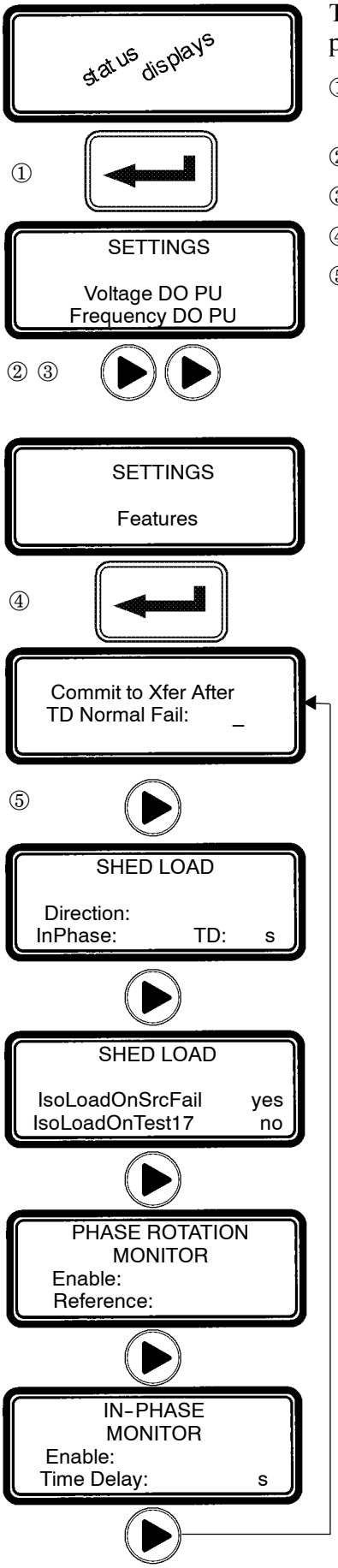
① These features appear only on the display for a 4ACTS, 7ACTS, or 7ACTB closed–transition transfer switch.

② These features appear only on the display for a 4ACTS, 7ACTS or 7ACTB closed–transition transfer switch or a 4ADTS, 7ADTS, or 7ADTB delayed–transition transfer switch.

③ These features do not appear on the display unless both sources have 3 phase sensing enabled.

④ These features appear only on a 4ATS, 7ATS, or 7ATB (open–transition automatic transfer switch).

Features Settings



continued on next page

The controller (CP) Features settings can be displayed and changed from the key–pad. Some settings may require a password (if the controller is set up for one).

① From any of the **Status** displays, press the enter/save settings key to move to the **Settings** level of menus.

② Then press the right arrow key to move to **Setting Time Delays** menu.

③ Press the right arrow key again to move to **Settings Features** menu.

④ Now press the enter/save settings key to move to the first **Features** display

⑤ You can press the right arrow key to see the other **Features** menus (as shown below). An overview explanation of each setting is listed below.

7 Features Menus (last menu loops back to first)

Commit to Xfer After TD Normal Fail see page 2–1

This display shows the commit to transfer setting. It affects the transfer sequence as follows:

Yes – If Normal fails, CP continues transfer sequence to emergency even if Normal returns before Emergency becomes acceptable.

No – If Normal fails, CP cancels the transfer sequence to emergency if Normal returns before Emergency becomes acceptable.

Shed Load see page 2–1

This display shows status of 3 load shed parameters:

Direction – from Emergency or from Normal

InPhase – yes means transfer delayed until sources are in phase

TD – 3 second default time delay

Shed Load Options see page 2–1

This display appears only for 4ACTS, 4ADTS, 7ACTS, 7ACTB, 7ADTS, or 7ADTB. It determines switch position after the shed load transfer.

IsoLoadOnSrcFail – determines switch position during a source failure.

IsoLoadOnTest17 – determines switch position during feat. 17 activation.

Yes – Load is not connected to either source. (see wiring diagram

No – Load is connected to the opposing source. for feature 17 desc.)

Phase Rotation Monitor see page 2–1

This display shows status of phase rotation monitor and desired reference phase rotation. It only appears if both sources are set to 3–phase sensing.

Enabled – Yes means phase rotation is considered as part of the source acceptability criteria for each source. If the phase rotation of the source does not match the reference phase rotation, that source is considered unacceptable. If phase rotation of the two sources is different, the load will be transferred to the source with the reference phase rotation.

Reference – phase rotation order: ABC or CBA (ABC is default)

In–Phase Monitor see page 2–1

This display appears only for 4ATS, 7ATS, or 7ATB. It shows the status of in–phase monitor and in–phase time delay (1.5 second is default setting).

Enabled – Yes means in–phase transfer is initiated when any of these conditions are met: Transfer Test (Feature 5) signal, connected source fails, retransfer to acceptable Normal occurs and Emergency source acceptable.

CTTS Bypass / Shed Load (not shown) see page 2–1

This display shows status of the closed–transition bypass options.

FailSyncAutoBypass – Yes means if the fail to sync alarm occurs, the controller will bypass the closed–transition mode and will make a delayed–transition transfer. The load disconnect time is set by the **Bypass DT Delay** parameter.

Bypass InPhase – Yes means the inphase monitor is active during load transfer.

Y – Y Primary Failure Detection (not shown) see page 2–1

This display shows status of a special control algorithm which is described in *Application Note 381339–276*.

Enable – Yes means the algorithm is activated to detect Normal primary single phase failure in Y–Y systems.

Sense Delay — 1 second default time delay.

TD E>N Y–Y — 1 hour default time delay.

Note: This function should only be considered for use where the Normal source is provided through a Y–Y transformer. This function requires the Normal source voltage unbalance monitoring to be enabled.

General Settings

Unless otherwise specified on the order, the controller general settings are set at the factory to the default values. If a setting must be changed, follow the procedure on the next page. Some settings may require a password (if the controller is set up for one).

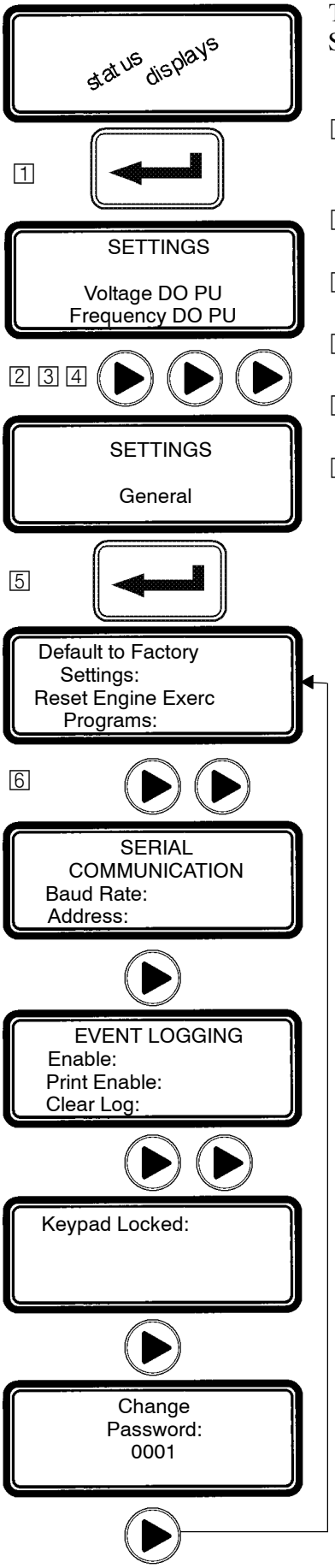
⚠ CAUTION

Any indiscriminate change in these settings may affect the normal operation of the Automatic Transfer Switch. This change could allow the load circuits to remain connected to an inadequate source

Parameter	Default Setting	Adjustment Range	Display Screen (see next page)
language	ENGLISH*	ENGLISH FRENCH CDN ENGLISH EU ENGLISH EU S1–S2 ENGLISH S1–S2* SPANISH GERMAN PORTUGUESE	Menu Language ENGLISH
serial communications baud rate	19.2k	off, x9600, 9600, 19.2k, Mbus9600, Mbus19.2k	SERIAL COMMUNICATION Baud Rate
serial communications address	1	0 to 63	SERIAL COMMUNICATION Address
event log enable	no	yes or no	EVENT LOGGING Enable
print enable	no	yes or no	EVENT LOGGING Print Enable
clear log	no	yes or no	EVENT LOGGING Clear Log
door–mounted user controls locked but not the *Power Control Center* (this setting on 4000 Series only)	no	yes or no	Keypad Locked
password	1111	4 characters letters or numbers	Change Password

* **Note**: If the language setting *ENGLISH S1–S2* is selected the usual display words *Normal (N)* and *Emergency (E)* are changed to *Source 1 (S1)* and *Source 2 (S2)*.

General Settings



The controller (CP) general setting can be displayed and changed from the keypad. Some settings may require a password (if the controller is set up for one).

1 From any of the **Status** displays, pres the enter/save settings key to move to the **Settings** level of menus.

2 Press the right arrow key to move to **Setting Time Delays** menu.

3 Press the right arrow key again to move to **Settings Features** menu.

4 Press the right arrow key again to move to **Settings General** menu.

5 Now press the enter/save settings key to move to the first **General** display

6 You can press the right arrow key to see the other **General** menus (as shown below). An overview explanation of each setting is listed below.

6 General Settings Menus (last menu loops back to first)

Default to Factory Settings see page 2–1
This display (upper half) allows the user to reset the majority of controller settings to their factory default values.

Reset Engine Exerc Programs see page 2–1
This display (lower half) also allows the user to reset the engine exerciser routines. **YES** means reset. **NO** means do not reset.

Menu Language (not shown) see page 2–1
This display shows the language in which the messages will be shown.
English is the default language.

Serial Communication see page 2–1
This display allows the user to configure the serial communications port of the controller.
Baud Rate — off, 9600, x9600. 19.2 k, Mbus9600, Mbus19.2k
x9600 selects 9600 and the Group 1/7 CP protocol
Address — can be set from 0 to 63

Event Logging see page 2–1
This display allows the user to enable the event logging feature of the controller and to clear the event log.
Enable — **YES** means to start event logging; **NO** means turn it off.
Print Enable — **YES** means enables printer option; **NO** turns it off.
Clear Log — **YES** means erase the event log; **NO** means keep it.

Print Event Log (not shown) see page 2–1
This display shows the status of the optional printer.
Also see Printer Interface Module instructions 381339–218.

Keypad Locked (on 4000 Series only) see page 2–1
This display allows the user to lock or unlock the door–mounted user controls. (not the *Power Control Center*). **YES** means locked. **NO** means unlocked.

Change Password see page 2–1
This display allows the user to change the controller password.

Engine Exerciser Settings

Unless otherwise specified on the order, the controller engine exerciser settings are set at the factory to the default values. If a setting must be changed, follow the procedure on the next page. Some settings may require a password (if the controller is set up for one).

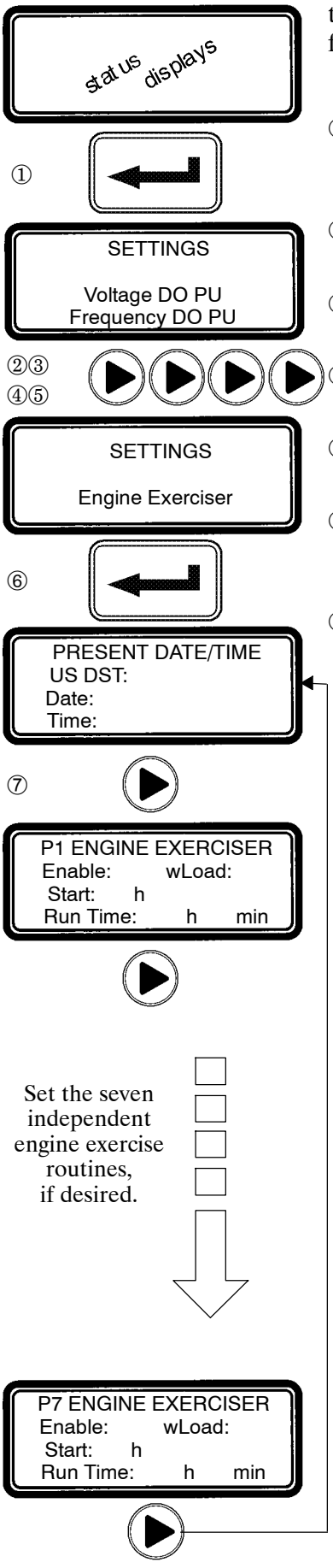
⚠ CAUTION

Any indiscriminate change in these settings may affect the normal operation of the Automatic Transfer Switch. This change could allow the load circuits to remain connected to an inadequate source

Parameter	Default Setting	Adjustment Range	Display Screen (see next page)
month	JAN	JAN, FEB, MAR, APR, MAY, JUN, JUL, AUG, SEP, OCT, NOV, DEC	PRESENT DATE/TIME Date
day	1	1 to 31	PRESENT DATE/TIME Date
year *	1	00 to 99	PRESENT DATE/TIME Date
hour	1	0 to 23	PRESENT DATE/TIME Time
minute	1	0 to 59	PRESENT DATE/TIME Time
engine exerciser enable (P1 to P7)	no	yes or no	P1 ENGINE EXERCISER Enable
engine exerciser transfer load (P1 to P7)	no	yes or no	P1 ENGINE EXERCISER wLoad
engine exerciser start hour (P1 to P7)	0	0 to 23	P1 ENGINE EXERCISER Start h
engine exerciser start minute (P1 to P7)	0	0 to 59	P1 ENGINE EXERCISER Start min
engine exerciser run week (P1 to P7)	all	all, alternate, first, second, third, fourth, or fifth	
engine exerciser run day (P1 to P7)	SUN	SUN, MON, TUE, WED, THU, FRI, SAT	
engine exerciser duration hours (P1 to P7)	0	0 to 23	P1 ENGINE EXERCISER Run TIme h
engine exerciser duration minutes (P1 to P7)	0	0 to 59	P1 ENGINE EXERCISER Run TIme min

* For the year 2000, enter 00.

Engine Exerciser Settings



The controller (CP) engine exerciser setting can be displayed and changed from the keypad. Some settings may require a password (if the controller is set up for one).

① From any of the **Status** displays, press the enter/save settings key to move to the **Settings** level of menus.

② Press the right arrow key to move to **Setting Time Delays** menu.

③ Press the right arrow key again to move to **Settings Features** menu.

④ Press the right arrow key again to move to **Settings General** menu.

⑤ Press the right arrow key again to move to **Settings Engine Exerciser**.

⑥ Now press the enter/save settings key to move to the first **Engine Exerciser-** menu.

⑦ You can press the right arrow key to see the other Engine Exerciser menus (as shown below). An overview explanation of each setting is listed below.

8 Engine Exerciser Settings Menus
(last menu loops back to first)

Present Date/Time see page 2–1

This display allows the user to change the controller date and time.

US DST — US Daylight Saving Time. APR – OCT, MAR – NOV, or OFF. MAR – NOV begins in 2007.

P(1—7) Engine Exerciser(s) see page 2–1

These displays (P1 through P7) allow the user to set the controller's seven independent engine exerciser routines. Each routine functions in the same manner. Six parameters need to be configured for each routine (P1, P2, P3, P4, P5, P6, P7 — not all have to be used).

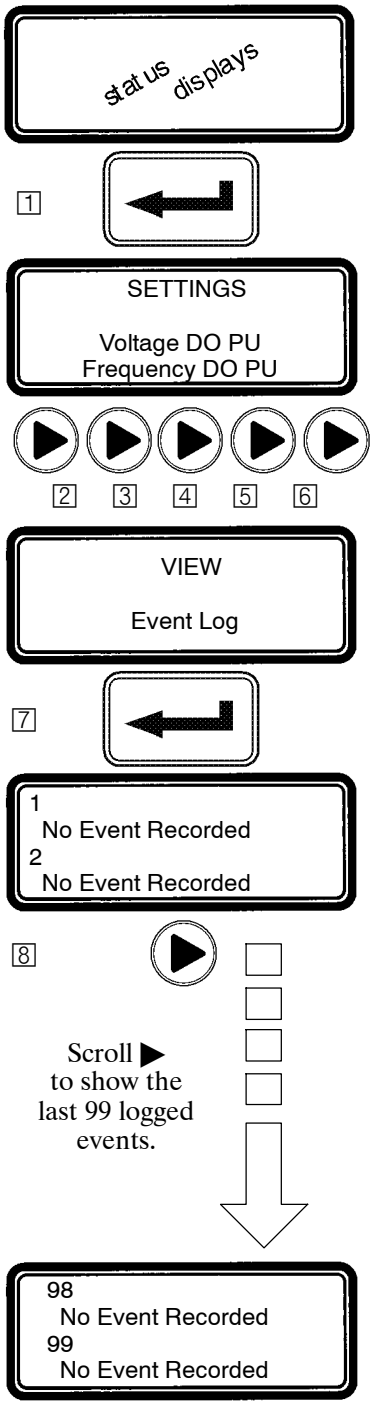
Enable — YES enables the routine; NO turns it off.

wLoad — YES transfers load to Emergency; NO = no transfer.

Start — when the routine will start the generator
- time (hour, minute)
- week (all, alternate, 1st, 2nd, 3rd, 4th, or 5th week)
- day of the week (mon, tue, wed, thu, fri, sat, sun)

Run Time — duration (length of time) that the generator will run.

View Event Log



The controller event logging feature can be displayed from the keypad. Some settings may require a password (if the controller is set up for one).

1 From any of the **Status** displays, press the enter/save settings key to move to the **Settings** level of menus.

2 Press the right arrow key to move to **Setting Time Delays** menu.

3 Press the right arrow key again to move to **Settings Features** menu.

4 Press the right arrow key again to move to **Settings General** menu.

5 Press the right arrow key again to move to **Settings Engine Exerciser**.

6 Press the right arrow key again to move to **View Event Log**.

7 Now press the enter/save settings key to move to the events logged display.

8 You can press the right arrow key to see the other events logged. An overview explanation of each setting is listed below.

Logged Events

This display shows the last 99 logged events. Each event display shows the event number (1 is the most recent, 99 is the oldest), the time and date of the event, the event type, and the event reason (if applicable).

Event Types

Nine types of events are logged. They are (displayed event & meaning) :

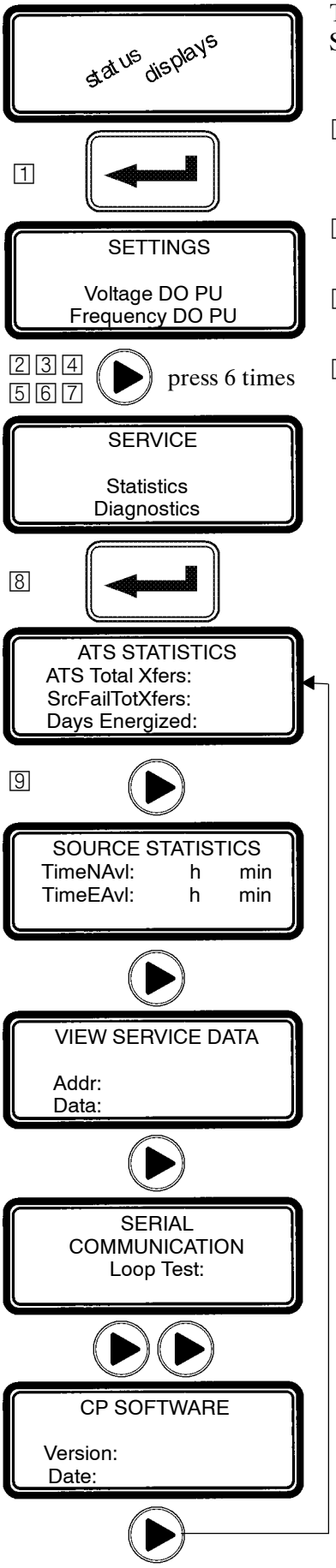
Eng Start	The controller has signaled the engine to start
Xfer N>E	The controller has initiated transfer from normal to emergency
Xfer E>N	The controller has initiated transfer from emergency to normal
Eng Stop	The controller has signaled the engine to stop
EmergAcc	The emergency source has become acceptable
EmergNAcc	The emergency source has become not acceptable
NormAcc	The normal source has become acceptable
NormNAcc	The normal source has become not acceptable
XfrAbort	The transfer has been aborted

Event Reasons

Twenty–one reasons for events are logged. They are (displayed reason & meaning):

LoadShed	Load shed requested
NormFail	Normal source failure
ManualXfr	Manual transfer
Test 5	Test requested (Feature 5)
Test 17	Test requested (Feature 17)
Comm	Serial communications
EngExerc	Engine Exerciser
EmergFail	Emerg source failure
NormUV	Normal source under voltage
NormOV	Normal source over voltage
NormUF	Normal source under frequency
NormOF	Normal source over frequency
NormPHR	Normal source phase rotation
NormVUNB	Normal source voltage unbalance
EmergUV	Emergency source under voltage
EmergOV	Emergency source over voltage
EmergUF	Emergency source under frequency
EmergOF	Emergency source over frequency
EmergPHR	Emergency source phase rotation
EmergVUNB	Emergency source voltage unbalance
Feature 6	Feature 6 activated

Service — Statistics / Diagnostics



The controller service statistics / diagnostics can be displayed from the keypad. Some settings may require a password (if the controller is set up for one).

1 From any of the **Status** displays, press the enter/save settings key to move to the **Settings** level of menus.

2 3 4 5 6 7 Press the right arrow key six times to move to **Service** menu.

8 Now press the enter/save settings key to move to the first **Service** menu.

9 You can press the right arrow key to see the other **Service** menus (as shown below). An overview explanation of each setting is listed below.

7 Service Menus (last menu loops back to first)

ATS Statistics

This display shows the total number of transfers, the total number of transfers due to source failures, and the total number of days that the ATS has been energized since the controller has been installed. These values cannot be reset.

Source Statistics

This display shows the total time that the normal and emergency sources have been acceptable since installation of the controller. These values cannot be reset.

View Service Data

This display is for service personnel only.

Serial Communication

This display allows the user to test the serial communications port of the controller. To perform the test, the transmit lines of the serial communications port are connected to the receive lines so that the signals sent by the controller are also received by the controller. The test is activated by pressing the enter/save settings key while viewing this display. If the controller receives the same information that it sent, test is passed, otherwise it fails.

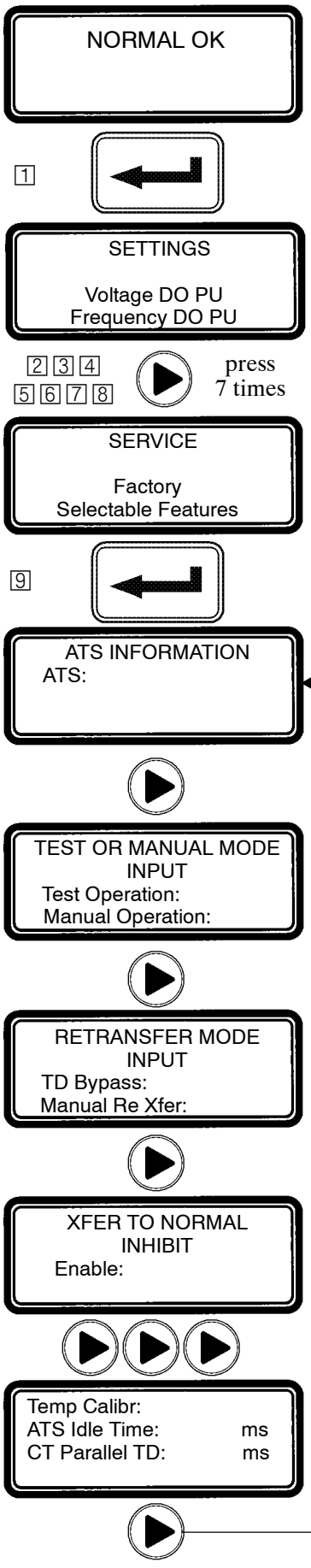
I/O Status (not shown)

These displays show the status of several of the controller's input and output lines.

CP Software

This display shows the version of the loaded software and the date of its release.

Service — Factory Selectable Features



The controller service factory selectable features can be displayed from the membrane controls. These factory settings should not be changed by the customer (they cannot be changed without entering the factory password).

1 From the **ATS Status** display (NORMAL OK), press the enter/save settings button to move down to the **Settings** level of menus.

2 3 4 5 6 7 8 Press the right arrow key 7 times to move to **Service** menu.

9 Now press the enter/save settings button to move down to the first **Service** factory selectable feature.

You can press the right arrow key to see the other Service menus (as shown below). An overview explanation of each setting is listed below.

8 Service Menus (last menu loops back to first)

ATS Information

This display shows the transfer switch ampere size, whether the switch is a bypass switch or a non–bypass switch, and any name or description inform–ation that has been assigned to it through the serial communications port.

Test or Manual Mode Input

This display shows the setting of the Feature 5/6Z input. This input can be used for either Feature 5 or 6Z. Yes means active; no means not used.

Test Operation — Feature 5
Manual Operation — Feature 6Z
This Feature is not available for automatic operation.

Retransfer Mode Input

This display shows the settings for Features 6B/6C inputs. This input can be used for either Feature 6B or 6C. Yes means active; no means not used.

TD Bypass — Feature 6B
Manual Re Xfer — Feature 6C

These Features are typically set to *Yes* with the inhibit Feature overridden with external factory wiring. These Features are not available for customer use.

Xfer to Normal Inhibit and Emergency (not shown)

This display shows whether the Feature 34A input is enabled (yes) or disabled (no).

Likewise, the next display **Xfer to Emerg** shows whether the Feature 34B input is enabled (yes) or disabled (no).

Factory Calibration (not shown)

This display is for factory calibration only and should be used by factory personnel only.

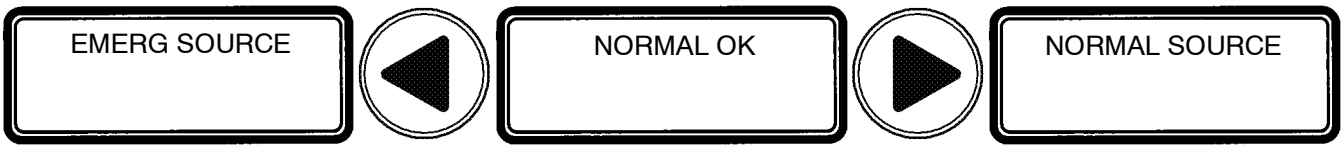
Other

These displays show various parameters that should be accessed by factory personnel only.

Status Information

The controller (CP) provides the status of the automatic transfer switch (ATS) and of both the normal and emergency sources. This information is at the *status level* of all screens and no password is required to view them.

You can press the right arrow key to see the status of the Normal Source or press the left arrow key to see the status of the Emergency source (the menus loop back).



ATS Status

The ATS Status is the primary display. It shows the present status of the ATS. Transfer sequence status and running time delays are shown. For inphase or closed–transition transfers, phase relation between the sources is also shown.

Tip ☞

The ATS Status display can be directly reached from anywhere in the menu structure by pressing the escape key three times.

Normal Source Status

The Normal Source Status display shows the rms voltage of each of the phases, the source frequency in Hz, and the phase rotation. If enabled, the voltage unbalance will also be displayed.

Emergency Source Status

The Emergency Source Status display shows the rms voltage of each of the phases, the source frequency in Hz, and the phase rotation. If enabled, the voltage unbalance will also be displayed.

Source Acceptability

The CP considers a source unacceptable if any of these conditions are true:

- Any phase voltage of the source is less than the voltage dropout setting.
- Any phase voltage is greater than voltage trip setting for more than 3 sec.
- Frequency of the source is less than the frequency dropout setting.
- Frequency is greater than frequency trip setting for more than 3 seconds.
- Phase rotation does not match specified phase rotation (only if enabled).
- The phase unbalance is greater than the unbalance dropout setting (only if enabled).

The CP considers a source acceptable again when all these conditions are true:

- Each phase voltage is greater than the voltage pickup setting.
- Each phase voltage is less than trip voltage setting by more than 2% of nom
- The frequency of the source is greater than the frequency pickup setting.
- Frequency is less than the frequency trip setting by more than 2% of nom.
- Phase rotation matches the specified phase rotation (only if enabled).
- The phase unbalance is less than the unbalance pickup setting (only if enabled).

Display Messages and their Meaning

The following messages (in alphabetical order) can appear on the CP display:

Display Message	Meaning or Explanation	Also Refer To
ATS LOCKED OUT!	An error condition has occurred and the controller has locked out all further attempts to transfer the load. Press the Alarm Reset pushbutton to clear this message.	Transfer Switch Operator's Manual
EMERG SOURCE	The emergency status display shows the emergency voltages, voltage unbalance (if enabled), and frequency.	page 3–1
ENGINE EXERCISE WITH LOAD	The engine exerciser is running the engine–generator set with load (the transfer switch transfers the load to the generator).	pages 2–10, 2–11
ENGINE EXERCISE WITHOUT LOAD	The engine exerciser is running the engine–generator set without load (the transfer switch does not transfer the load to the generator).	pages 2–10, 2–11
Enter Password:	A password is required to proceed further in the change process. Enter the correct password to continue or press the escape key to clear this message.	pages 2–1, 2–8
FAILURE TO SYNCHRONIZE ALARM	The failure to synchronize time delay has expired. This alarm occurs when the sources fail to synchronize within the specified time. Press the Alarm Reset pushbutton to clear this message. (4ACTS, 7ACTS, 7ACTB)	pages 4–4, 4–5
Load Disconnected	The load is disconnected (4ADTS, 7ADTS, 7ADTB)	pages 4–6, 4–7
Load on Emerg	The load is connected to the emergency source.	
Load on Normal	The load is connected to the normal source.	
LOAD SHED FROM EMERG	The load shed signal is active and the load has been shed from the emergency source.	page 2–6
LOAD SHED FROM NORMAL	The load shed signal is active and the load has been shed from the normal source.	page 2–6
NORMAL FAILED	The normal source is not acceptable.	page 3–1
NORMAL OK	The normal source is accepted.	page 3–1
NORMAL SOURCE	The normal status display shows the normal source voltages, voltage unbalance (if enabled), and frequency.	page 3–1
POWER–UP INHIBIT *stays on*	The controller has powered up and has recognized an error condition.	Contact ASI
TD Emerg>Normal:	The emergency to normal load transfer time delay (Feature 3A) is running. The amount of time remaining is shown.	page 2–4
TD Engine Cooldown:	The engine–generator set unloaded cooldown time delay (Feature 2E) is running. The amount of time remaining is shown.	page 2–4
TD Load Disconnect:	The load disconnect time delay is running. The amount of time remaining is shown. (4ADTS, 7ADTS, 7ADTB)	pages 4–6, 4–7

continued on next page

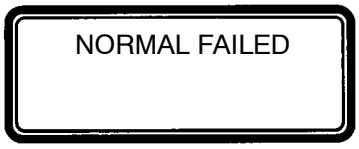
Display Messages and their Meaning (continued)

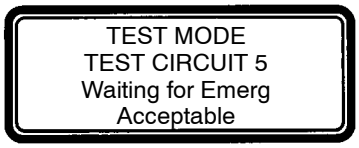
The following messages (in alphabetical order) can appear on the CP display:

Display Message	Meaning or Explanation	Also Refer To
TD Normal Fail:	The normal source failure time delay (Feature 1C) is running. The amount of time remaining is shown.	page 2–4
TD Normal>Emerg:	The normal to emergency load transfer time delay (Feature 2B) is running. The amount of time remaining is shown.	page 2–4
TD Post Transfer	The post–transfer time delay (Feature 31M or 31N) is running. The amount of time remaining is shown.	page 2–4
TD Pre Transfer	The pre–transfer time delay (Feature 31F or 31G) is running. The amount of time remaining is shown.	page 2–4
TEST MODE SERIAL COMM	A test has been initiated via the serial communications port.	page 2–13
TEST MODE TEST CIRCUIT 5	Test circuit Feature 5 is active (**Transfer Test**).	Transfer Switch Operator's Manual
TEST MODE TEST CIRCUIT 17	Test circuit Feature 17 is active (remote test).	page 2–6
Transfer to Emerg Inhibited	Load transfer to emergency is inhibited.	
Transfer to Normal Inhibited	Load transfer to normal source is inhibited.	
Waiting for Emerg Acceptable	The controller is waiting for the emergency source to become acceptable so that it can continue in the transfer sequence.	page 3–1
Waiting for In–Phase	The controller is waiting for the sources to come in phase so that it can make an in phase load transfer. The phase angle and frequency difference are also displayed. This message will be displayed until the sources come in phase. (4ATS, 7ATS, 7ATB)	pages 4–1, 4–2
Waiting for In–Sync	The controller is waiting for the sources to come into synchronism so that it can make a closed–transition load transfer. The three parameters required for synchronization (phase angle, frequency difference, and voltage difference) are also displayed. If the sources do not have the same rotation, this will also be displayed. (4ACTS, 7ACTS, 7ACTB)	pages 4–4, 4–5
WRONG PASSWORD !!!	An incorrect password has been entered.	page 2–1
XTD PARALLEL ALARM	The extended parallel time delay has expired, which indicates that the sources have been paralleled for longer than the specified extended parallel time. Press the Alarm Reset pushbutton to clear this message. (4ACTS, 7ACTS, 7ACTB)	pages 4–4, 4–5
PARM CHCKSUM ERROR	An internal memory error has been detected. On occurance of this error message, memory is cleared and all parameters need to be reset.	Contact ASI
UNKNOWN ERROR	System error.	Contact ASI

Open–Transition (2–position) Automatic Transfer (4ATS,7ATS,7ATB)

Load Transfer To Emergency





The sequence for load transfer to the emergency source begins automatically when the controller detects a normal source failure or a transfer test signal.

Normal Source Failure. The Normal source is considered unacceptable when any one of six voltage, frequency, or phase rotation conditions occur (see page 3–1).

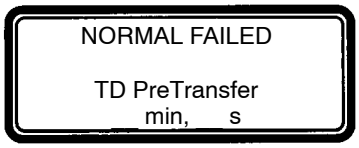
Transfer Test Signal. Test transfer signal can be from the **Transfer Control** switch (Feature 5), the engine–generator exerciser clock (Feature 11C), or via the serial port (Feature 72A). When using the **Transfer Control** switch, it must be held in the *Transfer Test* position until the emergency source becomes available (within 15 seconds).

The controller begins the load transfer sequence by de–energizing the SE relay and starting the Feature 1C time delay. Feature 1C time delay on engine starting prevents nuisance starting of the engine–generator set and load transfer to emergency due to momentary failures of the normal source. If the normal source is restored (voltage returns above the dropout point) while Feature 1C time delay is running, the SE relay is re–energized and the transfer sequence is terminated. (For transfer test the Feature 1C time delay is bypassed.)

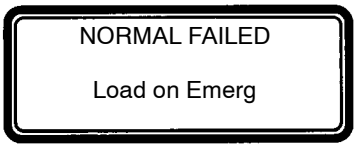
Engine Start Signal. When the Feature 1C time delay ends, the controller de–energizes the NR relay which signals the engine–generator to start. The controller monitors the emergency source, waiting for it to become acceptable. Usually about 10 seconds elapse from dropout of the NR relay to acceptance of the emergency source. This interval occurs because the engine–generator must crank, start, and run up to nominal pickup points. If the emergency source is available immediately, the controller will accept it as soon as the NR relay drops out.

When the emergency source becomes acceptable, the controller starts the Feature 2B time delay on transfer to emergency (if desired). Feature 2B time delay allows the emergency source to stabilize before load transfer. If the emergency source fails while Feature 2B time delay is running, the controller again waits for the emergency source to become acceptable again and restarts Feature 2B.

Feature 31F

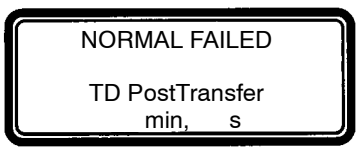


At the conclusion of the Feature 2B time delay, the controller is ready to transfer the load to emergency. If enabled, Feature 31F time delay will run prior to transfer and the Feature 31 output will be active while the time delay runs. Also, if Feature 27 inphase monitor control (for motor loads) is enabled, the controller will inhibit transfer until the sources are in phase.



Load Transfer. To transfer the load to the emergency source the controller energizes ER relay. The transfer switch TS coil energizes, and all transfer switch contacts (mains, controls, auxiliaries) reverse position. Transfer switch is now supplying the load from emergency source.

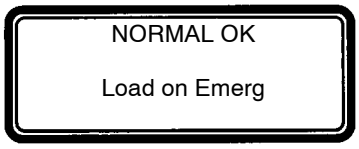
If enabled, Feature 31M time delay will run after the transfer and the Feature 31 output will be active while the time delay runs.



Feature 31M

Open–Transition (2–position) Automatic Transfer Switches continued

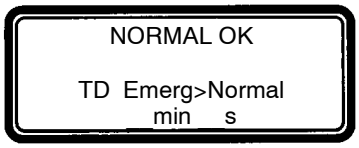
Load Retransfer To Normal



The sequence for load retransfer to the normal source begins automatically when the controller detects a restored normal source or a cancelled transfer test signal.

Normal Source Restoration. The Normal source is considered acceptable again when all six voltage, frequency, or phase rotation conditions occur (see page 3–1).

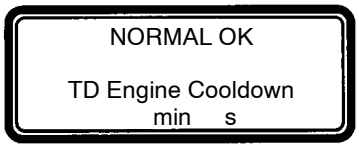
Cancel Transfer Test. Removal of the test transfer signal can be by the **Transfer Control** switch (Feature 5), engine–generator exerciser clock (Feature 11C), or via serial port (Feature 72A). When using the **Transfer Control** switch, it must be released from the *Transfer Test* position.



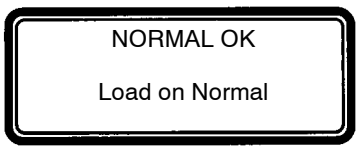
The controller begins the load retransfer sequence by starting the Feature 3A time delay. Feature 3A time delay on retransfer to normal allows the normal source to stabilize. If the normal source fails while the Feature 3A time delay is running, the controller waits for the normal source again to become acceptable and restarts the Feature 3A time delay. If the emergency source fails while Feature 3A is running, the controller bypasses the time delay for immediately load retransfer. To bypass Feature 3A time delay, turn the **Transfer Control** switch to the *Retransfer Delay Bypass* position.

At the conclusion of the Feature 3A time delay, the controller is ready to transfer the load to normal. If Feature 27 inphase monitor control is enabled, the controller will inhibit transfer until the sources are in phase.

Load Retransfer. To retransfer the load to the normal source the controller de–energizes ER relay and energizes SE relay. The transfer switch TS coil energizes, and all transfer switch contacts (mains, controls, auxiliaries) reverse position. The transfer switch is now supplying the load from the normal source again

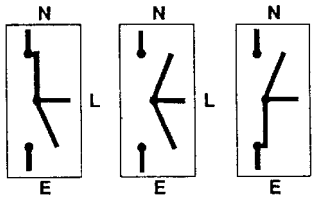


Engine Cooldown & Stop. After load retransfer to the normal source, the controller starts Feature 2E time delay. Feature 2E time delay provides an unloaded cooldown running period for the engine–generator. At the end of the time delay, the controller energizes the NR relay and the engine–generator is signalled to shutdown.



Closed–Transition Automatic Transfer (4ACTS, 7ACTS, 7ACTB)

The 4ACTS, 7ACTS, and 7ACTB provides load transfer in either closed (make–before–break) or open (break–before–make) transition modes depending upon the condition of the two power sources. Control logic automatically determines whether the load transfer should be open or closed transition. If both sources are acceptable, such as during a transfer test or when retransferring back to Normal, closed–transition transfer occurs without interrupting the electrical loads. If either source is not present, such as when normal fails, open–transition load transfer occurs in the break–before–make mode.



NORMAL FAILED

Open–Transition Load Transfer to Emergency Source due to Normal Source Failure

The sequence for open–transition load transfer to the emergency source begins automatically when the controller detects an unacceptable normal source. The Normal source is considered unacceptable when any one of six voltage, frequency, or phase rotation abnormal conditions occur (see page 3–1).

Normal Source Failure. An under voltage condition on any phase of the normal source means that the voltage has fallen below the preset dropout point.

The controller begins the load transfer sequence by de–energizing the SE and SE2 relays and starting the Feature 1C time delay. Feature 1C time delay on engine starting prevents nuisance starting of the engine–generator set and load transfer to emergency due to momentary failures of the normal source. If the normal source is restored (voltage returns above the dropout point) while Feature 1C time delay is running, the SE and SE2 relays are re–energized and the transfer sequence is terminated. (For transfer test the Feature 1C time delay is bypassed.)

Engine Start Signal. When the Feature 1C time delay ends, the controller de–energizes the NR relay which signals the engine–generator to start. The controller monitors the emergency source, waiting for it to become acceptable. Both voltage and frequency must reach preset pickup points before the emergency source is accepted. Usually about 10 seconds elapse from dropout of the NR relay to acceptance of the emergency source. This interval occurs because the engine–generator must crank, start, and run up to nominal pickup points. If the emergency source is available immediately, the controller will accept it as soon as the NR relay drops out.

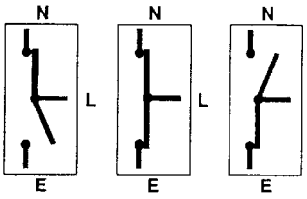
When the emergency source becomes acceptable, the controller starts the Feature 2B time delay on transfer to emergency (if desired). If the emergency source fails while Feature 2B time delay is running, the controller again waits for the emergency source to become acceptable again and restarts Feature 2B.

At the conclusion of the Feature 2B time delay, the controller is ready to transfer the load to emergency. If enabled, Feature 31F time delay will run prior to transfer and the Feature 31F output will be active while the time delay runs.

TEST MODE
TEST CIRCUIT 5
Load on Emerg

Load Transfer. To transfer the load to the emergency source the controller energizes the ER relay. The transfer switch CN coil energizes, and all CN transfer switch contacts (mains, controls, auxiliaries) reverse position to disconnect the Normal source. Then the controller energizes the ER2 relay. The transfer switch CE coil energizes, and all CE transfer switch contacts (mains, controls, auxiliaries) reverse position to connect the Emergency source. The transfer switch is now supplying the load from emergency source. If enabled, Feature 31M time delay will run after the transfer and the Feature 31M output will be active while the time delay runs.

Closed–Transition Automatic Transfer Switches continued



TEST MODE
TEST CIRCUIT 5
Waiting for Emerg
Acceptable

Closed–Transition Load Transfer to Emergency Source due to Transfer Test

The sequence for closed–transition load transfer to the emergency source begins automatically when the controller detects a transfer test signal.

Transfer Test Signal. Test transfer signal can be from the **Transfer Control** switch (Feature 5), the engine–generator exerciser clock (Feature 11C), or via the serial port (Feature 72A). When using the **Transfer Control** switch, it must be held in the *Transfer Test* position until the emergency source becomes available (within 15 seconds).

The controller begins the load transfer sequence by de–energizing the SE, SE2, and NR relays. Feature 1C engine starting time delay is bypassed during transfer test.

Engine Start Signal. When the NR relay de–energizes it signals the engine–generator to start. The controller monitors the emergency source, waiting for it to become acceptable. Both voltage and frequency must reach preset pickup points before the emergency source is accepted. Usually about 10 seconds elapse from dropout of the NR relay to acceptance of the emergency source. This interval occurs because the engine–generator must crank, start, and run up to nominal pickup points. If the emergency source is available immediately, the controller will accept it as soon as the NR relay drops out.

When the emergency source becomes acceptable, the controller starts the Feature 2B time delay on transfer to emergency (if desired). If the emergency source fails while Feature 2B time delay is running, the controller again waits for the emergency source to become acceptable again and restarts Feature 2B.

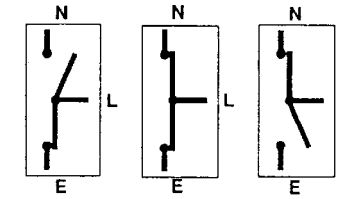
At the conclusion of the Feature 2B time delay, the controller starts the synchronization time delay which allows both sources to stabilize. After the synchronization time delay, the controller starts the in–sync monitor. Three criteria must be met for the sources to be considered in–sync. The phase difference between the sources must be less than 5 degrees, the frequency difference must be less than 0.2 Hz, and the voltage difference must be less than 5%. These parameters are displayed. The controller waits for the sources to become in–sync. At the same time, the failure to sync time delay is running. If the failure to sync time exceeds the user selected time, the failure to sync output is activated and remains active until it is reset via the alarm reset. The controller continues the transfer sequence even after the failure to synchronize alarm becomes active.

TEST MODE
TEST CIRCUIT 5
Load on Emerg

When the sources become in–sync the controller is ready to transfer the load to emergency.

Load Transfer. To transfer the load to the emergency source the controller energizes the ER2 relay. The transfer switch CE coil energizes, and all CE transfer switch contacts (mains, controls, auxiliaries) reverse position. The load is connected to both the Normal and Emergency sources. The extended parallel time delay is started and the controller energizes the ER relay. The transfer switch CN coil energizes, and all CN transfer switch contacts (mains, control, auxiliaries) reverse position to disconnect the Normal source. The load is now only connected to the Emergency source. If the sources are paralleled longer than the extended parallel time setting the controller activates an extended parallel output. It also deenergizes the ER and ER2 relays, energizes the SE and SE2 relays, and it locks out any further transfer operations. This lock–out condition is reset via the alarm reset.

Closed–Transition Automatic Transfer Switches continued



NORMAL OK

Load on Emerg

NORMAL OK

TD Emerg>Normal
min s

NORMAL OK

TD Engine Cooldown
min s

NORMAL OK

Load on Normal

Closed–Transition Load Retransfer To Normal

The sequence for load retransfer to the normal source begins automatically when the controller detects a restored normal source or a cancelled transfer test signal.

Normal Source Restoration. The Normal source is considered acceptable again when all six voltage, frequency, or phase rotation conditions occur (see page 3–1).

Cancel Transfer Test. Removal of the test transfer signal can be by the **Transfer Control** switch (Feature 5), engine–generator exerciser clock (Feature 11C), or via serial port (Feature 72A). When using the **Transfer Control** switch, it must be released from the *Transfer Test* position.

The controller begins the load retransfer sequence by starting the Feature 3A time delay. Feature 3A time delay on retransfer to normal allows the normal source to stabilize. If the normal source fails while the Feature 3A time delay is running, the controller waits for the normal source again to become acceptable and restarts the Feature 3A time delay. If the emergency source fails during while Feature 3A is running, the controller bypasses the time delay for immediately load retransfer. To bypass Feature 3A time delay, turn the **Transfer Control** switch to the *Retransfer Delay Bypass* position.

At the conclusion of the Feature 3A time delay, the controller starts the synchronization time delay which allows both sources to stabilize. After the synchronization time delay the controller starts the in–sync monitor and the failure to sync time delay. When the sources become in–sync the controller is ready to transfer the load to normal.

Load Retransfer. To retransfer the load to the normal source the controller de–energize the ER and ER1 relays and energizes the SE relay. The transfer switch CN coil energizes, and all CN transfer switch contacts (mains, controls, auxiliaries) reverse position to connect the Normal source. The load is now connected to both sources. The extended parallel time delay is started and the SE2 relay is energized. The transfer switch CE coil energizes, and all CE transfer switch contacts (mains, controls, auxiliaries) reverse position to disconnect the Emergency source. The transfer switch is now supplying the load from the normal source again. If the sources are paralleled longer than the extended parallel time setting the controller activates an extended parallel output. It also deenergizes the SE and SE2 relays, energizes the ER and ER2 relays, and it locks out any further transfer operations. This lock–out condition is reset via the alarm reset.

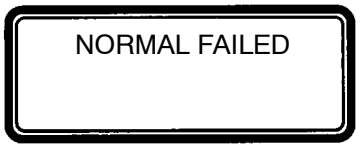
Engine Cooldown & Stop. After load retransfer to the normal source, the controller starts Feature 2E time delay. Feature 2E time delay provides an unloaded cooldown running period for the engine–generator. At the end of the time delay, the controller energizes the NR relay and the engine–generator is signalled to shutdown.

Bypass Closed–Transition Load Transfer

A pending closed–transition load transfer can be bypassed by using the Closed Transition Bypass switch. Depending upon the configuration of the controller, bypassing the closed–transition load transfer sequence will result in either an open or delayed– transition transfer.

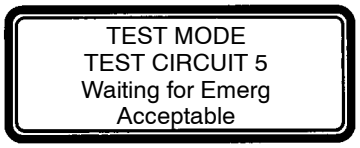
Delayed–Transition Automatic Transfer (4ADTS, 7ADTS, 7ADTB)

Load Transfer To Emergency



The sequence for load transfer to the emergency source begins automatically when the controller detects a normal source failure or a transfer test signal.

Normal Source Failure. The Normal source is considered unacceptable when any one of six voltage, frequency, or phase rotation conditions occur (see page 3–1).



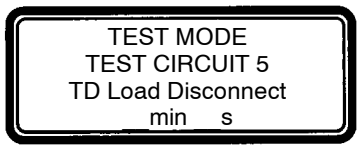
Transfer Test Signal. Test transfer signal can be from the **Transfer Control** switch (Feature 5), the engine–generator exerciser clock (Feature 11C), or via the serial port (Feature 72A). When using the **Transfer Control** switch, it must be held in the *Transfer Test* position until the emergency source becomes available (within 15 seconds).

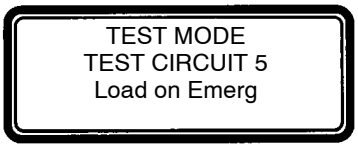
The controller begins the load transfer sequence by de–energizing the SE and SE2 relays and starting the Feature 1C time delay. Feature 1C time delay on engine starting prevents nuisance starting of the engine–generator set and load transfer to emergency due to momentary failures of the normal source. If the normal source is restored (voltage returns above the dropout point) while Feature 1C time delay is running, the SE and SE2 relays are re–energized and the transfer sequence is terminated. (For transfer test the Feature 1C time delay is bypassed.)

Engine Start Signal. When the Feature 1C time delay ends, the controller de–energizes the NR relay which signals the engine–generator to start. The controller monitors the emergency source, waiting for it to become acceptable. Both voltage and frequency must reach preset pickup points before the emergency source is accepted. Usually about 10 seconds elapse from dropout of the NR relay to acceptance of the emergency source. This interval occurs because the engine–generator must crank, start, and run up to nominal pickup points. If the emergency source is available immediately, the controller will accept it as soon as the NR relay drops out.

When the emergency source becomes acceptable, the controller starts the Feature 2B time delay on transfer to emergency (if desired). Feature 2B time delay allows the emergency source to stabilize before load transfer. If the emergency source fails while Feature 2B time delay is running, the controller again waits for the emergency source to become acceptable again and restarts Feature 2B.

At the conclusion of the Feature 2B time delay, the controller is ready to transfer the load to emergency.

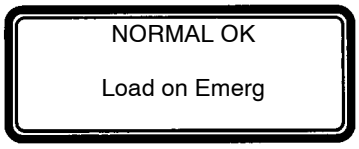




Load Transfer. To transfer the load to the emergency source in a delayed–transition mode the controller energizes ER relay first. The transfer switch CN coil energizes and opens the CN transfer switch contacts. The load is disconnected from both sources. The load disconnect time delay starts. When this time delay ends, the controller energizes the ER relay. The transfer switch CE coil energizes and closes the CE transfer switch main contacts. The transfer switch is now supplying the load from emergency source.

Delayed–Transition Automatic Transfer Switches continued

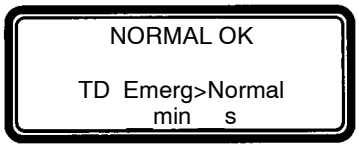
Load Retransfer To Normal



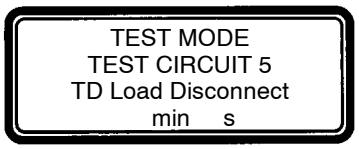
The sequence for load retransfer to the normal source begins automatically when the controller detects a restored normal source or a cancelled transfer test signal.

Normal Source Restoration. The Normal source is considered acceptable again when all six voltage, frequency, or phase rotation conditions occur (see page 3–1).

Cancel Transfer Test. Removal of the test transfer signal can be by the **Transfer Control** switch (Feature 5), engine–generator exerciser clock (Feature 11C), or via serial port (Feature 72A). When using the **Transfer Control** switch, it must be released from the *Transfer Test* position.

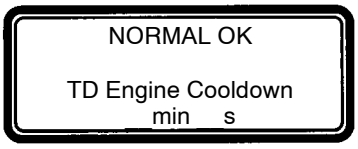


The controller begins the load retransfer sequence by starting the Feature 3A time delay. Feature 3A time delay on retransfer to normal allows the normal source to stabilize. If the normal source fails while the Feature 3A time delay is running, the controller waits for the normal source again to become acceptable and restarts the Feature 3A time delay. If the emergency source fails during while Feature 3A is running, the controller bypasses the time delay for immediately load retransfer. To bypass Feature 3A time delay, turn the **Transfer Control** switch to the *Retransfer Delay Bypass* position

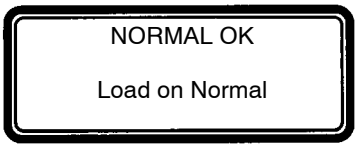


At the conclusion of the Feature 3A time delay, the controller is ready to transfer the load to normal.

Load Retransfer. To retransfer the load to the normal source in a delayed–transition mode the controller de–energizes the ER and ER2 relays and energizes the SE2 relay. The transfer switch CE coil energizes and opens the CE transfer switch main contacts. The load is disconnected from both sources. The load disconnect time delay starts. When this time delay ends the controller energizes the ER relay. The transfer switch CN coil energizes and closes the CN transfer switch main contacts. The transfer switch is now supplying the load from the normal source again.



Engine Cooldown & Stop. After load retransfer to the normal source, the controller starts Feature 2E time delay. Feature 2E time delay provides an unloaded cooldown running period for the engine–generator. At the end of the time delay, the controller energizes the NR relay and the engine–generator is signalled to shutdown.



Controller Cover Removal

⚠ DANGER

Hazardous voltage capable of causing shock, burns, or death is connected to controller. Deenergize all power before removing cover.

NOTICE

ATTENTION

Observe precautions for handing electrostatic sensitive devices.

Touch ground first !
Electrostatic
sensitive device.

The Group 5 controller (CP) is used for sensing, timing, and control functions with 4000 & 7000 Series Automatic Transfer Switches. This Appendix shows the controller DIP switch actuator settings and jumper block settings for input voltage, frequency, phases, and type of transfer switch used (open, closed, delayed transition). These controls should only be used by trained technicians from ASCO Services, Inc. (ASI 1–800–800–2726).

DIP switch actuators see page A–2

Voltage jumper blocks see page A–4

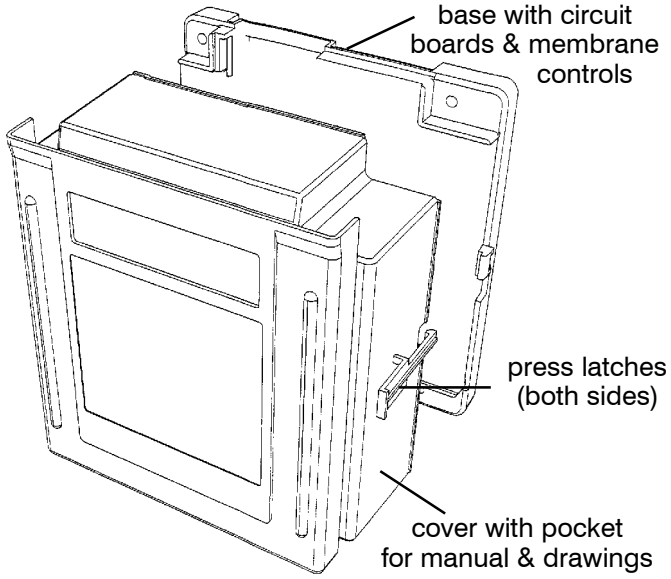


Figure A–1. Cover release latches.

⚠ CAUTION

Any indiscriminate change in DIP switch and jumper block settings may damage the controller and/or cause an inoperative ATS.

⚠ CAUTION

Risk of explosion if battery is replaced by an incorrect type. Dispose of used batteries according to local ordinances.

DIP Switch Actuators

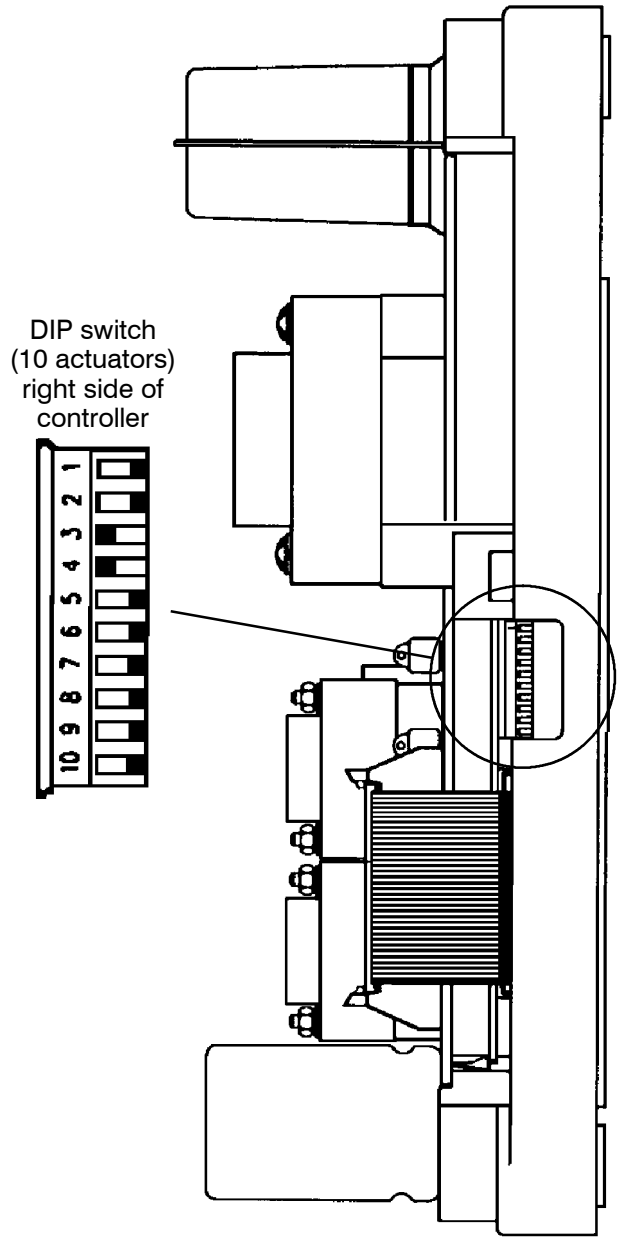


Figure A–2. Location of DIP switch.

The DIP switch in the Group 5 controller is located on the right side through a opening in the base. The following tables show what each actuator does.

Transfer Switch Type

DIP switch actuators 1 and 2 select the type of transfer switch used with the controller (open–transition, closed–transition, or delayed–transition). See Table A.

Table A. Transfer switch type — DIP actuators 1 & 2.

DIP switch actuator	open transition or *		closed transition	delayed-transition
1	⇨	⇦	⇦	⇨
2	⇨	⇦	⇨	⇦

* For open–transition, both actuators 1 & 2 must be in the same position (either both right or both left).

⚠ CAUTION

To avoid permanently damaging the Group 5 controller and/or disabling it, be certain that the setting matches the transfer switch type.

Nominal Source Voltage Selection

DIP switch actuators 3, 4, 5, and 6 select the input voltage to the controller. See Table B.

⚠ CAUTION

To avoid permanently damaging to the Group 5 controller, be certain that the voltage setting matches the transfer switch system voltage.

Table B. Nominal Input Voltage — DIP actuators 3, 4, 5, & 6.

DIP switch actuator	Input Voltage to Controller															
	115	120	208	220	230	240	277	380	400	415	440	460	480	550	575	600
3	⇦	⇨	⇦	⇨	⇦	⇨	⇦	⇨	⇦	⇨	⇦	⇨	⇦	⇨	⇦	⇨
4	⇦	⇦	⇨	⇨	⇦	⇦	⇨	⇨	⇦	⇦	⇨	⇨	⇦	⇦	⇨	⇨
5	⇦	⇦	⇦	⇦	⇨	⇨	⇨	⇨	⇦	⇦	⇦	⇦	⇨	⇨	⇨	⇨
6	⇦	⇦	⇦	⇦	⇦	⇦	⇦	⇦	⇨	⇨	⇨	⇨	⇨	⇨	⇨	⇨

Frequency of Sources

DIP switch actuator 7 selects either 50 or 60 Hz source frequency. See Table C.

Table C. Source Frequency — DIP actuator 7.

DIP switch actuator	50 Hz	60 Hz
7	⇦	⇨

Phases of Normal & Emergency Sources

DIP switch actuators 8 and 9 select either 1 phase or 3 phase for the Normal and Emergency sources. See Tables D and E.

Table D. Normal Source Phases — DIP actuator 8.

DIP switch actuator	1 Phase	3 Phase
8	⇦	⇨

Table E. Emergency S. Phases — DIP actuator 9.

DIP switch actuator	1 Phase	3 Phase
9	⇦	⇨

Data Input Lock

The Group 5 controller has an external input for a dry contact that, if closed, prevents setting changes from the keypad. DIP switch actuator 10 selects either yes or no for the external input (such as a key switch). Placing DIP switch actuator 10 in the **Yes** position enables the controller to respond to the external input. See Table F.

Lost or Forgotten Password

Moving DIP switch actuator 10 to the **Yes** position will allow a new password to be input (as long as the external input is open). Once the new password has been entered, return DIP switch actuator 10 to the **No** position. See Table F.

Table F. Lock Input — DIP actuator 10.

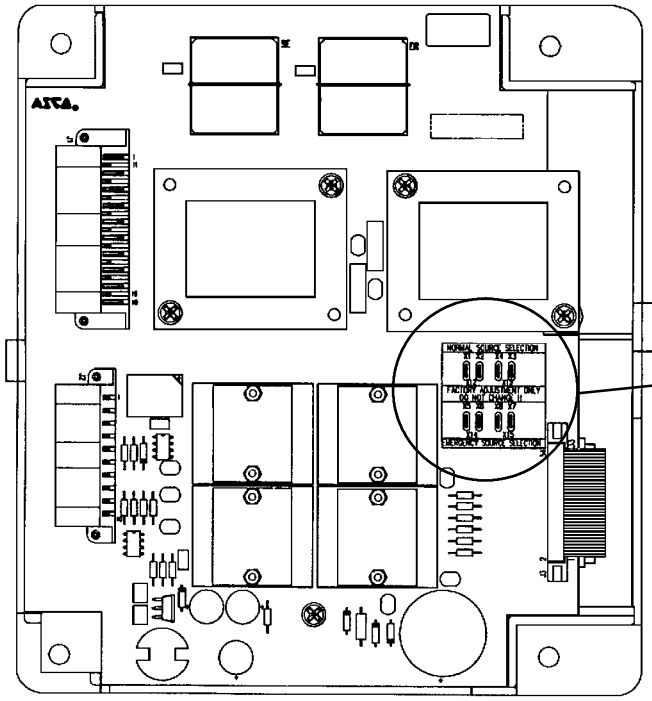
DIP switch actuator	Yes	No
10	⇦	⇨

Voltage Jumper Blocks

⚠ CAUTION

To avoid permanently damaging the Group 5 controller, be certain that the voltage setting matches the transfer switch system voltage.

Eight jumper blocks on the Group 5 controller are arranged in one of two patterns for the power supply to meet the requirements of the 16 different voltage inputs (shown in Table B on page A–2). These jumpers are located on the front right side near the ribbon cable. See Figures A–3 and A–4.



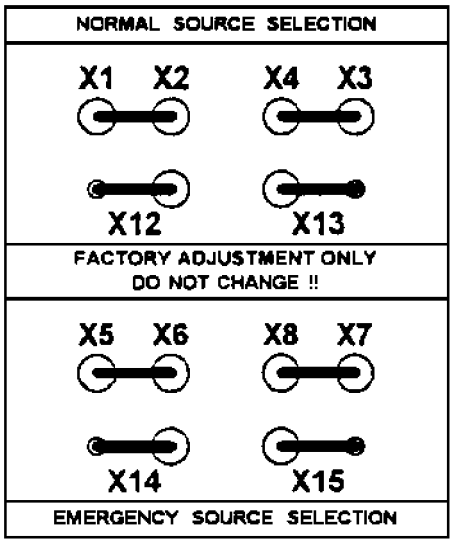
Note: Also see page A–2 for Nominal Source Voltage Selection DIP switch actuator settings.

jumper blocks (see Figure A–4)

Figure A–3. Location of jumper blocks.

Nominal voltage
115 — 277 V
(115, 120, 208, 220, 230, 240, 277)

Position jumpers HORIZONTALLY



Nominal voltage
380 — 600 V
(380, 400, 415, 440, 460, 480, 550, 575, 600)

Position jumpers VERTICALLY

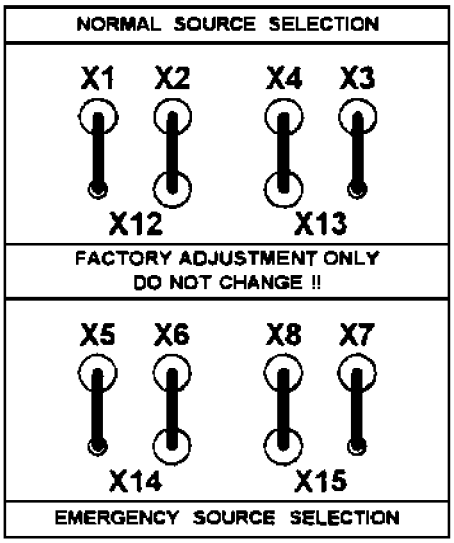


Figure A–4. Power supply jumper arrangements.

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Operator's Manual

ASCO® 7000 Series 7ATB Automatic Transfer & Bypass–Isolation Switches J design 150 through 600 amp.

⚠ DANGER

DANGER is used in this manual to warn of high voltages capable of causing shock, burns, or death.

⚠ WARNING

WARNING is used in this manual to warn of possible personal injury.

⚠ CAUTION

CAUTION is used in this manual to warn of possible equipment damage.

Refer to the outline and wiring drawings provided with your 7000 Series ATB for all installation and connection details and accessories.

Refer to *Group 5 Controller User's Guide* 381333–126 for ATS status display messages, time delays, pickup & dropout settings, and adjustments.

An experienced licensed electrician must install the 7ATB.

Rating Label

Each 7000 Series 7ATB contains a rating label to define the load and fault circuit withstand/closing ratings. Refer to the label on the Transfer Switch for specific values.

⚠ WARNING

Do not exceed the values on the rating label. Exceeding the rating can cause personal injury or serious equipment damage.

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ASCO Power Technologies® 50 Hanover Road, Florham Park, New Jersey 07932–1591 USA
For sales or service call 1 800 800–2726 (ASCO) www.ascopower.com

ASCO POWER TECHNOLOGIES CANADA PO Box 1238, 17 Airport Road, Brantford, Ontario, Canada N3T 5T3
telephone 519 758–8450, fax 519 758–0876, for service call 1 888 234–2726 (ASCO) www.asco.ca

381333–307 A

EMERSON Network Power

Nameplate

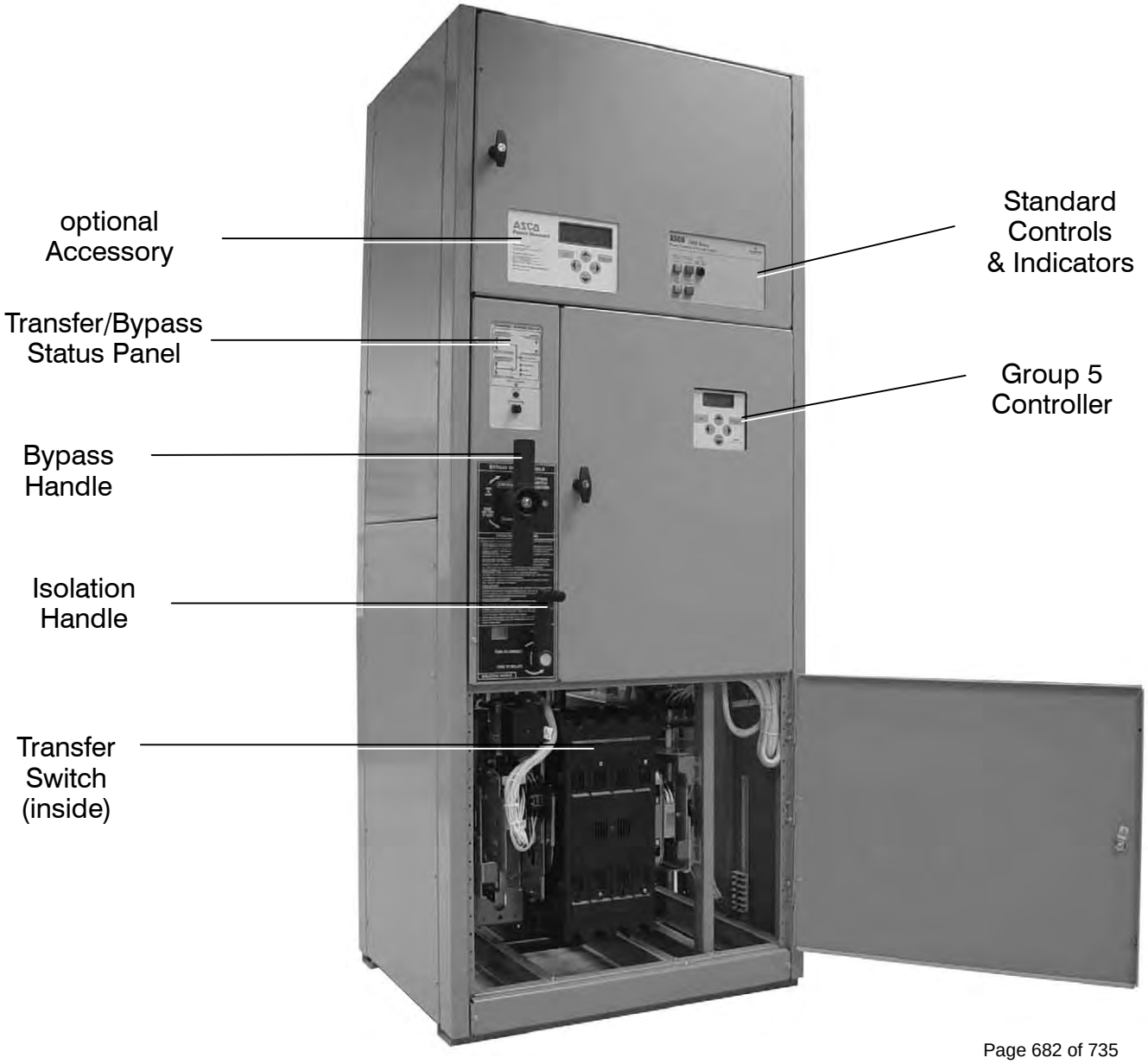
The Transfer Switch nameplate includes data for each specific 7000 Series ATB. Use the switch only within the limits shown on this nameplate. A typical Catalog Number is shown below with its elements explained.

Catalog Number Identification

Typical 7000 Series ATB catalog no. for overlapping neutral, 3 pole, 600 amp, 480 V, ATS in Type 1 enclosure:

J7ATB C 3 600 N 5 C

Neutral	Phase Poles	Amperes	Voltage		Controller	Enclosure
A – solid	2 – single Ø	150	A 115	J 400	5 – standard	C – type 1
B – switched	3 – three Ø	200	B 120	K 415	5X – if accessories ordered	F – type 3R
C – overlapping		230	C 208	L 440		G – type 4
blank – none		260	D 220	M 460		L – type 12
		400	E 230	N 480		blank – open type
		600	F 240	P 550		
			G 277	Q 575		
			H 380	R 600		



SECTION 1 INSTALLATION

ASCO 7000 Series Automatic Transfer & Bypass–Isolation Switches (7ATBs) are factory wired and tested. Field installation requires mounting and connection of service cables, and auxiliary control circuits (if required).

Remove the Shipping Skid

Open the enclosure's lower front door and also remove the lower rear access panel. Then remove the four lag screws (2 in front, 2 in rear) securing the enclosure to the shipping skid.

Supporting Foundation

The supporting foundation for the enclosure must be level and straight. Refer to the applicable enclosure outline drawing included with the switch for all mounting details including door opening space.

If bottom cable entry is used, the foundation must be prepared so that the conduit stubs are located correctly. Refer to the enclosure outline drawing for specified area and location. Provide cable bending space and clearance to live metal parts. When a concrete floor is poured, use interlocking conduit spacer caps or a wood or metal template to maintain proper conduit alignment.

Mounting

Refer to the applicable enclosure outline drawing furnished with this switch and mount the automatic transfer switch according to details and instructions shown on diagram.

Line Connections

Refer to the Wiring Diagram provided with the switch. All wiring must be made in accordance with the National Electrical Code and local codes.

Do not remove the barrier from the transfer switch. Always protect the transfer switch, bypass switch, and isolation contacts and mechanisms from construction grit and metal chips when cabling.

⚠ DANGER

De–energize the conductors before making any line or auxiliary circuitry connections. Be sure that Normal and Emergency line connections are in proper phase rotation. Place engine generator starting control in the OFF position. Make sure engine generator is not in operation.

Testing Power Conductors

Do not connect the power conductors to the transfer switch until they are tested. Installing power cables in conduit, cable troughs and ceiling-suspended hangers often requires considerable force. The pulling of cables can damage insulation and stretch or break the conductor's strands. For this reason, after the cables are pulled into position, and before they are connected, they should be tested to verify that they are not defective or have been damaged during installation.

⚠ CAUTION

Protect the switch from construction grit and metal chips to prevent malfunction or shortened life of the 7ATB switch.

Connecting Power Conductors

After the power cables have been tested, connect them to the appropriate terminal lugs on the bypass switch as shown on the wiring diagram provided with the switch. Make sure the lugs provided are suitable for use with the cables being installed. Standard terminal lugs are solderless screw type and will accept the wire sizes listed on the drawings provided with the 7ATB. Be careful when stripping insulation from the cables; avoid nicking or ringing the conductor. Remove surface oxides from cables by cleaning with a wire brush. When aluminum cable is used, apply joint compound to conductors. Tighten cable lugs to the torque specified on rating label.

Controller Ground

A grounding wire must be connected to the controller's lower left mounting stud. Because the controller is mounted on the enclosure door, a conductive strap must be used between the enclosure and the door. This connection provides proper grounding which does not rely upon the door hinges.

Harnesses

The transfer switch is connected to the left side of the controller by a plug–in harness (two plugs).

Engine Starting Contacts

All customer connections, including the engine control contact connections, are located on terminal block TB which is mounted on the top right side of the enclosure. Refer to the wiring diagram provided with the automatic transfer switch and connect the engine start wires to the appropriate terminals. See Figure 1–1 and Table A.

Table A. Engine start connections.

When normal source fails	Terminals on Terminal Block TB
contact closes	TB1 and TB2
contact opens	TB1 and TB3

Note: To temporarily disable engine control from the automatic transfer switch you can unplug J3 from the small P3 receptacle at the bottom of the assembly. Be sure to reconnect plug J3 to the P3 receptacle for automatic transfer switch operation.

Auxiliary Circuits

Connect auxiliary circuit wires to appropriate terminals on transfer switch terminal block TB as shown on the wiring diagram provided with this automatic transfer switch.

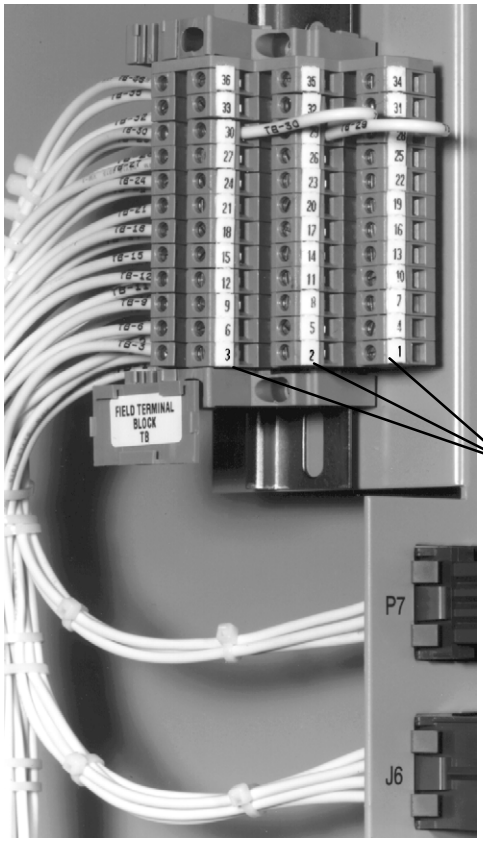


Figure 1-1. Customer terminal block on the top right side of the enclosure.

Functional Test

The Functional Test consists of two checks:

- ❒ 1 — Voltage Checks, page 1–3
- ❒ 2 — Electrical Operation, page 1–4

⚠ CAUTION

Do these checks in the order presented to avoid damaging the 7ATB.

Read all instructions on the Wiring Diagram and labels affixed to the automatic transfer & bypass–isolation switch. Note the control features that are provided and review their operation before proceeding.

Continue to **1 – Voltage Checks** on next page.

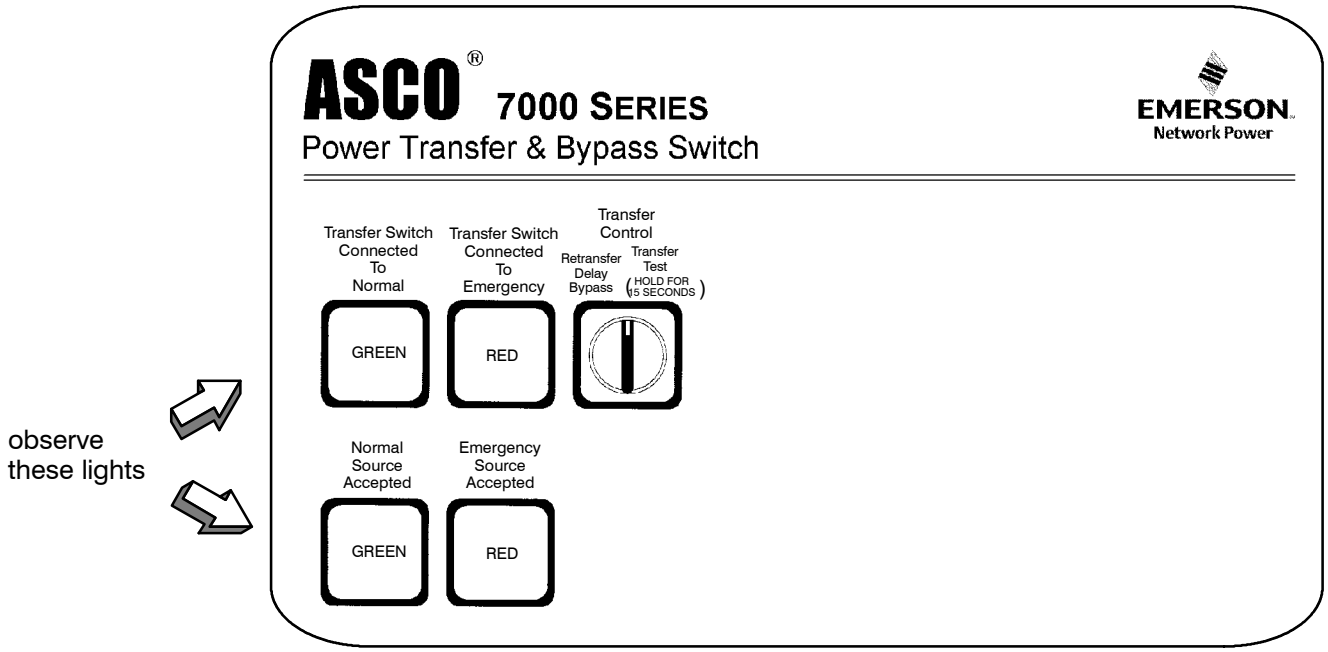


Figure 1-2. Standard controls and indicators.

Functional Test

Read all instructions on the *Wiring Diagrams* and labels affixed to the 7ATB. Note the control features that are provided and review their operation before proceeding.

After installing the 7ATB check the following:

– Bypass Handle should be in the *NORMAL* position.
– Isolation Handle should be in the *CONN* position.
– TS transfer switch Normal contacts should be *C* (closed)
Emergency contacts should be *O* (open)

If handles are not in correct positions, follow instructions for Bypassing and Isolating the automatic transfer switch in **Section 3**. **Do not force the handles**. Electrical interlocks prevent a wrong sequence of operation.

1 – Voltage Checks

First check nameplate on transfer switch; rated voltage must be the same as normal and emergency line voltages.

⚠ DANGER

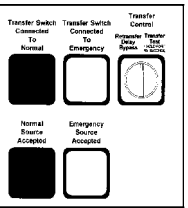
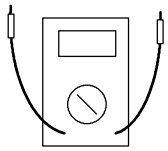
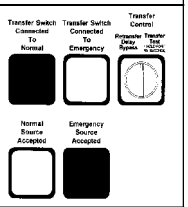
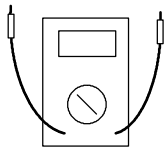
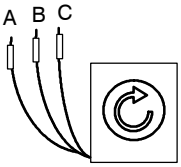
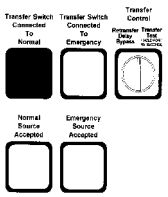
Use extreme caution when using a meter to measure voltages. Do not touch power terminals; shock, burns, or death could result !

Perform steps 1–6 at the right. Observe the status lights. See Figure 1–2.

■ Black square means light is on.
❒ White square means light is off.

* If necessary, adjust voltage regulator on generator per the manufacturer's recommendations. The 7ATB will respond only to rated voltage specified on the nameplate.

Now continue to **2 – Electrical Operation** on next page.

1	Close the normal source circuit breaker. The *Transfer Switch Connected To Normal* and the *Normal Source Accepted* lights should come on.	
2	Use an accurate voltmeter to check phase to phase and phase to neutral voltages present at the transfer switch normal source terminals.	
3	Close the emergency source circuit breaker. (Start generator, if necessary.) The *Transfer Switch Connected To Normal* & *Emergency Source Accepted* lights should come on.	
4	Use an accurate voltmeter to check phase to phase and phase to neutral voltages present at the transfer switch emergency source terminals.*	
5	Use a phase rotation meter to check phase rotation of emergency source; it must be the same as the normal source.	
6	Shut down the engine–generator, if applicable. The *Emergency Source Accepted* light should go off. Then put the starting control selector switch (on the generator set) in the *automatic* position. Close enclosure door.	

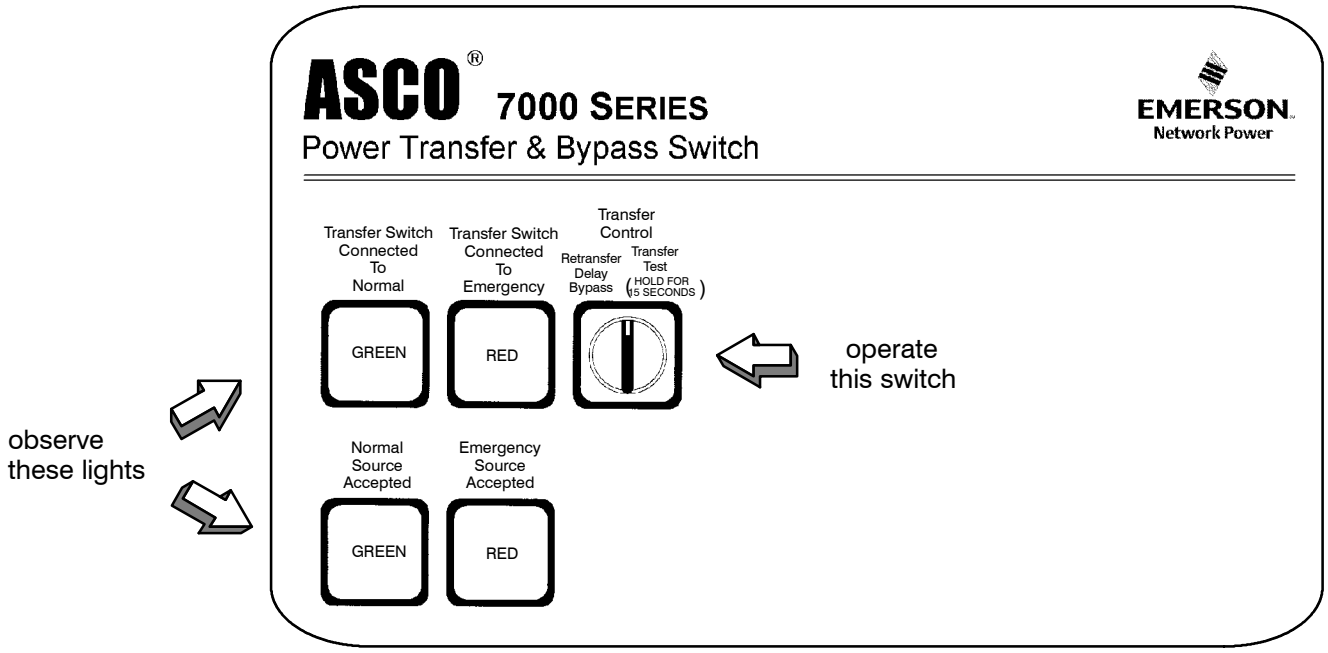


Figure 1-3. Standard controls and indicators.

2 – Electrical Operation

This procedure checks electrical operation of the ATS.

⚠ WARNING

Be sure to close the enclosure door before proceeding to prevent personal injury in case of electrical system fault.

Transfer Test

The ATS should still be bypassed. Both normal and emergency sources must be available and the emergency source generator (if used) must be capable of being started; put engine starting control in *automatic* position. The *Transfer Switch Connected to Normal* light and the *Normal Source Accepted* light should be on.

1. Turn the **Isolation Handle** counterclockwise to the *TEST* position.

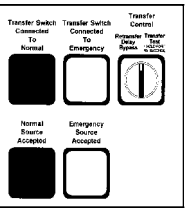
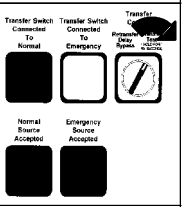
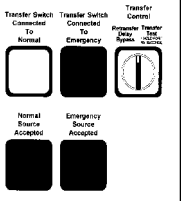
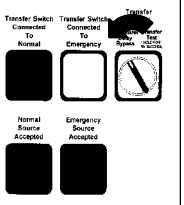
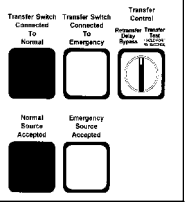
   NOTE: The engine generator may be signalled to start while turning the Isolation Handle. If emergency source is available, the ATS may operate to the emergency position. If it does, operate **Retransfer Delay Bypass** switch.

2. Perform steps 1–5 at right. Observe the status lights. See Figure 1–3.

   ■ Black square means light is on.
   ❒ White square means light is off.

3. Turn the **Isolation Handle** clockwise to the *CONN* (connected) position.
4. Turn the **Bypass Handle** clockwise to the *OPEN* position.

This completes the Functional Test of the 7ATB.

1	The *Transfer Switch Connected to Normal* and *Normal Source Accepted* lights should be on.	
2	Turn and hold **Transfer Control** switch clockwise to *Transfer Test* until the engine starts and runs (within 15 sec.). The *Emergency Source Accepted* light should come on.	
3	Transfer switch will operate to the Emergency position after Feature 2B time delay. The *Transfer Switch Connected To Emergency* light should come on and *Load Connected to Normal* light goes off.	
4	Transfer switch will operate back to Normal position after Feature 3A time delay. For immediate retransfer turn **Transfer Control** counterclockwise to *Retransfer Delay Bypass*. The *Transfer Switch Connected To Normal* light should come on; *Transfer Switch Connected to Emergency* light should go off.	
5	The engine–generator will stop after the Feature 2E time delay (unloaded running engine cool-down). The *Emergency Source Accepted* light should go off.	

SECTION 2 TESTING & SERVICE

TRANSFER TEST

Test the Automatic Transfer Switch portion of the 7000 Series 7ATB at least once a month. This procedure checks the electrical operation of the Transfer Switch and Controller. Put the engine–generator starting control (at the engine–generator set) in automatic mode.

In the following test the generator will start, the load will be transferred to the Emergency source, then back to the Normal source. An interruption to the load will occur, unless the the Transfer Switch contacts are bypassed before the test. See pages 3–1 through 3–4 for bypassing & isolating instructions if no interruption of load is required.

⚠ WARNING

Be sure to close the enclosure door before proceeding to prevent personal injury in case of electrical system fault.

Perform the five–step **Electrical Operation – Transfer Test** procedure on page 1–4.

PREVENTIVE MAINTENANCE

Reasonable care in preventive maintenance will insure high reliability and long life for the 7000 Series 7ATB. An annual preventive maintenance program is recommended.

ASCO Services, Inc. (ASI) is ASCO Power Technologies's national service organization. In the US ASI can be contacted at 1-800-800-2726 for information on preventive maintenance agreements.

Checklist for Yearly Inspection

⚠ DANGER

Hazardous voltage capable of causing shock, burns, or death is used in this switch. Deenergize both Normal – Emergency power sources before performing inspections!

- ❒ **Clean the 7ATB enclosure.**
  Brush and vacuum away any excessive dust accumulation. Remove any moisture with a clean cloth.
- ❒ **Check the transfer switch contacts.**
  Bypass, isolate, and withdraw the transfer switch. Then remove the transfer switch interphase barriers and check the condition of the contacts. Replace contacts when pitted or worn excessively. Reinstall the interphase barriers carefully. See page 3–4.
- ❒ **Maintain transfer switch lubrication**.
  If switch is subjected to severe dust or abnormal operating conditions, renew factory lubrication on all movements and linkages. Relubricate solenoid operator if TS coil is replaced. Don't use oil; order ***lubrication kit 75-100***.
- ❒ **Check all cable connections & retighten them**.

REPLACEMENT PARTS

Replacement parts are available in kit form. When ordering parts provide the Serial No., Bill of Material No. (BOM), and Catalog No. from the transfer switch nameplate. Contact your local ASCO Power Technologies Sales Office or ASI:

In the United States
call 1 – 800 – 800 – ASCO (2726)

In Canada
call 1 – 888 – 234 – ASCO (2726)

DISCONNECTING THE CONTROLLER

The harness disconnect plugs are furnished for repair purposes only and should not have to be unplugged. If the controller must be isolated, follow these steps:

⚠ DANGER

Bypass–Isolation Switch is energized! Do not touch isolation contact fingers; shock, burns, or death could result!

Disconnecting the Plugs

1. Bypass and Isolate the ATS (see Section 3).
2. Open the upper enclosure door.
3. Separate the two quick disconnect plugs by squeezing the latches. Do not pull on the harness wires.

Reconnecting the Plugs

1. The ATS should be still bypassed and isolated.
2. The two harness plugs and sockets are keyed. Carefully align the plugs with the sockets and press straight in until the latches click.
3. Close the enclosure doors.
4. Follow *Return to Service* instructions on page 3–5.

MANUAL LOAD TRANSFER

This procedure manually transfers load to other source if the Transfer Switch or Controller are out of service.

⚠ WARNING

Close enclosure doors to prevent personal injury in case of electrical system fault.

1. Bypass the connected ATB source. Turn Bypass Handle to *EMERGENCY* or *NORMAL* (see page 3–2).
2. Isolate to Test. Turn the Isolation Handle to *TEST* position (see page 3–3).
3. Turn the Bypass Handle to *OPEN*, then to the other source (see page 3–1). The load will be interrupted.
4. Turn the Isolation Handle clockwise to the *CONN* [connected] position (see page 3–4).

TROUBLE-SHOOTING

Note any optional accessories that may be furnished on the 7ATB and review their operation. Refer to any separate drawings and/or instructions that may be packed with the 7ATB. See Table B.

⚠ DANGER

Hazardous voltage capable of causing shock, burns, or death is used in this switch. Do not touch the power or load terminals of the bypass switch or transfer switch!

Table B. Trouble-Shooting Checks.

PROBLEM	CHECK IN NUMERICAL SEQUENCE		
	1 – OPERATION	2 – GEN-SET	3 – VOLTAGE
Engine–generator set does not start when the **Transfer Control** switch is turned and held in *Transfer Test* position or when normal source fails.	Hold *Transfer Test* switch 15 seconds or the outage must be long enough to allow for Feature 1C time delay plus engine cranking and starting.	Starting control must be in the automatic position. Batteries must be charged and connected. Check wiring to engine starting contacts.	–
Transfer switch does not transfer the load to the emergency source after the engine–generator set starts.	Wait for Feature 2B time delay to time out.	Generator output circuit breaker must be closed. Generator frequency must be at least 95% of nominal (57 Hz for a 60 Hz system.) *	Voltmeter should read at least 90% of nominal phase to phase voltage between transfer switch terminals EA & EC (or EL1 & EL2 for 2 pole)*
Transfer switch does not transfer the load to normal source when normal returns or when the **Transfer Control** switch is released.	Wait for Feature 3A time delay to time out.	–	Voltmeter should read at least 90% of nominal phase to phase voltage between transfer switch terminals NB & NC, NC & NA, & NA & NB (or NL1 & NL2 for 2 pole).
Engine–generator-set does not stop after load retransfer to the normal source.	Wait for Feature 2E time delay to time out.	Starting control must be in the automatic position.	–

* These are factory settings. Refer to **Controller's User's Guide**.

If the problem is isolated to circuits on the controller or the transfer switch, call your local ASCO Power Technologies sales office or ASI: in the United States, call 1–800–800–2726 or in Canada call 1–888–234–2726. Furnish the Serial No., Catalog No., and Bill of Material (BOM) No. from the transfer switch nameplate.

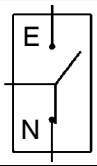
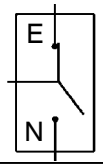
MAINTENANCE HANDLE

⚠ DANGER

Bypass and isolate the Transfer Switch before using the maintenance handle! See pages 3–1 through 3–4. Remove the maintenance handle after using it; store it inside.

1. Bypass, isolate, and withdraw the transfer switch (pages 3–1 through 3–4). Then locate and remove the maintenance handle from the clip (inside lower left side). Insert the handle into the hole in the molded hub on the left side of the operator of the transfer switch See Figure 2–1 and Table C.

Table C. Maintenance handle positions.

ATS Position		Handle	Indicators
Normal		 up	E = O upper contacts open N = C lower contacts closed
Emergency		 down	E = C upper contacts closed N = O lower contacts open

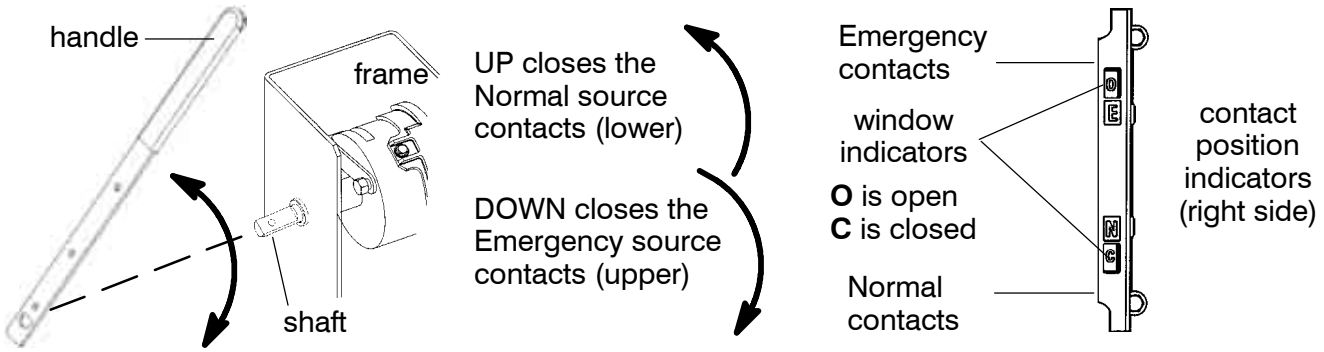


Figure 2–1. Maintenance handle operation and contact position indicators.

SECTION 3 BYPASSING & ISOLATING

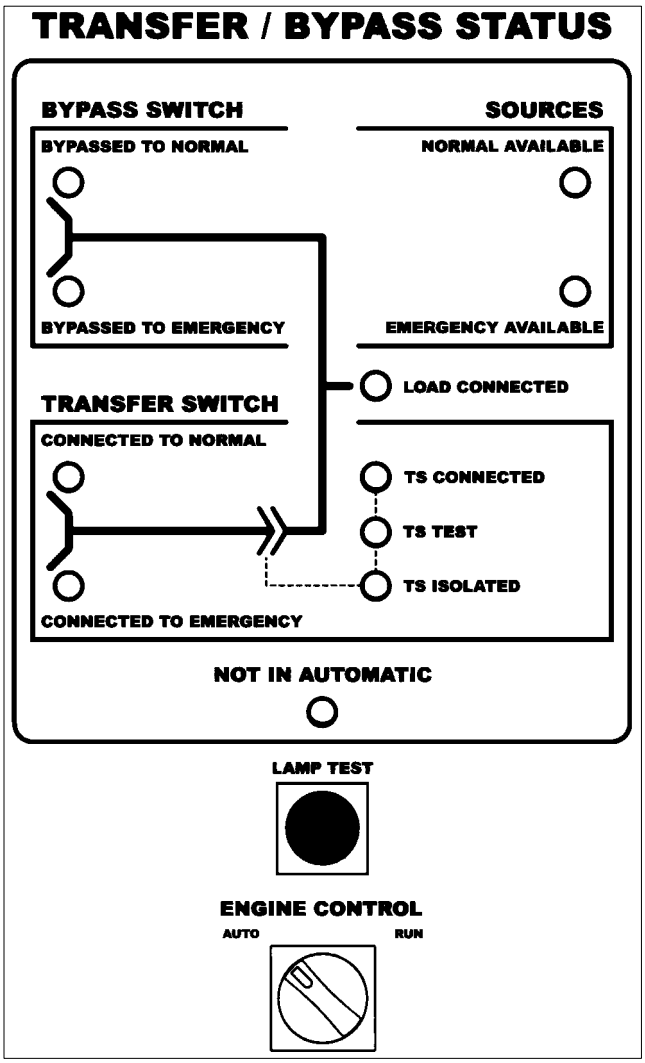


Figure 3–1. Status lights and Engine Control.

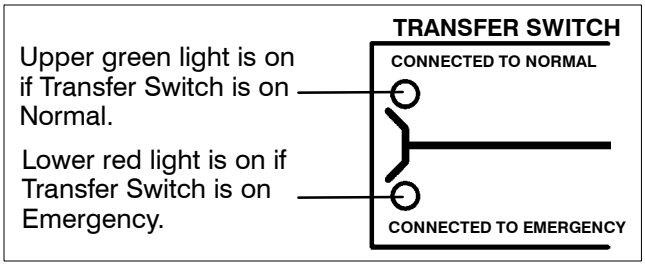


Figure 3–2. Status lights for Transfer Switch main contact position.

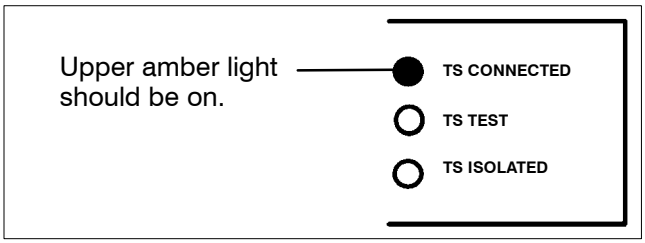


Figure 3–3. Status lights for Transfer Switch isolation contact position.

BYPASSING THE ATS*

This procedure explains how to Bypass the closed transfer switch contacts. Bypassing is required before the Transfer Switch can be tested or isolated. The Bypass Switch Handle must be in the *OPEN* position (green window indicator) and the Isolation Handle must be in the *CONN* [connected] position (window indicator). The *TS Connected* light must be on. See Figures 3–1, 3–2, 3–3.

⚠ CAUTION

You can only bypass to the same source that the Transfer Switch is connected. Solenoid interlock prevents incorrect operation.

1. Observe which *Transfer Switch Connected To* light is on (*Normal* or *Emergency)* on the door. This is the position of the transfer switch (see Figure 3–2).

2. Follow the directions on next page to Bypass to the same source as connected to transfer switch (select Normal or Emergency).

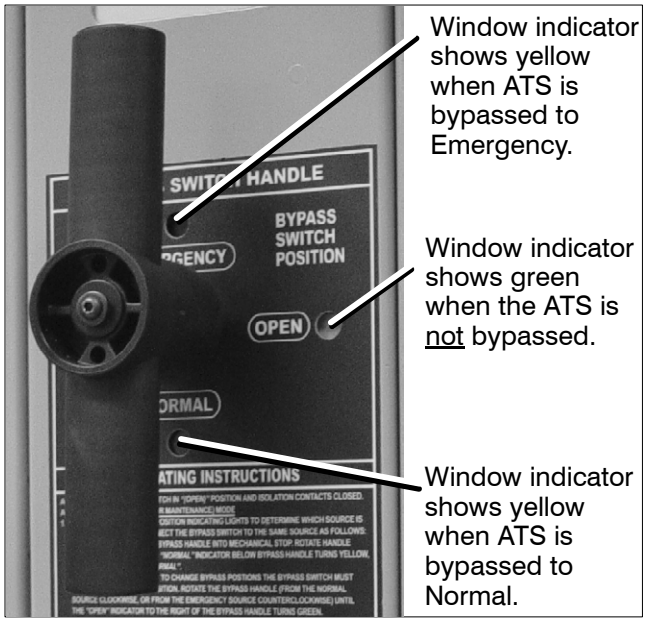


Figure 3–4. Bypass Handle and three position window indicators.

NOTE: The 7ATB contains mechanical (window) indicators for the bypass switch and transfer switch positions in addition to the LED status lights.

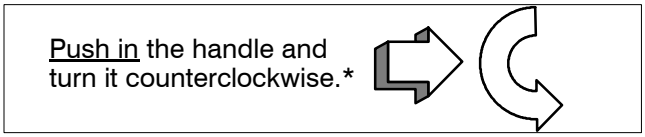
Allowable Positions of the Bypass Switch in relation to Positions of the Transfer Switch
(with Isolation Handle in the *Conn* [connected] position and *TS Connected* light on)

Transfer Switch	Bypass Switch can be in either	
If Transfer Switch is in Normal position.	Open or	Normal
If Transfer Switch is in Emergency position.	Open or	Emergency

BYPASSING & ISOLATING *(continued)*

To Bypass Normal Source*

(Load connected to Normal Source)
The *Transfer Switch Connected To Normal* light is on and *Transfer Switch Connected To Emergency* light is off.



Push in* the Bypass Handle all the way, then turn it counterclockwise until *Bypass Switch Position* shows closed on NORMAL (yellow window indicator). The green light *Bypassed to Normal* will come on and the amber light *Not In Automatic* will flash.

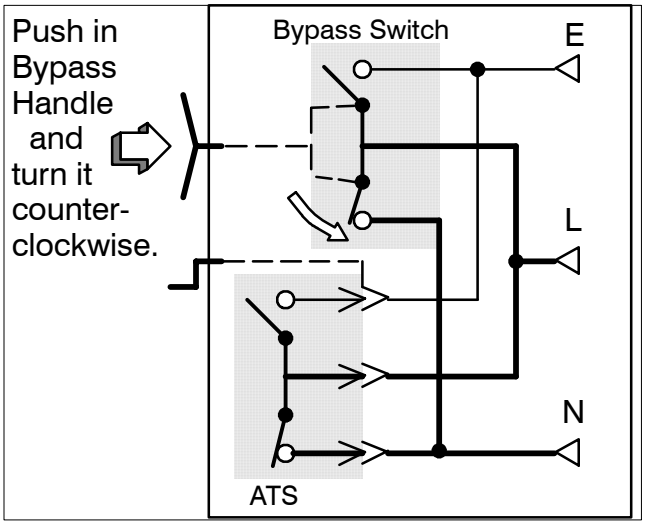
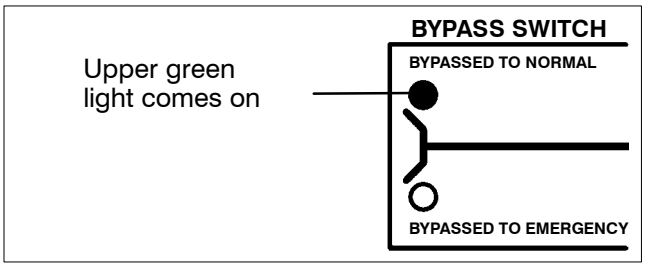


Figure 3–5. Bypass to Normal diagram.



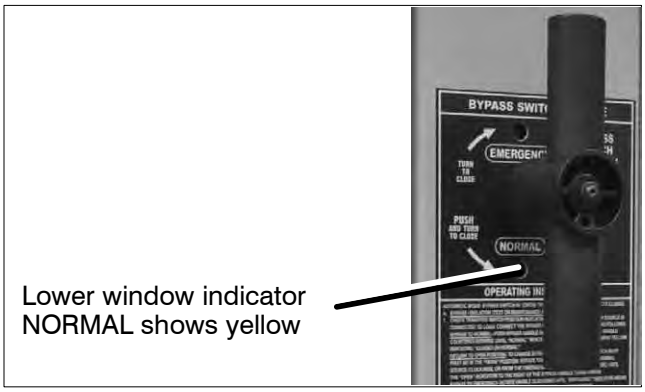
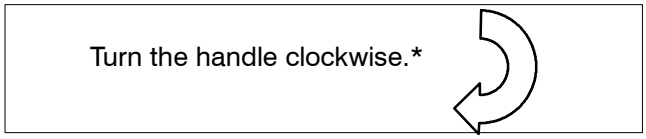


Figure 3–6. Status light and window indicator for Bypassed to Normal Source.

To Bypass Emergency Source*

(Load connected to Emergency Source)
The *Transfer Switch Connected To Emergency* light is on and *Transfer Switch Connected To Normal* light is off.



Turn* the Bypass Handle clockwise until *Bypass Switch Position* shows closed on EMERGENCY (yellow window indicator). The red light *Bypassed to Emergency* will come on and the amber light *Not In Automatic* will flash.

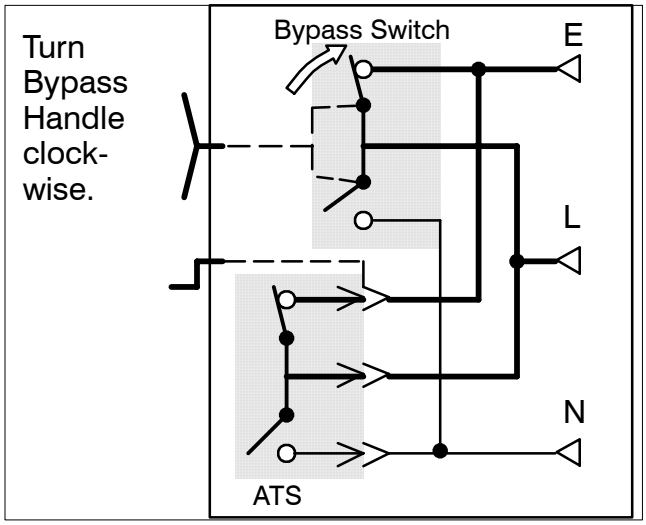
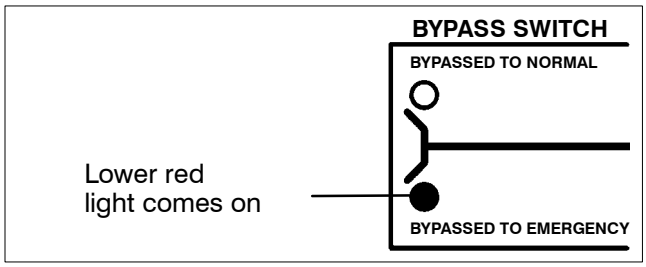


Figure 3–7. Bypass to Emergency diagram.



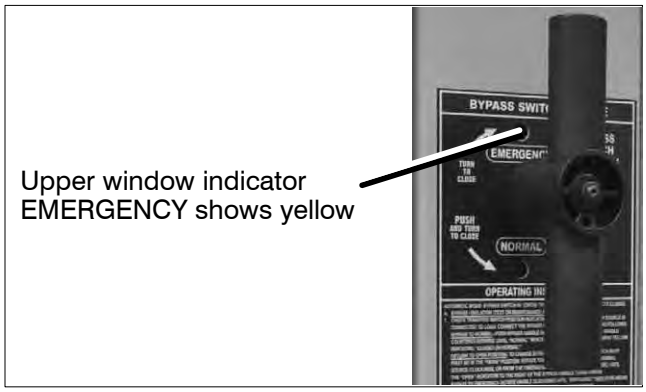


Figure 3–8. Status light and window indicator for Bypassed to Emergency Source.

The automatic transfer switch can now be put in the *TEST* or *OPEN* position. See **ISOLATING** on page 3–3.

*** NOTE**: When Accessory 40*B (reversed Normal & Emergency connections) is specified, the handle operation is reversed. Follow instructions on the door.

ISOLATING THE ATS

Isolating is required before any service work can be performed on the automatic transfer switch (ATS). Refer to Figures 3–9, 3–10, 3–11, and 3–12.

1. Bypass the closed automatic transfer switch contacts. See **BYPASSING** on pages 3–1 and 3–2.

2. Turn the Isolation Handle counterclockwise (approx. 8 turns) until window shows *TEST*. The *TS Test* amber light should come on. The ATS can be tested now without load interruption (see page 2–1).

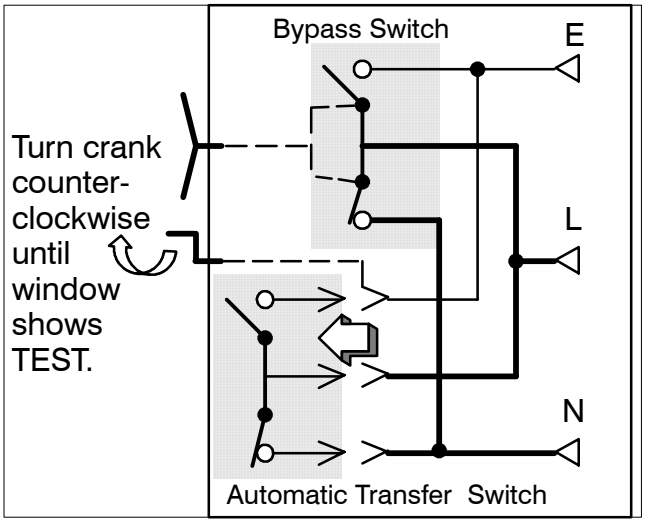
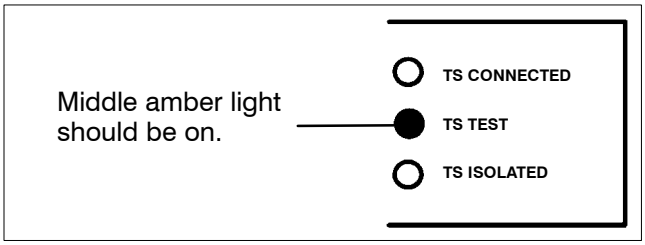


Figure 3–9. *CONNECTED* to *TEST* position.



position window — CONN **TEST** ISOLATE — counterclockwise – draws out the transfer switch

Figure 3–10. Isolation Handle turned to *TEST*.

NOTE: In the TEST position the transfer switch solenoid operator circuit is energized through secondary disconnects.

⚠ DANGER

Hazardous voltage capable of causing electrical shock, burns, or death; do not touch any control circuit terminals.

3. Continue turning Isolation Handle counterclockwise (approx. 6 turns) until the window shows *ISOLATE*. The *TS Isolated* amber light should come on.

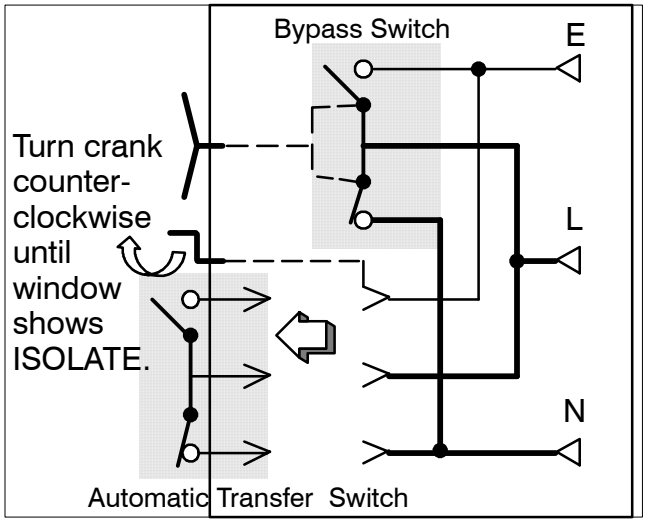
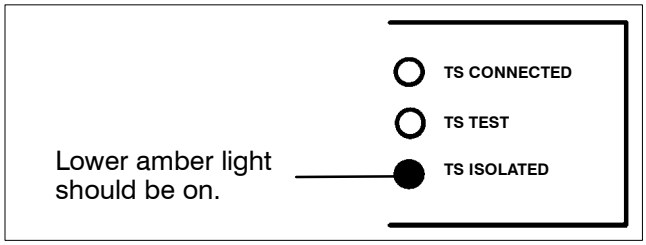


Figure 3–11. *TEST* to *ISOLATE* position.



position window — CONN TEST **ISOLATE** — counterclockwise – draws out the transfer switch

Figure 3–12. Isolation Handle turned to *ISOLATE*.

4. Open the lower enclosure door. Pull out both left and right side rails then use the two tab handles to roll out the transfer switch. It can be safely inspected in this position. The transfer switch can also be removed for easier maintenance operations. See Figure 3–13.

⚠ DANGER

Hazardous voltage capable of causing electrical shock, burns, or death; do not touch any control circuit terminals.

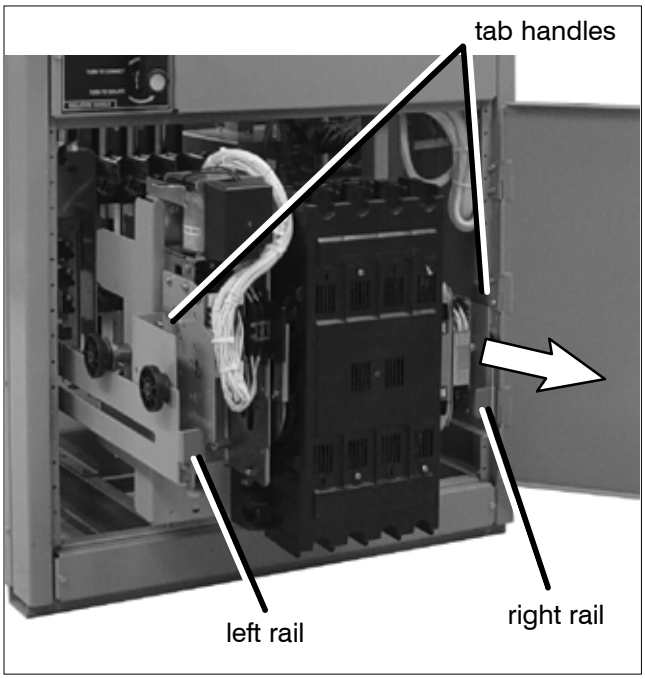


Figure 3–13.Transfer switch isolated and pulled out for inspection.

See page 2–2 for maintenance handle use. A lifting yoke 812053 is available to facilitate lifting by using an overhead crane or similar equipment. See **WARNING**.

⚠ WARNING

The Transfer Switch weighs about 120 lbs. depending upon the number of poles. Use lifting device 812053 or other device capable of lifting this weight to avoid personal injury or equipment damage. Two persons are recommended.

Contact Inspection

Contact condition should be checked annually. Discoloration is normal. Do not file contacts because it wastes material. Instead use light emery paper to clean up the contact surfaces. The non–replaceable main contacts are designed to last the life of the transfer switch.

⚠ DANGER

To prevent the possibility of fatal electrical shocks and burns, bypass, isolate, and withdraw the transfer switch before working on it.

1. **Deenergize transfer switch** (pages 3–1 thru 3–4) Bypass, isolate, and withdraw transfer switch. Use a voltmeter to verify that no electrical power is present at the transfer switch terminals.
2. **Use the maintenance handle** (page 2–2). Open the contacts that will be inspected by using the detachable maintenance handle.
3. **Remove the barrier** (Figure 3–14). Use a phillip screwdriver to loosen (ccw) four or six captive round–head screws holding the barrier to the arc chutes. Then pull the barrier straight outward to remove it.
4. **Reinstall the barrier**. Install the barrier over the arc chutes. Use a phillips screwdriver to tighten (cw) the four or six round–head screws to secure the barrier to the arc chute insulator nuts. See Figure 3–14.

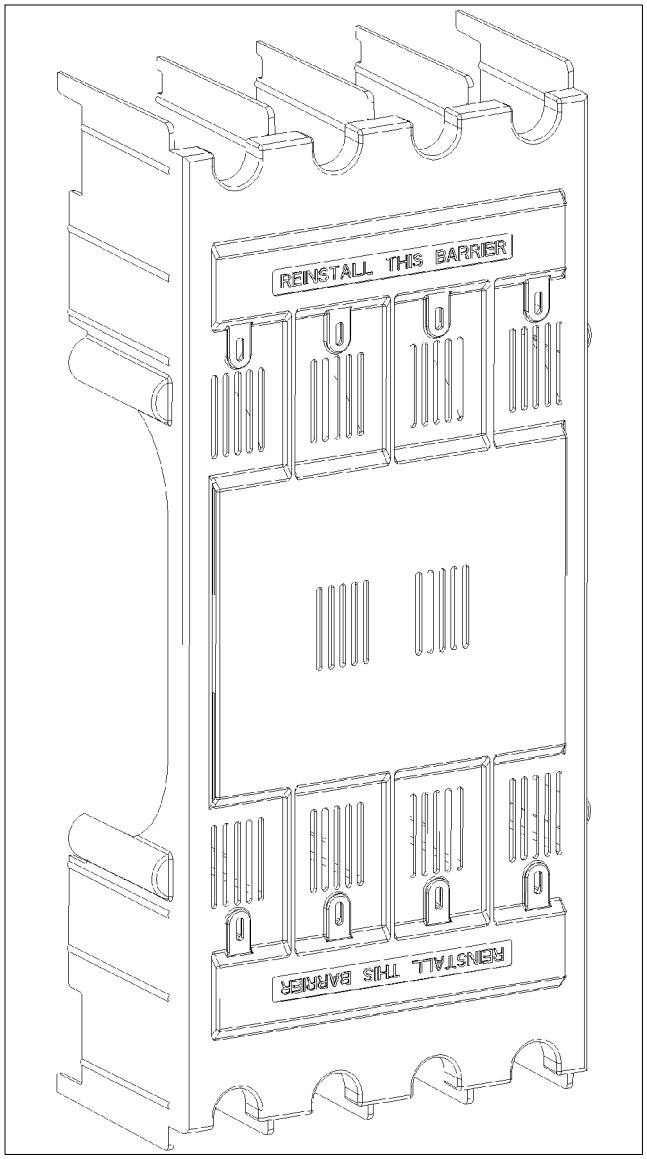


Figure 3–14. Barrier removal.

RETURN TO SERVICE

This procedure explains how to return the automatic transfer switch (ATS) to service after inspection and maintenance. Observe the *Bypass Switch Position* indicator and lights).

1. Use the two tab handles to roll the transfer switch into the enclosure (isolation contacts facing inward) until the crank bearings stop against the draw–in plates. Then push in both side rails and close the enclosure door.

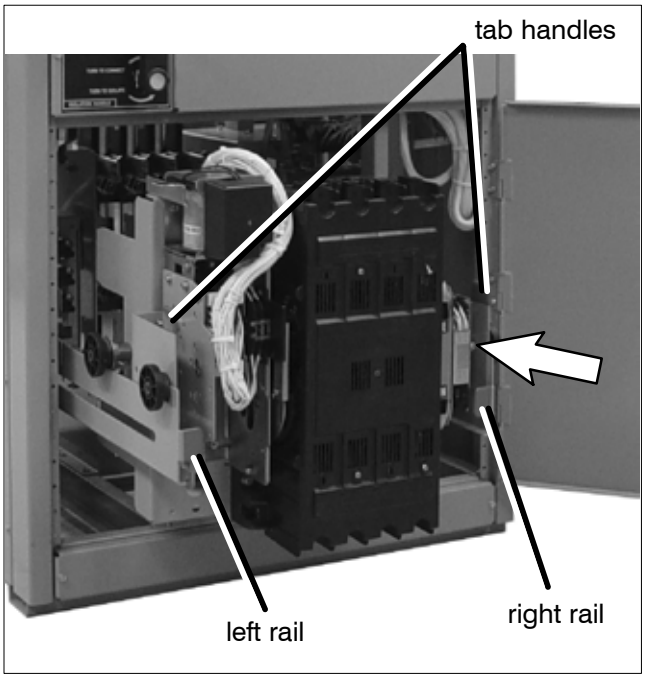


Figure 3–15.Transfer switch isolated and pulled out for inspection.

⚠ WARNING

Close the enclosure door to prevent personal injury in case of electrical system fault.

2. Turn Isolation Handle clockwise (approx. 6 turns) until the window shows *TEST* and *TS TEST* light comes on.

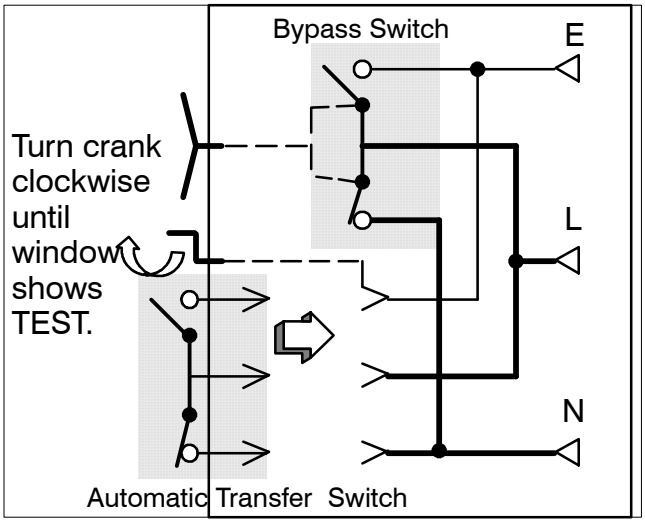


Figure 3–16. *ISOLATE* to *TEST* position.

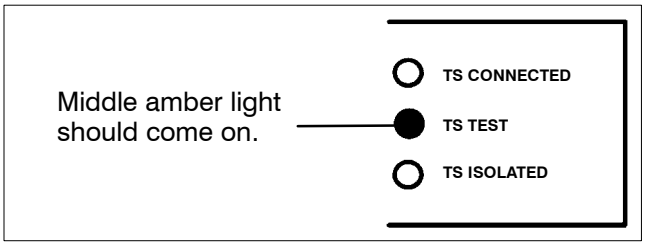


Figure 3–17. Isolation Handle turned to *TEST*.

3. The ATS can be tested now without load interruption (see page 2–1).

⚠ CAUTION

Solenoid interlock prevents you from closing the isolation contacts until the ATS is in the same position as the Bypass Switch.

4. Observe which *Bypass Switch Position* window indicator is yellow (*NORMAL* or *EMERGENCY*) at the Bypass Switch Handle. This indicates the source connected to the load.
5. Observe which *Transfer Switch Connected To* light is on (*Normal* or *Emergency*) on the door. This is the position of the Transfer Switch. If it is not in the same position as the Bypass Handle change the position of the Transfer Switch as follows:

To change the position of transfer switch

Operate to NORMAL	Operate to EMERGENCY
Turn **Transfer Control** switch to *Retransfer Delay Bypass*.	Turn **Transfer Control** switch to *Transfer Test* (hold 15 seconds).*
Connected To Normal light should come on.	*Connected To Emergency* light should comes on.

* If Feature 2B time delay is used, there will be a delay before transfer to Emergency.

NOTE: With Normal available, the automatic transfer switch will not stay in the emergency position unless Feature 3A time delay is used (at least 30 seconds).

⚠ WARNING

Do not close the isolation contacts unless the Transfer Switch (ATS) and Bypass Switch are in the same position!

6. When the transfer switch is in the same position as the Bypass Switch handle, continue turning the Isolation Handle clockwise (about 8 turns) until the window shows *CONN* (connected).

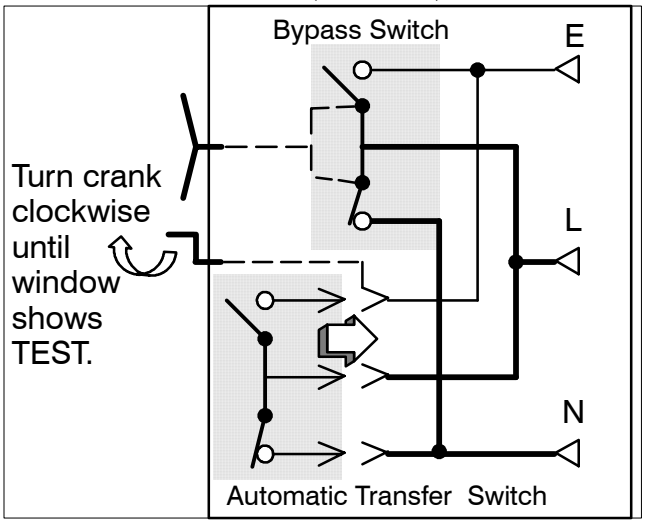
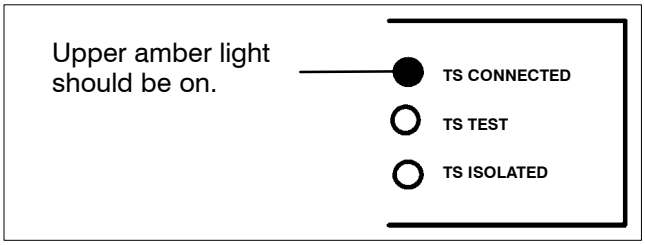


Figure 3–18. *TEST* to *CONN* (connected) position.



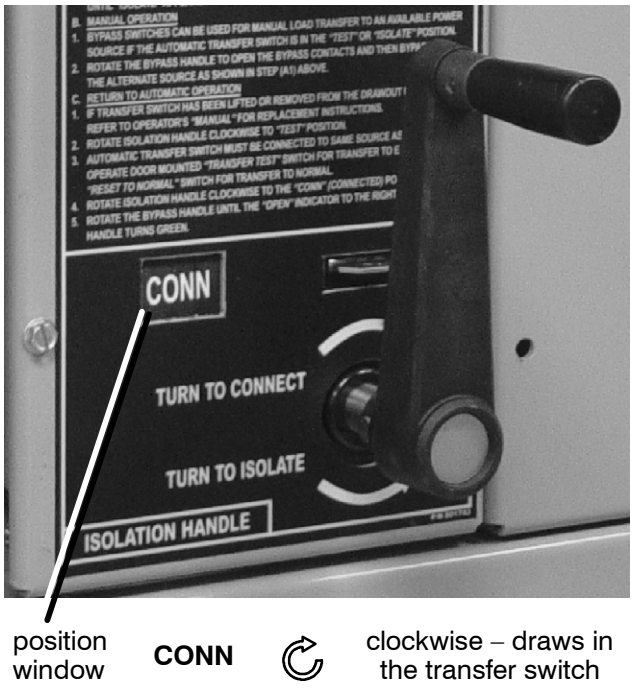


Figure 3–19. Isolation Handle turned to *CONN*.

RETURN TO SERVICE continued*

This procedure explains how to return the Bypass Switch Handle to the OPEN position. The Bypass Handle must be in the *CLOSED* position (yellow indicator on *NORMAL* or *EMERGENCY*) and the Isolation Handle must be in the *CONN* position (window). See Figures 3–20, 3–21, and 3–22.

⚠ CAUTION

You can only bypass to the same source that the ATS is connected. Solenoid interlock prevents incorrect operation.

1 Observe which Bypass Switch Position indicator is yellow (*NORMAL* or *EMERGENCY*) at the Bypass Switch Handle. This indicates the source connected to the load.

2 Un–Bypass to same source as the Bypass Switch Position as follows (select Normal or Emergency).

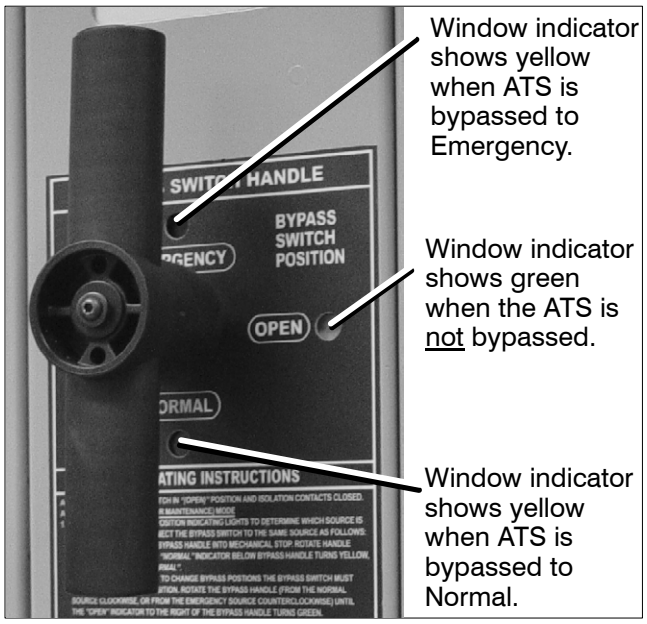


Figure 3–20. Bypass Handle and position indicators.

To Un–Bypass Normal Source*

(Load connected to Normal Source)
The *Transfer Switch Connected To Normal* light is on and *Transfer Switch Connected To Emergency* light is off.

Turn the handle clockwise.*

Turn* the Bypass Handle clockwise until the *Bypass Switch Position* shows OPEN (green window indicator). The *Bypassed to Normal* light should go off and the *Not In Automatic* light should go off.

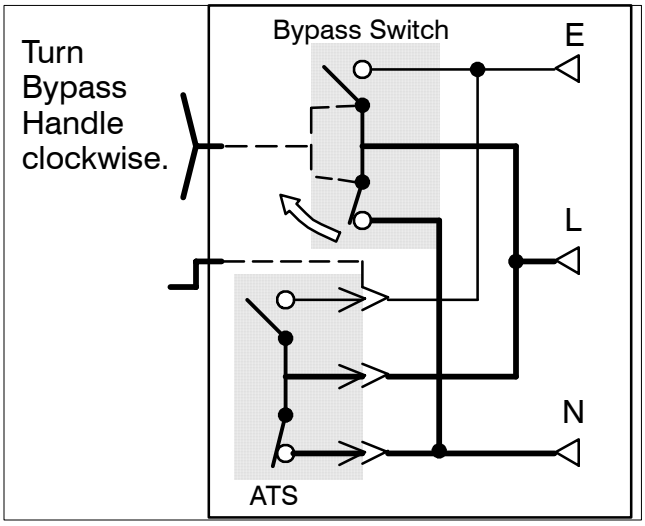


Figure 3–21. Un–Bypass Normal diagram.

To Un–Bypass Emergency Source*

(Load connected to Emergency Source)
The *Transfer Switch Connected To Emergency* light is on and *Transfer Switch Connected To Normal* light is off.

Turn the handle counterclockwise.*

Turn* the Bypass Handle counterclockwise until the *Bypass Switch Position* shows OPEN (green window indicator). The *Bypassed to Emergency* light should go off and the *Not In Automatic* light should go off.

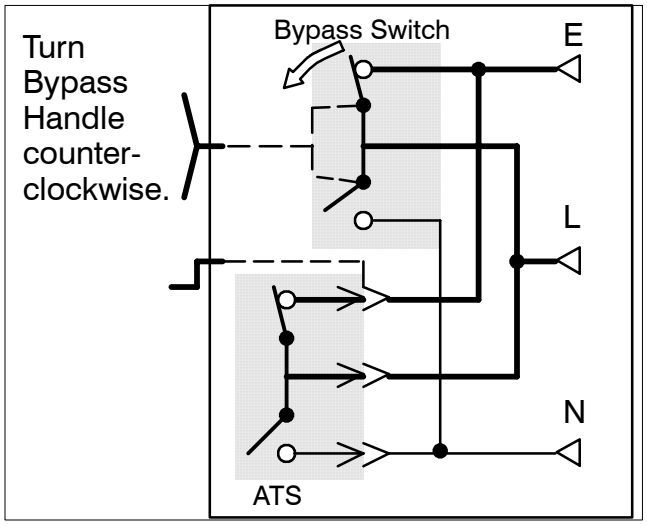


Figure 3–22. Un–Bypass Emergency diagram.

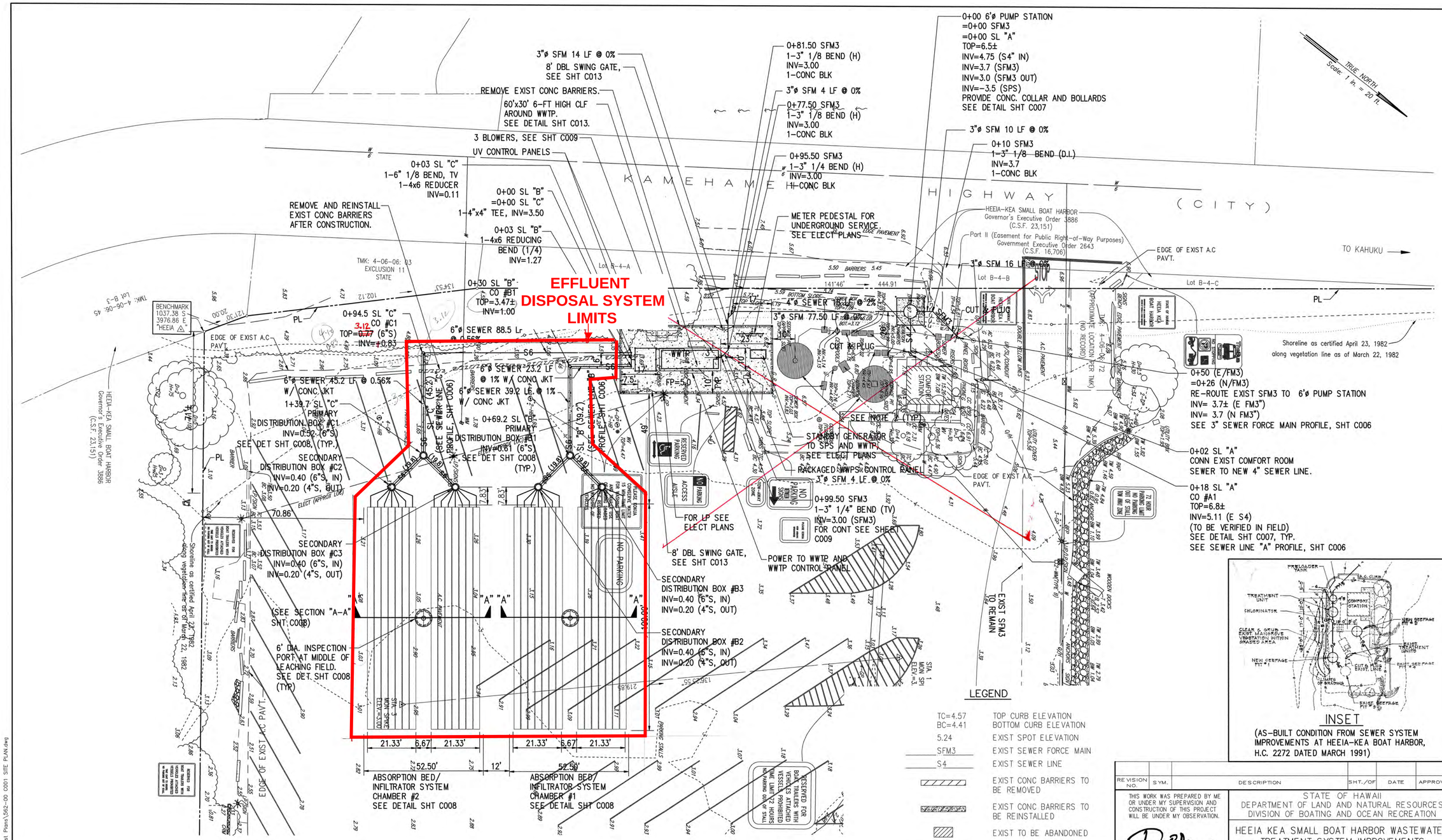
The Automatic Transfer & Bypass–Isolation Switch should be left in this position.

*** NOTE**: When Accessory 40*B (reversed Normal & Emergency connections) is specified, the handle push–pull operation is reversed. Follow instructions on the door.

INDEX

PART 7

Effluent Disposal System



INSET

(AS-BUILT CONDITION FROM SEWER SYSTEM IMPROVEMENTS AT HEEIA-KEA BOAT HARBOR, H.C. 2272 DATED MARCH 1991)

LEGEND

TC=4.57 BC=4.41	TOP CURB ELEVATION BOTTOM CURB ELEVATION
5.24	EXIST SPOT ELEVATION
SFM3	EXIST SEWER FORCE MAIN
S4	EXIST SEWER LINE
	EXIST CONC BARRIERS TO BE REMOVED
	EXIST CONC BARRIERS TO BE REINSTALLED
	EXIST TO BE ABANDONED
	EXIST EDGE OF AC PAVEMENT
SFM3	NEW SEWER FORCE MAIN
S4	NEW SEWER LINE
	NEW SEWER CLEANOUT
	DISTRIBUTION BOX
	NEW CHAIN LINK FENCE
	CUT AND PLUG

NOTES:

1. PROPER CARE SHOULD BE TAKEN DURING EXCAVATION AROUND EXISTING WATERLINE SO AS NOT TO CAUSE ANY BREAKAGE TO THE EXISTING LINE.
2. CRUSH OR REMOVE TOP OF EXISTING CESSPOOLS AND FILL WITH GRANULAR MATERIAL AND ABANDON. ALL OTHER EXISTING COMPONENTS OF THE WASTEWATER SYSTEM TO BE ADANDONED AFTER CONNECTION TO THE NEW WASTEWATER TREATMENT PLANT IS COMPLETE AND OPERATIONAL.

AS BUILT
HENRY'S EQUIPMENT RENTAL & SALES, INC.
SIGNATURE 3/1/20 DATE

REVISION NO.	SYM.	DESCRIPTION	SHT./OF	DATE	APPROVED

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION AND CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY OBSERVATION.

SIGNATURE
LICENSE EXP.: 4/30/20

DAVID B. BILLS LICENSED PROFESSIONAL ENGINEER No. 4518-C HAWAII, U.S.A.

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF BOATING AND OCEAN RECREATION

HEEIA KEA SMALL BOAT HARBOR WASTEWATER TREATMENT SYSTEM IMPROVEMENTS

SITE PLAN

BILLS ENGINEERING, INC.

DESIGNED: DB	SUBMITTED: BEI
DRAWN: RE/SI	DATE:
CHECKED: DB	SCALE: AS SHOWN
APPROVED:	DRAWING NO. C001
CHIEF ENGINEER	DATE

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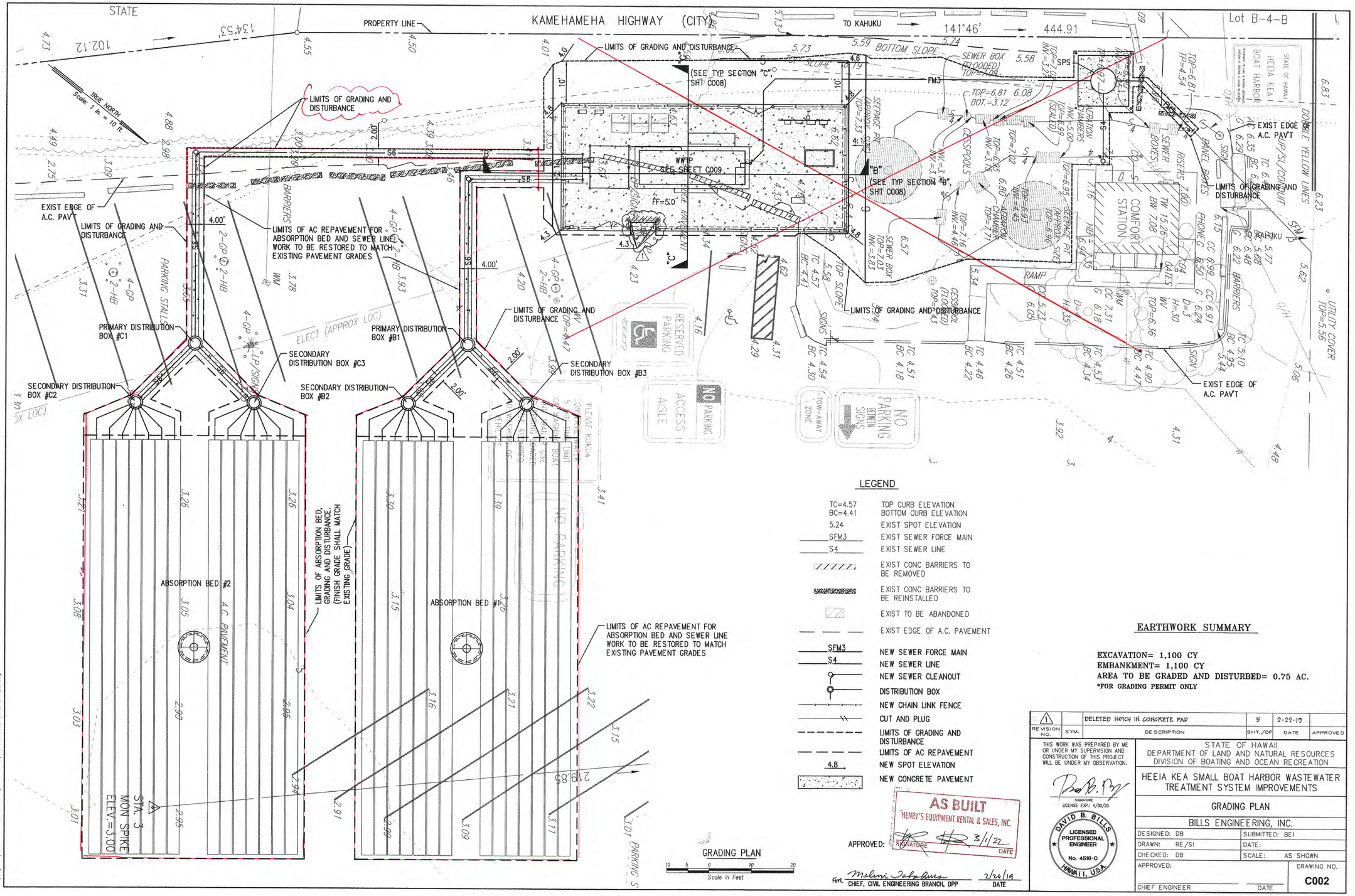

LEGEND

TC=4.57 BC=4.41	TOP CURB ELEVATION BOTTOM CURB ELEVATION
5.24	EXIST SPOT ELEVATION
SFM3	EXIST SEWER FORCE MAIN
S4	EXIST SEWER LINE
	EXIST CONC BARRIERS TO BE REMOVED
	EXIST CONC BARRIERS TO BE REINSTALLED
	EXIST TO BE ABANDONED
	EXIST EDGE OF A.C. PAVEMENT
SFM3	NEW SEWER FORCE MAIN
S4	NEW SEWER LINE
	NEW SEWER CLEANOUT
	DISTRIBUTION BOX
	NEW CHAIN LINK FENCE
	CUT AND PLUG
	LIMITS OF GRADING AND DISTURBANCE
	LIMITS OF AC REPAVEMENT
4.8	NEW SPOT ELEVATION
	NEW CONCRETE PAVEMENT

GRADING PLAN

10 5 0 10 20
Scale in Feet

EARTHWORK SUMMARY

EXCAVATION= 1,100 CY
EMBANKMENT= 1,100 CY
AREA TO BE GRADED AND DISTURBED= 0.75 AC.
*FOR GRADING PERMIT ONLY

AS BUILT
"HENRY'S EQUIPMENT RENTAL & SALES, INC."

APPROVED: SIGNATURE 3/1/22 DATE

for CHIEF, CIVIL ENGINEERING BRANCH, DPP 2/24/19 DATE

REVISION NO.	SYM.	DESCRIPTION	SHT./OF	DATE	APPROVED
1		DELETED NOTCH IN CONCRETE PAD	5	2-22-19	

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LICENSE EXP.: 4/30/20

DAVID B. BILLS LICENSED PROFESSIONAL ENGINEER No. 4516-C HAWAII, USA

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF BOATING AND OCEAN RECREATION

HEEIA KEA SMALL BOAT HARBOR WASTEWATER TREATMENT SYSTEM IMPROVEMENTS

GRADING PLAN

BILLS ENGINEERING, INC.

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CHECKED: DB	SCALE: AS SHOWN
APPROVED:	DRAWING NO. C002
CHIEF ENGINEER	DATE

JOB NO. B78C074A SHEET NO. 5 OF 29 SHEETS

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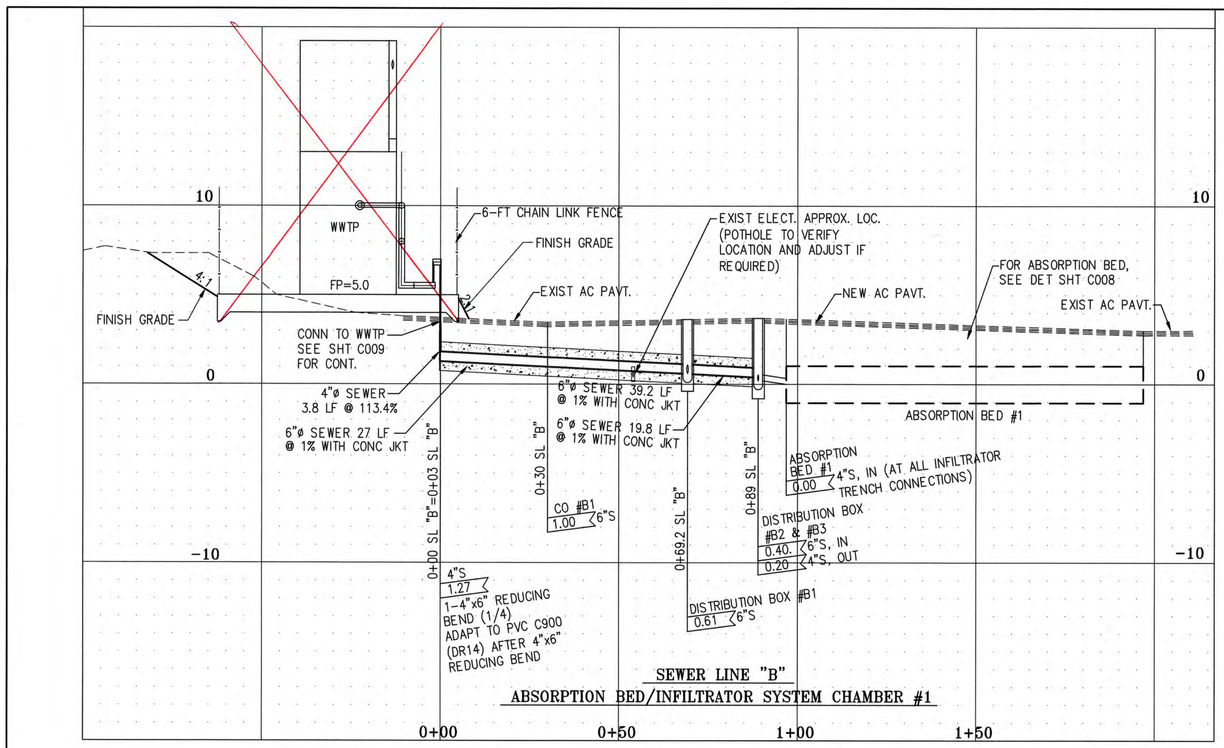
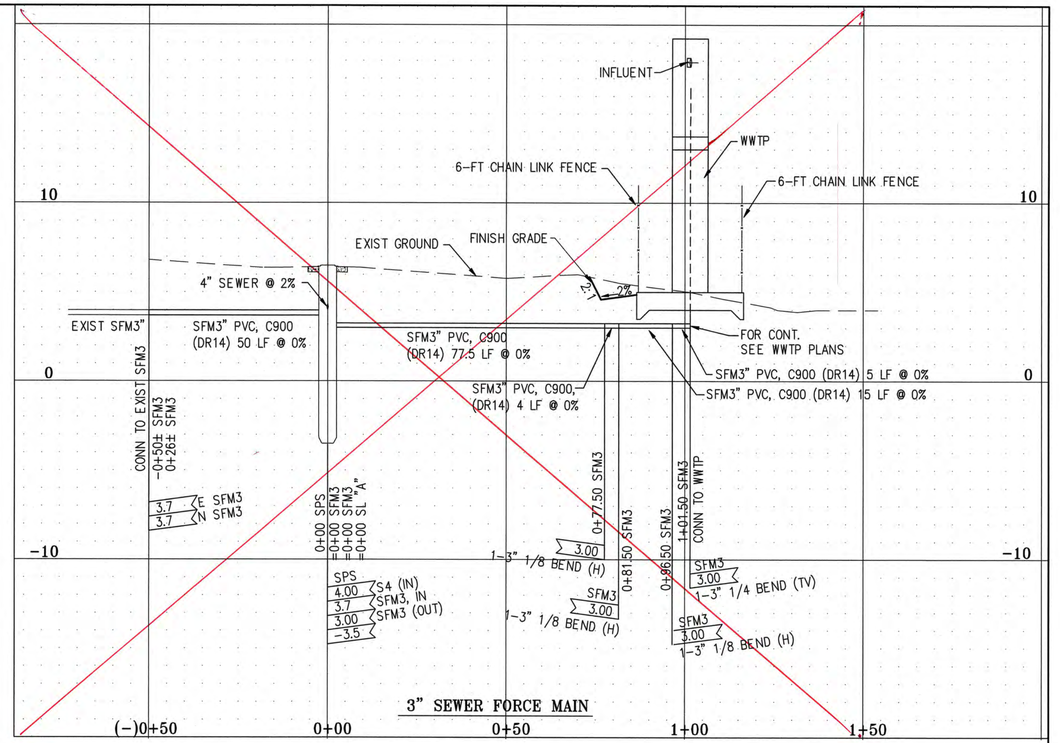
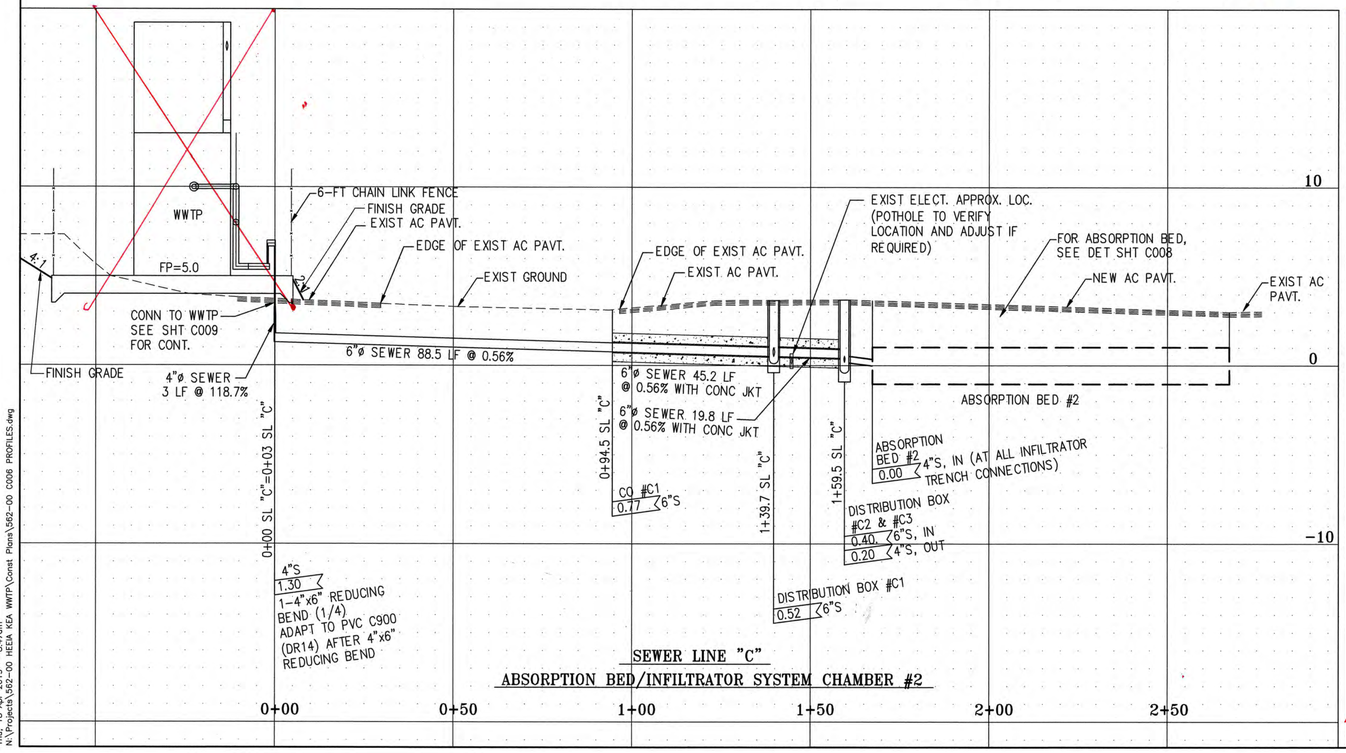


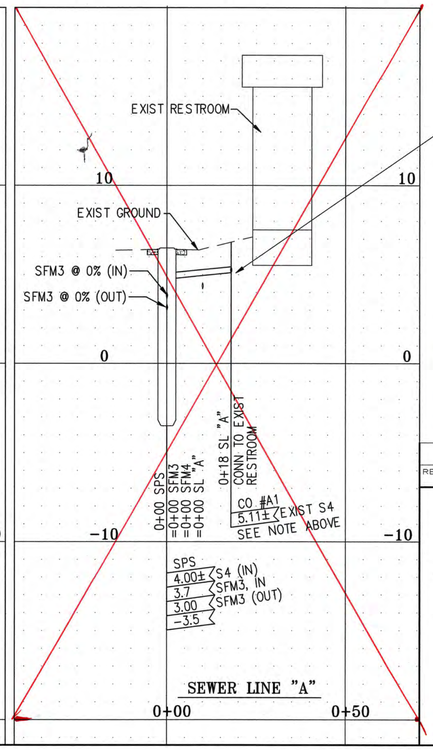
SEWER LINE "B"
ABSORPTION BED/INFILTRATOR SYSTEM CHAMBER #1



3" SEWER FORCE MAIN



SEWER LINE "C"
ABSORPTION BED/INFILTRATOR SYSTEM CHAMBER #2



SEWER LINE "A"

NOTE:
POTHOLE AND EXPOSE EXISTING S4" FROM RESTROOM TO EXISTING TREATMENT SYSTEM. INSTALL CLEAN-OUT TO GRADE AND RUN NEW S4" (PVC, C900, DR18) AT 2% TO NEW SPS. (ABANDON EXISTING S4" TO EXISTING WWTP BE FLUSHING AND FILLING WITH CLSM).

HORI 20 10 0 20 40
VERT 4 2 1 4 8
SCALE IN FEET

AS BUILT
HENRY'S EQUIPMENT RENTAL & SALES, INC.
SIGNATURE
8/1/22
DATE

REVISION NO.	SYM.	DESCRIPTION	SHT./OF	DATE	APPROVED

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SIGNATURE
LICENSE EXP.: 4/30/20

DAVID B. BILLS
LICENSED PROFESSIONAL ENGINEER
No. 4516-C
HAWAII, U.S.A.

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF BOATING AND OCEAN RECREATION

HEEIA KEA SMALL BOAT HARBOR WASTEWATER TREATMENT SYSTEM IMPROVEMENTS

PROFILES

BILLS ENGINEERING, INC.

DESIGNED: DB	SUBMITTED: BEI
DRAWN: RE/SI	DATE:
CHECKED: DB	SCALE: AS SHOWN
APPROVED:	DRAWING NO. C006
CHIEF ENGINEER	DATE

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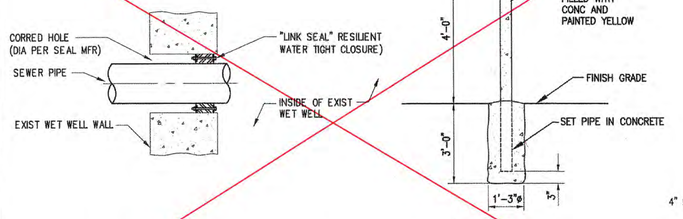
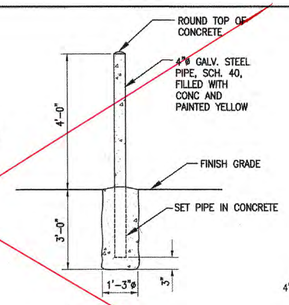


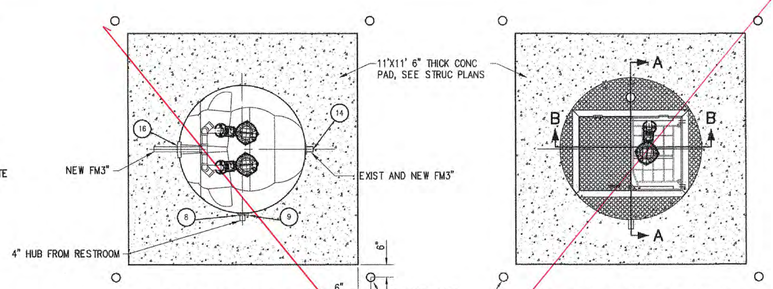
PIPE PENETRATION DETAIL

SCALE: 1" = 0'-6"



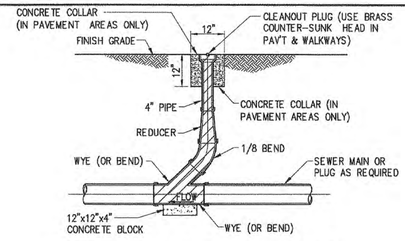
BOLLARD DETAIL

NOT TO SCALE



PLAN LESS COVER

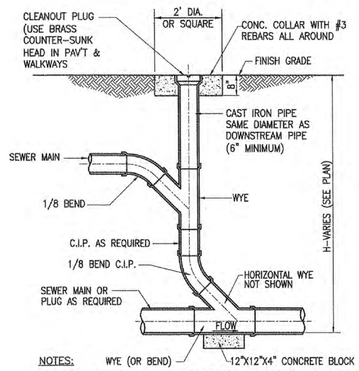
PLAN WITH COVER



NOTE: CROSS HATCHING SHOWS UNITS OF CAST IRON PIPE (CIP).

CLEANOUT DETAIL

NOT TO SCALE

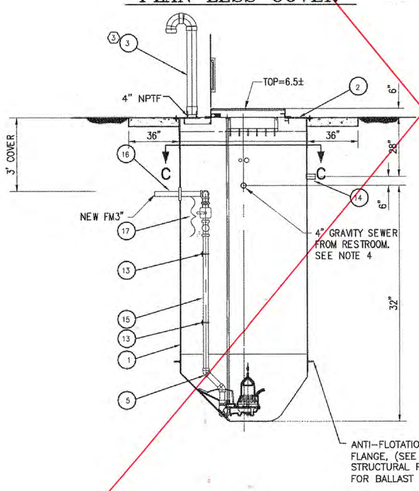


NOTES:

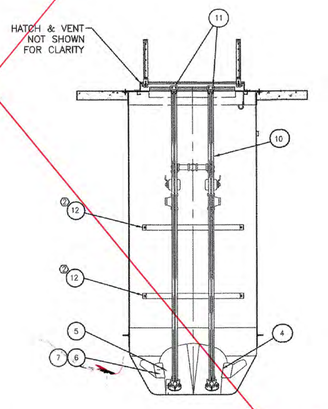
1. THE ENDS OF THE CAST IRON CLEANOUT PIPE SHALL HAVE AN INNER PIPE THREAD TO RECEIVE EITHER RAISED CLEANOUT PLUG OR COUNTERSUNK BRASS PLUG AS INDICATED.
2. APPLY GREASE TO CLEANOUT PLUG THREADS PRIOR TO INSTALLATION.

DROP CLEANOUT DETAIL

NOT TO SCALE



SECTION A-A



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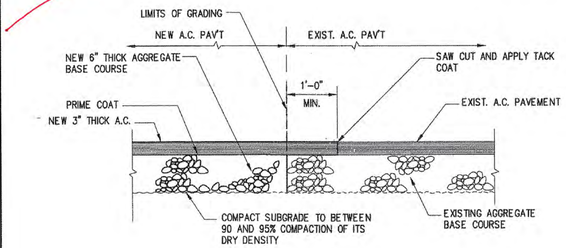
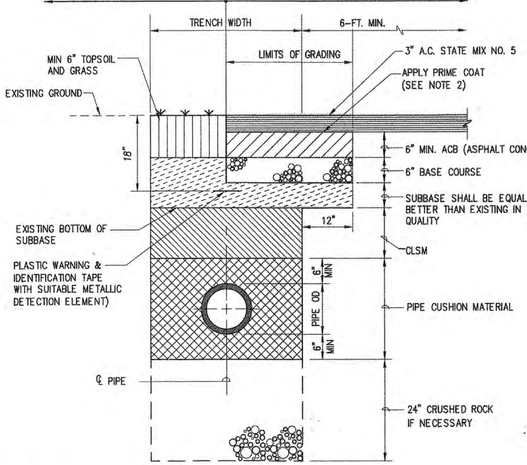


A.C. PAVEMENT CONNECTION DETAIL

NOT TO SCALE



REPAVING NOTES

1. PAVEMENT STRUCTURE SHALL BE EQUAL TO OR BETTER THAN EXISTING IN THICKNESS AND QUALITY.
2. FOR ROAD GRADES 0% TO 7.99% PRIME COAT IS NOT REQUIRED.
3. ALL DISTURBED PAVEMENT MARKINGS SHALL BE REPLACED AND ALL REQUIRED UTILITY ADJUSTMENTS SUCH AS MANHOLE COVERS ETC. SHALL BE DONE BY THE CONTRACTOR.
4. LENGTH OF REPAIRED TRENCH SHALL BE REPAVED TWO FEET IN ADDED LENGTH TO EACH END OF TRENCH.

TYPICAL SEWER TRENCH DETAIL (STATE)

SCALE: 3/4" = 1'-0"

PUMP STATION DATA

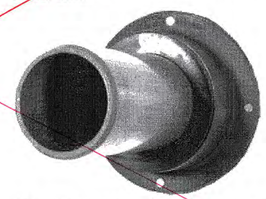
ITEM	DESCRIPTION	PART NUMBER	QTY
1	BASIN/CYLINDER ASSEMBLY, 5'		1
2	COVER, 5'		1
3	VENT PIPE, 4" (OPTIONAL)	14-68 22 02	1
4	DISCHARGE CONNECTION, 3"	619 95 00	2
5	PIPING KIT, JOG OVER FOR 4"		2
6 *	NUT, 3/4-10, 316 SST	94805A135	4
7 *	WASHER, 13/16 ID. 1 1/2 OD, GENERAL PURPOSE, 316 SST	91950A036	4
8	SEAL, CABLE WALL, LEVEL SENSOR	1860SCF125P	1
9	SEAL, CABLE WALL, PUMP		1
10	GUIDE BAR, 3/4", 316 SST		4
11	UPPER GUIDE BAR KIT, 3/4"		2
12	BRACING, DISCHARGE PIPE		2
13 *	U-BOLT 3/8-16 OD, 4 1/2", 4" PIPE	2950S76	4
14	HUB FOR 3" FORCE MAIN CONNECTION		1
15	PIPE, 4", SCH 40, PVC SST		FT
16	PIPING KIT, 3"		1
17	THREADED PIPING KIT, 4"		2

* McMASTER CARR

THE SEWAGE PUMP STATION SHALL BE A TOPS SEWAGE PUMP STATION AS MANUFACTURED BY FLYGT USING FLYGT PUMPS OR ENGINEER APPROVED EQUAL.

NOTES

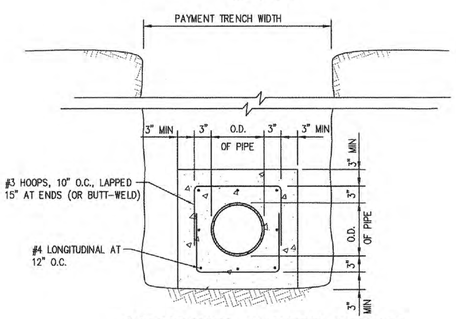
1. STATION DEPTH: MAX. 6ft., AVAILABLE IN 1ft INCREMENTS.
2. ALL BOLT PENETRATIONS THRU WALLS MUST BE SEALED WITH SILICONE SEALANT.
3. OPTIONAL PVC CANDY CANE STYLE VENT SHOWN. MUSHROOM STYLE VENT ALSO AVAILABLE.
4. EXPOSE GRAVITY SEWER AND MEASURE DEPTH FOR APPROPRIATE SEWER CONNECTION TO WET WELL. PUNCTURE WET WELL WALL WITH JIG SAW AND DRILL BIT, OR EQUAL. USE FLYGHT SEALING JOINT TO MAKE CONNECTION TO WET WELL. SEE DET BELOW.



INFLUENT PIPE SEALING DETAIL

SEWAGE PUMP STATION DETAIL

NOT TO SCALE



CONCRETE JACKET DETAIL

NOT TO SCALE

AS BUILT
HENRY'S EQUIPMENT RENTAL & SALES, INC.
SIGNATURE
3/1/22
DATE

APPROVED:

For Melvin Tokahara
CHIEF, CIVIL ENGINEERING BRANCH, DPP
(FOR GRADING ONLY)

2/16/19
DATE

REVISION NO.	SYM.	DESCRIPTION	SHT./OF	DATE	APPROVED

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION AND CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY OBSERVATION.

SIGNATURE
LICENSE EXP.: 4/30/20

DAVID B. BILLS
LICENSED PROFESSIONAL ENGINEER
No. 4616-C
HAWAII, U.S.A.

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF BOATING AND OCEAN RECREATION

HEEIA KEA SMALL BOAT HARBOR WASTEWATER TREATMENT SYSTEM IMPROVEMENTS

MISCELLANEOUS DETAILS - 1

BILLS ENGINEERING, INC.

DESIGNED: DB	SUBMITTED: BEI
DRAWN: RE/SI	DATE:
CHECKED: DB	SCALE: AS SHOWN
APPROVED:	DRAWING NO. C007
CHIEF ENGINEER	DATE

Fri, 25 Jan 2019 - 8:37am
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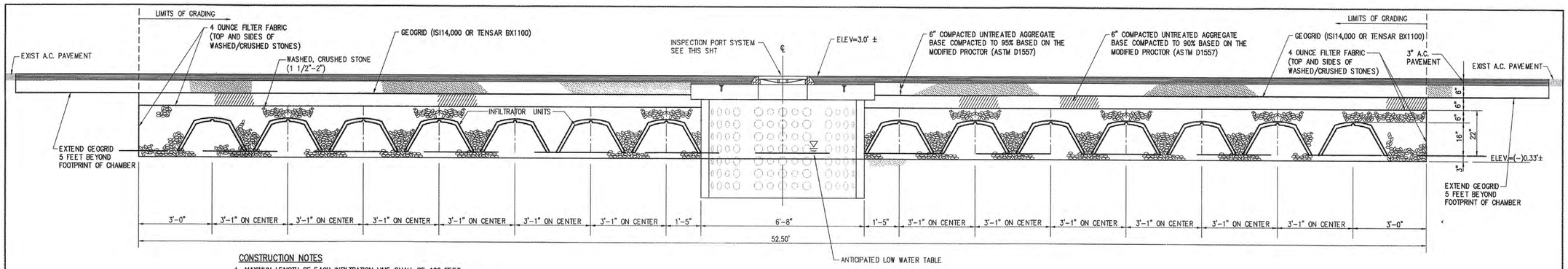
JOB NO. B78C074A SHEET NO. 10 OF 29 SHEETS



CONSTRUCTION NOTES

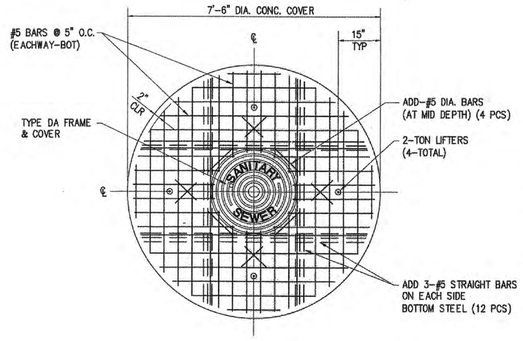
1. MAXIMUM LENGTH OF EACH INFILTRATION LINE SHALL BE 100 FEET.
2. INFILTRATION LINES SHALL BE UNIFORMLY SPACED AT A MAXIMUM OF 3'-1" APART.
3. INFILTRATION LINES SHALL BE LEVEL.
4. THE FLOOR OF THE ABSORPTION BED SHALL BE LEVEL.
5. WHERE NOT OTHERWISE SPECIFIED, THE CONSTRUCTION OF THE ADSORPTION BED SHALL CONFORM TO HAWAII ADMINISTRATIVE RULES, TITLE 11, CHAPTER 62, SECTION 34.
6. THE INFILTRATOR BEDS SHALL BE INFILTRATOR WATER TECHNOLOGIES HIGH CAPACITY INFILTRATOR CHAMBER H-20 OR ENGINEER APPROVED EQUAL. THE LAYOUT IS GENERIC. CONTRACTOR SHALL FOLLOW INSTALLATION DETAILS OF SPECIFIC INFILTRATION SYSTEM.

SECTION "A-A"

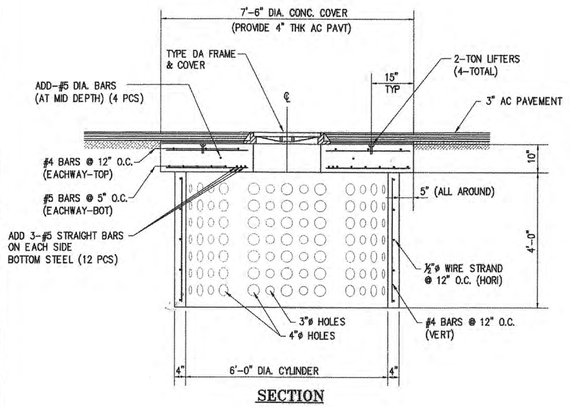
ABSORPTION BED/INFILTRATOR CHAMBER DETAIL

NOT TO SCALE

(TOTAL AREA PER BED = 5,250 SQ. FT., EFFECTIVE AREA PER BED = 4,267 SQ. FT.
EFFECTIVE AREA IS BED AREA LESS ZONE (6'-8") FOR INSPECTION PORT)



PLAN



SECTION

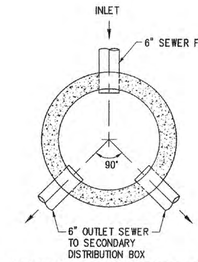
INSPECTION PORT SYSTEM DETAIL

NOT TO SCALE

(INSPECTION PORT SYSTEM SHALL BE PRICE CESSPOOL RING OR ENGINEER APPROVED EQUAL)

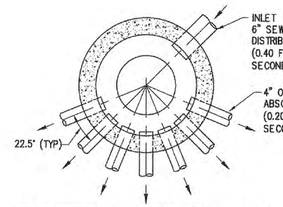
NOTES

1. ALL CONCRETE AND REINFORCED CONCRETE WORK SHALL BE DONE IN ACCORDANCE WITH APPLICABLE PROVISIONS OF THE AMERICAN CONCRETE INSTITUTE'S BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE (ACI 318-LATEST) AS SPECIFIED HEREIN.
2. CONCRETE COMPRESSIVE STRENGTH: 4000 PSI IN 28 DAYS
3. CEMENT SHALL CONFORM TO THE REQUIREMENTS OF THE CURRENT "STANDARD SPECIFICATION FOR PORTLAND CEMENT" ASTM DESIGNATION C-150.
4. MIXING: READY MIXED ASTM C-94
5. REINFORCING STEEL SHALL BE DEFORMED, INTERMEDIATE GRADE, CONFORMING TO THE CURRENT "STANDARD SPECIFICATIONS FOR BILLET-STEEL BARS FOR CONCRETE REINFORCEMENTS", ASTM A 615, GRADE 60
6. WIRE STRAND SHALL CONFORM TO ASTM A-416 AND HAVE A STRENGTH OF 270 KSI

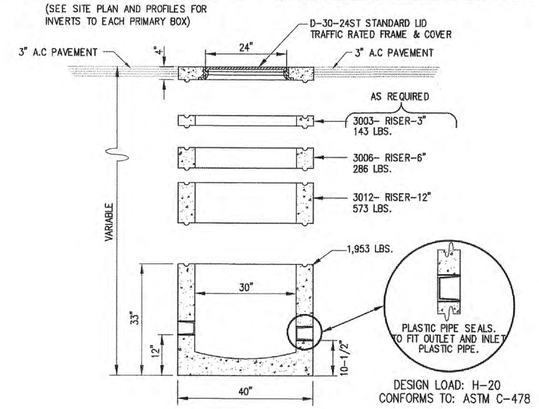


PRIMARY DISTRIBUTION BOX PLAN

(SEE SITE PLAN AND PROFILES FOR INVERTS TO EACH PRIMARY BOX)



SECONDARY DISTRIBUTION BOX PLAN



DESIGN LOAD: H-20
CONFORMS TO: ASTM C-478

NOTE:
INVERTS OF ALL OUTLETS ARE AT SAME ELEVATION.

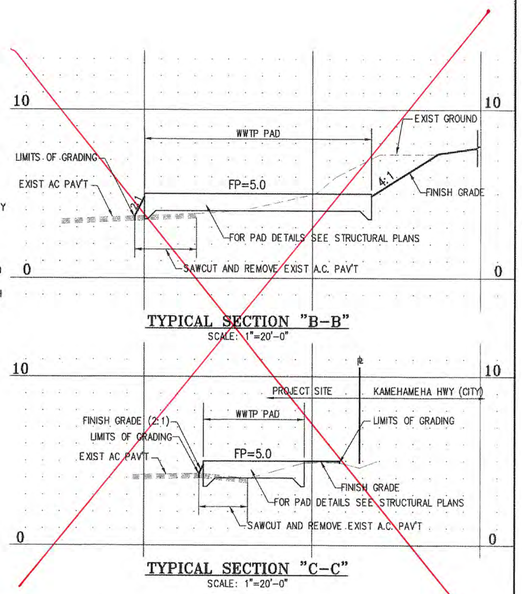
ELEVATION

DISTRIBUTION BOX DETAILS

NOT TO SCALE

(DISTRIBUTION BOX SHALL BE PRE-CAST COMMERCIAL DISTRIBUTION BOX OR ENGINEER APPROVED EQUAL)

AS BUILT
HENRY'S EQUIPMENT RENTAL & SALES, INC.
SIGNATURE DATE



TYPICAL SECTION "B-B"

SCALE: 1"=20'-0"

TYPICAL SECTION "C-C"

SCALE: 1"=20'-0"

APPROVED:

For Melvin Tokuyama 7/26/19
CHIEF, CIVIL ENGINEERING BRANCH, DPP (FOR GRADING ONLY) DATE

REVISION NO.	SYM.	DESCRIPTION	SHT./OF	DATE	APPROVED

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION AND CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY OBSERVATION.

SIGNATURE
LICENSE EXP.: 4/30/20

DAVID B. BILLS LICENSED PROFESSIONAL ENGINEER No. 4616-C HAWAII, U.S.A.

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF BOATING AND OCEAN RECREATION

HEEIA KEA SMALL BOAT HARBOR WASTEWATER TREATMENT SYSTEM IMPROVEMENTS

MISCELLANEOUS DETAILS - 2

BILLS ENGINEERING, INC.

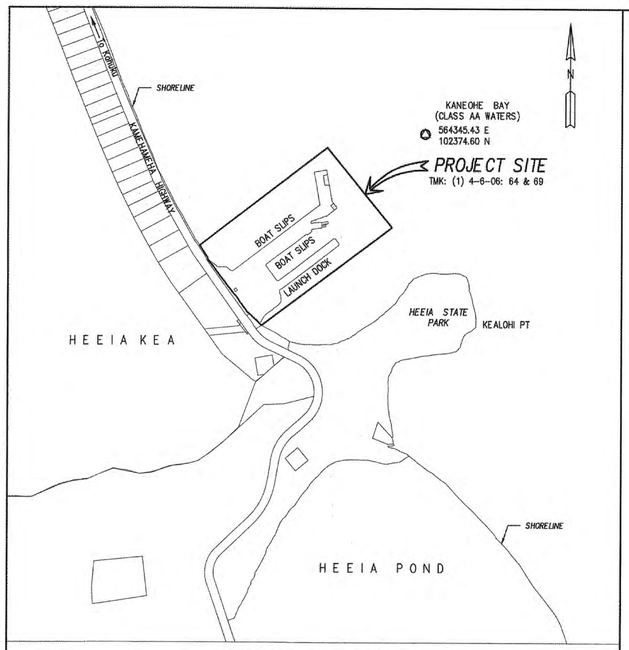
DESIGNED: DB	SUBMITTED: BEI
DRAWN: RE/SI	DATE:
CHECKED: DB	SCALE: AS SHOWN
APPROVED:	DRAWING NO. C008
CHIEF ENGINEER	DATE

Fri, 08 Feb 2019 - 1:29pm
N:\Projects\562-00 HEEIA KEA WWTP\Const Plans\562-00 C008 MISC DETAILS - 2.dwg

APPENDIX A

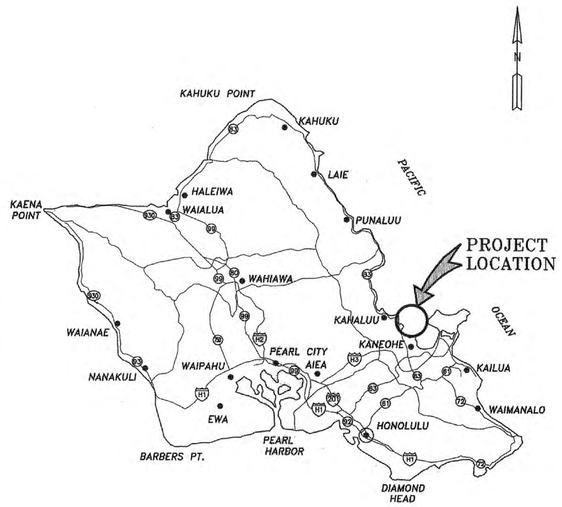
Wastewater Treatment Plant Plans (As-Builts)
Effluent Disposal System (As-Builts)

Wastewater Treatment Plans will be Added Prior to Start-Up



LOCATION MAP

SCALE: 1" = 300'



ISLAND OF OAHU

NOT TO SCALE

STATE OF HAWAII

DEPARTMENT OF LAND AND NATURAL RESOURCES

DIVISION OF BOATING AND OCEAN RECREATION

JOB NO. B78C074A

HEEIA KEA SMALL BOAT HARBOR WASTEWATER TREATMENT SYSTEM IMPROVEMENTS

INSTALLATION OF ABSORPTION BED SYSTEM

HEEIA, KOOLAUPOKO, OAHU, HAWAII

T.M.K.: (1) 4-6-06: 64 & 69

I N D E X

N.I.C.

APPROVED:

DIRECTOR, DEPARTMENT OF PLANNING & PERMITTING
CITY & COUNTY OF HONOLULU
(FOR SITE GRADING ONLY)

DATE: 3/4/19

APPROVED:

EDWARD R. UNDERWOOD
ADMINISTRATOR
DIVISION OF BOATING AND OCEAN RECREATION
DEPARTMENT OF LAND AND NATURAL RESOURCES

DATE: Jul 17, 2019

AS BUILT
HENRY'S EQUIPMENT RENTAL & SALES, INC.
SIGNATURE 3/4/20 DATE

DRAWING NO. T001

JOB NO. B78C074A

JOB NO. 2019/CP-007
JOB NO. B78C074A HEEIA KEA SMALL BOAT HARBOR WASTEWATER TREAMENT SYSTEM IMPROVEMENTS

CONSTRUCTION NOTES

1. ALL APPLICABLE CONSTRUCTION WORK SHALL BE DONE IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION, SEPTEMBER 1986, AND STANDARD DETAILS FOR PUBLIC WORKS CONSTRUCTION, SEPTEMBER 1984, AS AMENDED, OF THE DEPARTMENT OF PUBLIC WORKS, STATE OF HAWAII.
2. THE EXISTENCE AND LOCATION OF UNDERGROUND UTILITIES, APPURTENANCES AND STRUCTURES AS SHOWN ON THESE DRAWINGS WERE COMPILED FROM TOPOGRAPHIC SURVEYS PERFORMED BY CONTROLPOINT SURVEYING, INC. JOB NO. 17021, DATED MAY 25, 2017 AND SUPPLEMENTED ON JUNE 30, 2017. RECORD DRAWINGS PROVIDED BY UTILITY AND GOVERNMENT AGENCIES, AND FROM THE ENGINEER'S MEASUREMENTS. THE CONTRACTOR SHALL VERIFY THE LOCATIONS AND DEPTHS OF THE FACILITIES AND EXERCISE PROPER CARE IN EXCAVATING IN THE AREA. THE CONTRACTOR SHALL BE RESPONSIBLE AND SHALL PAY FOR ALL DAMAGES TO THE EXISTING UTILITIES. THE CONTRACTOR SHALL NOT ASSUME THAT WHERE NO UTILITIES ARE SHOWN, THAT NONE EXIST.
3. THE CONTRACTOR SHALL OBTAIN ALL NECESSARY PERMITS AND LICENSES, PAY ALL CHARGES, FEES AND TAXES, GIVE ALL NOTICES AND COMPLY WITH ALL LAWS, ORDINANCES, RULES AND REGULATIONS BEARING ON THE CONDUCT OF THE WORK AS DRAWN AND SPECIFIED.
4. WHEREVER CONNECTIONS OF NEW UTILITIES TO EXISTING UTILITIES ARE SHOWN ON THE DRAWINGS, THE CONTRACTOR SHALL EXPOSE THE EXISTING LINES AT THE PROPOSED CONNECTIONS TO VERIFY THEIR LOCATIONS AND DEPTHS PRIOR TO EXCAVATION FOR THE NEW LINES.
5. THE CONTRACTOR SHALL PROVIDE ACCESS TO AND FROM DRIVEWAYS AND PUBLIC STREETS AT ALL TIMES EXCEPT AS NOTED ON THE DRAWING.
6. WHEN TRENCH EXCAVATION IS ADJACENT TO OR UNDER EXISTING STRUCTURES OR FACILITIES, THE CONTRACTOR SHALL BE RESPONSIBLE FOR PROPERLY SHEETING AND BRACING THE EXCAVATION AND STABILIZING THE EXISTING GROUND TO RENDER IT SAFE AND SECURE FROM POSSIBLE SLIDES, CAVE-INS AND SETTLEMENT AND FOR PROPERLY SUPPORTING EXISTING STRUCTURES AND FACILITIES WITH BEAMS, STRUTS OR UNDER-PINNING TO FULLY PROTECT THEM FROM DAMAGE.
7. BACKFILL UNDER EXISTING STRUCTURES OR FACILITIES SHALL BE SANDY OR GRANULAR MATERIAL COMPLETELY PLACED AS SOON AS THE PIPE IS LAID AND TESTED. THE BACKFILL MATERIAL SHALL BE RAMMED WITH PROPER TOOLS UNTIL COMPACTED TO 90 TO 95 PERCENT OF ITS MAXIMUM DENSITY.
8. ALL ABANDONED PIPE OPENINGS SHALL BE PLUGGED WITH CLASS B CONCRETE TO A DEPTH OF 1½ TIMES THE DIAMETER OF PIPE.
9. VERIFY AND CHECK ALL DIMENSIONS AND DETAILS SHOWN ON THE DRAWINGS PRIOR TO THE START OF CONSTRUCTION. ANY DISCREPANCY SHALL BE IMMEDIATELY BROUGHT TO THE ATTENTION OF THE ENGINEER. COMMENCEMENT OF CONSTRUCTION SHALL INDICATE CONTRACTOR'S ACCEPTANCE OF EXISTING SITE CONDITIONS.
10. THE CONTRACTOR SHALL NOTIFY ALL UTILITY AGENCIES TO VERIFY THE ACTUAL LOCATIONS OF ALL UTILITIES IN THE PROJECT AREA PRIOR TO EXCAVATING. THE CONTRACTOR SHALL COORDINATE ALL WORK.
11. THE CONTRACTOR SHALL RESTORE TO THEIR ORIGINAL CONDITION ALL IMPROVEMENTS DAMAGED AS A RESULT OF THE CONSTRUCTION, INCLUDING PAVEMENTS, EMBANKMENTS, CURBS, SIGNS, LANDSCAPING, STRUCTURES, UTILITIES, WALLS, FENCES, ETC. AT NO ADDITIONAL EXPENSE TO THE STATE.
12. FOR BENCH MARK, SEE DRAWING NO. C001.
13. THE CONTRACTOR SHALL BE RESPONSIBLE FOR CONFORMANCE WITH THE APPLICABLE PROVISIONS OF THE WATER QUALITY AND WATER POLLUTION CONTROL STANDARDS CONTAINED IN HAWAII ADMINISTRATIVE RULES, TITLE 11, CHAPTER 54, "WATER QUALITY STANDARDS" AND TITLE 11 CHAPTER 55, "WATER POLLUTION CONTROL," AS AMENDED. BEST MANAGEMENT PRACTICES SHALL BE EMPLOYED AT ALL TIMES DURING CONSTRUCTION.
14. THE CONTRACTOR SHALL NOT PERFORM ANY CONSTRUCTION OPERATION SO AS TO CAUSE FALLING ROCKS, SOIL OR DEBRIS IN ANY FORM TO FALL, SLIDE OR FLOW INTO EXISTING DRAINAGE SYSTEMS, ADJOINING PROPERTIES, STREETS, NATURAL WATER COURSES OR OCEAN. SHOULD SUCH VIOLATIONS OCCUR, THE CONTRACTOR MAY BE CITED AND THE CONTRACTOR SHALL IMMEDIATELY MAKE ALL REMEDIAL ACTIONS NECESSARY AT NO COST TO THE STATE.
15. IN THE EVENT THAT ANY PREVIOUSLY UNIDENTIFIED ARCHAEOLOGICAL SITES OR REMAINS (SUCH AS ARTIFACTS, SHELLS, BONE OR CHARCOAL DEPOSITS, HUMAN BURIALS, ROCK OR CORAL ALIGNMENTS, PAVINGS, OR WALLS) ARE ENCOUNTERED, THE CONTRACTOR SHALL IMMEDIATELY SUSPEND WORK AND NOTIFY THE POLICE DEPARTMENT, STATE DEPARTMENT OF LAND AND NATURAL RESOURCES, HISTORIC PRESERVATION DIVISION (692-8015) AND THE ENGINEER. WORK IN THE IMMEDIATE AREA SHALL BE STOPPED UNTIL THE DIVISION IS ABLE TO ASSESS THE IMPACT AND MAKE FURTHER RECOMMENDATIONS FOR THE MITIGATIVE ACTIVITY.
16. CONFINED SPACE

    FOR ENTRY BY STATE PERSONNEL, INCLUDING INSPECTORS, INTO A PERMIT REQUIRED CONFINED SPACE AS DEFINED IN 29 CFR PART 1910.146(b), THE CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING:

    A. ALL SAFETY EQUIPMENT REQUIRED BY THE CONFINED SPACE REGULATIONS APPLICABLE TO ALL PARTIES OTHER THAN THE CONSTRUCTION INDUSTRY, TO INCLUDE, BUT NOT LIMITED TO, THE FOLLOWING:

    1) FULL BODY HARNESSES FOR UP TO TWO PERSONNEL.
    2) LIFELINE AND ASSOCIATED CLIPS.
    3) INGRESS/EGRESS AND FALL PROTECTION EQUIPMENT.
    4) TWO-WAY RADIOS (WALKIE-TALKIES) IF OUT OF LINE-OF-SIGHT.
    5) EMERGENCY (ESCAPE) RESPIRATOR (10-MINUTE DURATION).
    6) CELLULAR TELEPHONE TO CALL FOR EMERGENCY ASSISTANCE.
    7) CONTINUOUS GAS DETECTOR (CALIBRATED) TO MEASURE OXYGEN, HYDROGEN SULFIDE, CARBON MONOXIDE AND FLAMMABLES (CAPABLE OF MONITORING AT A DISTANCE AT LEAST 20-FEET AWAY).
    8) PERSONAL MULTI-GAS DETECTOR TO BE CARRIED BY INSPECTOR.

    B. CONTINUOUS FORCED AIR VENTILATION ADEQUATE TO PROVIDE SAFE ENTRY CONDITIONS.

    C. ONE ATTENDANT/RESCUE PERSONNEL TOPSIDE (TWO, IF CONDITIONS WARRANT IT).

17. THE CONTRACTOR SHALL NOTIFY THE STATE DIVISION OF BOATING AND OCEAN RECREATION OAHU DISTRICT MANAGER (PHONE NO. 832-3520) AND HEEIA KEA SMALL BOAT HARBOR HARBOR MASTER (973-9727) AT LEAST 2 WEEKS PRIOR TO ANY CLOSURE OR SHUTDOWN OF ANY SERVICE.
18. BOULDERS, ROCK, CORAL OR SIMILAR MATERIAL MAY BE ENCOUNTERED DURING EXCAVATION. EXCAVATION OF THESE MATERIALS SHALL BE DONE AT NO ADDITIONAL COST TO THE STATE.
19. CONTRACTOR SHALL MAKE ARRANGEMENTS FOR UTILITIES SUCH AS ELECTRICITY, WATER, TELEPHONE, ETC. REQUIRED FOR HIS OPERATION AND ALL COSTS SHALL BE BORNE BY THE CONTRACTOR.
20. THE CONTRACTOR SHALL TEST EXISTING UTILITIES PRIOR TO START OF WORK TO IDENTIFY THE PARTS OF THESE UTILITIES THAT ARE NOT IN WORKING ORDER. A REPRESENTATIVE OF THE STATE OF HAWAII, DIVISION OF BOATING AND OCEAN RECREATIONS SHALL BE PRESENT TO WITNESS THE TESTING. THE CONTRACTOR SHALL DOCUMENT THE CONDITION OF ALL EXISTING UTILITIES. THE CONTRACTOR SHALL RESTORE ALL DAMAGE CAUSED BY HIS/HER OPERATIONS TO ORIGINAL CONDITIONS OR BETTER AT HIS/HER OWN EXPENSE.

SEWER NOTES

1. ALL SEWER CONSTRUCTION SHALL BE PERFORMED IN ACCORDANCE WITH THE CITY'S STANDARD SPECIFICATIONS, SEPTEMBER 1986, THE DEPARTMENT OF PUBLIC WORKS STANDARD DETAILS, SEPTEMBER 1984, CURRENT CITY PRACTICES AND REVISED ORDINANCES OF HONOLULU, 1990, AS AMENDED, AND THE DESIGN STANDARDS OF THE DEPARTMENT OF WASTEWATER MANAGEMENT, JULY 2017.
2. CRUSHED ROCK CRADLE IS PERMITTED WHERE SOIL IS STABLE. IN AREAS OF UNSTABLE SOIL, THE DESIGN CONSULTANT WILL WORK WITH THE CONSTRUCTION ENGINEER TO DETERMINE THE SUPPORT REQUIRED.
3. MINIMUM SLOPE FOR SEWER LATERALS SHALL BE 1.00% UNLESS OTHERWISE NOTED.
4. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ANY SEWAGE SPILLS CAUSED DURING CONSTRUCTION. THE CONTRACTOR SHALL NOTIFY THE STATE OF HAWAII DEPARTMENT OF HEALTH AND UTILIZE APPROPRIATE SAMPLING AND ANALYZING PROCEDURES. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL PUBLIC NOTIFICATION AND PRESS RELEASES. THIS WORK SHALL BE DONE AT THE CONTRACTOR'S EXPENSE.
5. THE CONTRACTOR SHALL INSTALL "RAINSTOPPER" MANHOLE INSERTS IN ALL SEWER MANHOLES WITH TYPE "SA" FRAME AND COVER.
6. GEOTEXTILE FABRIC TO ENVELOP THE PIPE CRADLE AND SELECT BACKFILL MATERIAL SHALL BE PROVIDED WHERE GROUNDWATER OR UNSTABLE SOIL CONDITIONS ARE ENCOUNTERED.
7. INVERTS SHOWN FOR EXISTING SEWER PIPING ARE APPROXIMATE. THE CONTRACTOR SHALL VERIFY LOCATION AND INVERT OF EXISTING SEWER. IN THE EVENT THAT ANY CHANGE IN ALIGNMENT OR GRADE FOR THE PROPOSED SEWERS ARE REQUIRED DUE TO EXISTING SEWER LINE INVERT OR UNFORESEEN CONFLICT WITH OTHER UTILITIES, THE CONTRACTOR SHALL ADJUST INVERTS AND ALIGNMENTS FOR NEW PIPING ACCORDINGLY. MODIFICATIONS SHALL BE SUBMITTED TO THE ENGINEER FOR APPROVAL PRIOR TO PROCEEDING WITH RE-ALIGNMENT WORK.
8. CONTRACTOR SHALL PHOTOGRAPH ALL STAGES OF THE INSTALLATION OF THE WASTEWATER SYSTEM INCLUDING EXCAVATED AREAS AND TRENCHES PRIOR TO INSTALLATION, WASTEWATER SYSTEM AND PIPING PRIOR TO BACKFILL, AND WASTEWATER SYSTEM AND PIPING AFTER BACKFILLED AND PRIOR TO SURFACE RESTORATION. THE CONTRACTOR SHALL SUBMIT TWO (2) SETS OF PHOTOS (4" x 6") TO THE ENGINEER AFTER COMPLETION OF EACH STAGE NOTED.

PUBLIC HEALTH SAFETY AND CONVENIENCE NOTES

1. THE CONTRACTOR SHALL OBSERVE AND COMPLY WITH ALL FEDERAL, STATE AND LOCAL LAWS REQUIRED FOR THE PROTECTION OF PUBLIC HEALTH, SAFETY AND ENVIRONMENTAL QUALITY.
2. THE CONTRACTOR, AT HIS/HER OWN EXPENSE, SHALL KEEP THE PROJECT AND ITS SURROUNDING AREAS FREE FROM DUST NUISANCE. THE WORK SHALL BE IN CONFORMANCE WITH THE AIR POLLUTION STANDARDS AND REGULATIONS OF THE STATE OF HAWAII, DEPARTMENT OF HEALTH. THE STATE SHALL REQUIRE SUPPLEMENTARY MEASURES IF REQUIRED.
3. THE CONTRACTOR SHALL PROVIDE, INSTALL AND MAINTAIN ALL NECESSARY SIGNS, LIGHTS, FLARES, BARRICADES, MARKERS, CONES AND OTHER PROTECTIVE FACILITIES AND SHALL TAKE ALL NECESSARY PRECAUTIONS FOR THE PROTECTION, CONVENIENCE AND SAFETY OF THE PUBLIC.
4. THE CONTRACTOR'S ATTENTION IS DIRECTED TO STATE OF HAWAII, DEPARTMENT OF HEALTH, TITLE 11, HAWAII ADMINISTRATIVE RULES, CHAPTER 46, "COMMUNITY NOISE CONTROL" IN WHICH MAXIMUM ALLOWABLE NOISE LEVELS HAVE BEEN SET. IF THE CONSTRUCTION ACTIVITIES FOR THIS PROJECT WILL EXCEED THE ALLOWABLE NOISE LEVELS, THE CONTRACTOR WILL BE REQUIRED TO OBTAIN A PERMIT FROM THE DIRECTOR OF THE DEPARTMENT OF HEALTH. THE CONTRACTOR SHALL OBTAIN A COPY OF CHAPTER 46 AND BECOME FAMILIAR WITH THE NOISE LEVEL RESTRICTIONS AND THE PROCEDURES FOR OBTAINING A PERMIT FOR CONSTRUCTION ACTIVITIES. APPLICATION AND INFORMATION ON VARIANCES ARE AVAILABLE AT THE ENVIRONMENTAL HEALTH SERVICES DIVISION, 591 ALA MOANA BOULEVARD, HONOLULU, HAWAII 96813 OR BY TELEPHONE (586-4700).
5. CONTRACTOR SHALL PROVIDE A TEMPORARY SAFE PEDESTRIAN PASSAGEWAY AROUND ALL CONSTRUCTION ACTIVITY WHENEVER PEDESTRIAN WALKWAYS ARE OBSTRUCTED. THE TEMPORARY PEDESTRIAN PASSAGEWAY SHALL CONFORM TO AMERICANS WITH DISABILITIES ACT ACCESSIBILITY GUIDELINES (ADAAG) SECTION 4.1.1(4).

GENERAL NOTES FOR TRAFFIC CONTROL:

1. THE CONTRACTOR SHALL DEVELOP WORKABLE TRAFFIC CONTROL PLAN FOR THE PROJECT.
2. CONES OR DELINEATORS SHALL BE EXTENDED TO A POINT WHERE THEY ARE VISIBLE TO APPROACHING TRAFFIC.
3. REGULATORY AND WARNING SIGNS WITHIN THE CONSTRUCTION ZONE THAT ARE IN CONFLICT WITH THE TRAFFIC CONTROL PLANS SHALL BE REMOVED OR COVERED. ALL SIGNS SHALL BE RESTORED UPON THE COMPLETION OF THE WORK.
4. FLAGGERS AND/OR POLICE OFFICERS SHALL BE IN SIGHT OF EACH OTHER OR IN DIRECT COMMUNICATION AT ALL TIMES.
5. ALL TRAFFIC LANES SHALL BE A MINIMUM OF NINE (9) FEET WIDE.
6. ALL CONSTRUCTION WARNING SIGNS SHALL BE PROMPTLY REMOVED OR COVERED WHENEVER THE MESSAGE IS NOT APPLICABLE OR NOT IN USE.
7. THE BACKS OF ALL SIGNS USED FOR TRAFFIC CONTROL SHALL BE APPROPRIATELY COVERED TO PRECLUDE THE DISPLAY OF INAPPLICABLE SIGN MESSAGES (I.E. WHEN THE SIGNS HAVE MESSAGES ON BOTH FACES).
8. LANE CLOSURE SHALL BE LIMITED ONLY TO THE EXTENT OF ACCOMPLISHING EACH DAY'S WORK. AS SOON AS EACH DAY'S WORK IS COMPLETED, THE CONTRACTOR SHALL REMOVE ALL TRAFFIC CONTROL DEVICES NO LONGER NEEDED TO PERMIT FREE AND SAFE PASSAGE OF PUBLIC TRAFFIC.
9. PERMANENT PAVEMENT MARKINGS AND TRAFFIC SIGNS SHALL BE REPLACED UPON COMPLETION OF WORK.
10. DRIVEWAYS SHALL BE KEPT OPEN UNLESS THE OWNERS OF THE PROPERTY USING THE RIGHT-OF-WAY ARE OTHERWISE PROVIDED FOR SATISFACTORILY. FURTHER, THE PERMITTEE SHALL CONTROL TRAFFIC GOING IN AND OUT OF DRIVEWAYS.

ABBREVIATIONS:

AC	ASPHALTIC CONCRETE	T	TOP
BC	BOTTOM CURB	TC	TOP CURB
BFP	BACKFLOW PREVENTOR	TEL.	TELEPHONE
C	CONCRETE	TRANS.	TRANSFORMER
D	DIAMETER	TS	TOP STEM
G	G, GAS	UTIL.	LIGHT POLE
GP	GUARD POST	WM	WATER METER
H	HEIGHT	WMH	WATER MANHOLE
LP	LIGHT POLE	WV	WATER VALVE
SMH	SEWER MANHOLE	SEWER LINE	—— S12" ——
		WATER LINE	—— W12" ——

NOTE:

UNDERGROUND UTILITY LINES AND/OR STRUCTURES, IF SHOWN, ARE PROVIDED FOR INFORMATION ONLY AND ARE BASED ON INFORMATION SHOWN ON PLANS/MAPS PREPARED BY OTHERS. THE INFORMATION SHOWN, THEREFORE, MAY OR MAY NOT BE REPRESENTATIVE OF THE ACTUAL FIELD CONDITIONS. THE UNDERGROUND UTILITY LINES AND/OR STRUCTURES MAY OR MAY NOT BE PRESENT AT THE LOCATIONS SHOWN OR OTHER UNDERGROUND UTILITY LINES AND/OR STRUCTURES NOT SHOWN MAY BE PRESENT.

AS BUILT
HENRY'S EQUIPMENT RENTAL & SALES, INC.
SIGNATURE 3/1/22 DATE

REVISION NO.	SYM.	DESCRIPTION	SHT./OF	DATE	APPROVED

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION AND CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY OBSERVATION.

SIGNATURE
LICENSE EXP.: 4/30/20

DAVID B. BILLS ★ LICENSED PROFESSIONAL ENGINEER ★ No. 4516-C HAWAII, U.S.A.

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF BOATING AND OCEAN RECREATION

HEEIA KEA SMALL BOAT HARBOR WASTEWATER TREATMENT SYSTEM IMPROVEMENTS

GENERAL NOTES AND ABBREVIATIONS

BILLS ENGINEERING, INC.

DESIGNED: DB	SUBMITTED: BEI
DRAWN: RE/SI	DATE:
CHECKED: DB	SCALE: AS SHOWN
APPROVED:	DRAWING NO. T002
CHIEF ENGINEER DATE	

Thu, 18 Apr 2019 - 10:17pm
N:\Projects\562-00 HEEIA KEA WWTP\Const Plans\562-00 T002 Notes & Abbreviations.dwg

JOB NO. B78C074A SHEET NO. 2 OF 29 SHEETS

GRADING NOTES

1. ALL GRADING WORK SHALL BE DONE IN ACCORDANCE WITH CHAPTER 14, ARTICLES 13, 14, 15 & 16 AS RELATED TO GRADING, SOIL EROSION AND SEDIMENT CONTROL OF THE REVISED ORDINANCES OF HONOLULU, 1990, AS AMENDED, AND SOILS REPORT BY SHINSATO ENGINEERING, INC. ENTITLED "GEOTECHNICAL INVESTIGATION PROPOSED WASTEWATER TREATMENT PLANT FACILITY, HEEIA KEA SMALL BOAT HARBOR, KAMEHAMEHA HIGHWAY, KANEOHE, HAWAII" AS PREPARED BY SHINSATO ENGINEERING INC, JUNE 21, 2017.
2. NO CONTRACTOR SHALL PERFORM ANY GRADING OPERATION SO AS TO CAUSE FALLING ROCKS, SOIL OR DEBRIS IN ANY FORM TO FALL, SLIDE OR FLOW ONTO ADJOINING PROPERTIES, STREETS OR NATURAL WATERCOURSES. SHOULD SUCH VIOLATIONS OCCUR, THE CONTRACTOR MAY BE CITED AND THE CONTRACTOR SHALL IMMEDIATELY MAKE ALL REMEDIAL ACTIONS NECESSARY.
3. THE CONTRACTOR, AT HIS OWN EXPENSE, SHALL KEEP THE PROJECT AREA AND SURROUNDING AREA FREE FROM DUST NUISANCE. THE WORK SHALL BE IN CONFORMANCE WITH THE AIR POLLUTION CONTROL STANDARDS CONTAINED IN THE HAWAII ADMINISTRATIVE RULES, TITLE 11, CHAPTER 60.1, "AIR POLLUTION CONTROL".
4. THE UNDERGROUND PIPES, CABLES OR DUCTLINES KNOWN TO EXIST BY THE ENGINEER FROM HIS SEARCH OF RECORDS ARE INDICATED ON THE PLANS. THE CONTRACTOR SHALL VERIFY THE LOCATIONS AND DEPTHS OF THE FACILITIES AND EXERCISE PROPER CARE IN EXCAVATING IN THE AREA. WHEREVER CONNECTIONS OF NEW UTILITIES ARE SHOWN ON THE PLANS, THE CONTRACTOR SHALL EXPOSE THE EXISTING LINES AT THE PROPOSED CONNECTIONS TO VERIFY THEIR LOCATIONS AND DEPTHS PRIOR TO EXCAVATION FOR THE NEW LINES.
5. ADEQUATE PROVISIONS SHALL BE MADE TO PREVENT SURFACE WATERS FROM DAMAGING THE CUT FACE OF AN EXCAVATION OR THE SLOPED SURFACES OF A FILL. FURTHERMORE, ADEQUATE PROVISIONS SHALL BE MADE TO PREVENT SEDIMENT-LADEN RUNOFF FROM LEAVING THE SITE.
6. ALL SLOPES AND EXPOSED AREAS SHALL BE SODDED OR PLANTED AS SOON AS FINAL GRADES HAVE BEEN ESTABLISHED. PLANTING SHALL NOT BE DELAYED UNTIL ALL GRADING WORK HAS BEEN COMPLETED. GRADING TO FINAL GRADE SHALL BE CONTINUOUS, AND ANY AREA WITHIN WHICH WORK HAS BEEN INTERRUPTED OR DELAYED SHALL BE PLANTED.
7. FILLS ON SLOPES STEEPER THAN 5:1 SHALL BE KEYED.
8. THE CITY SHALL BE INFORMED OF THE LOCATION OF THE BORROW/DISPOSAL SITE FOR THE PROJECT WHEN THE APPLICATION FOR A GRADING PERMIT IS MADE. THE BORROW/DISPOSAL SITE MUST ALSO FULFILL THE REQUIREMENTS OF THE GRADING ORDINANCE.
9. NO GRADING WORK SHALL BE DONE ON SATURDAYS, SUNDAYS AND HOLIDAYS AT ANY TIME WITHOUT PRIOR NOTICE TO THE DIRECTOR D.P.P., PROVIDED SUCH GRADING WORK IS ALSO IN CONFORMANCE WITH THE COMMUNITY NOISE CONTROL STANDARDS CONTAINED IN THE HAWAII ADMINISTRATIVE RULES, TITLE 11, CHAPTER 46, "COMMUNITY NOISE CONTROL".
10. THE LIMITS OF THE AREA TO BE GRADED SHALL BE FLAGGED BEFORE THE COMMENCEMENT OF THE GRADING WORK.
11. THE GENERAL CONTRACTOR/DEVELOPER/OWNER OF THE PROJECT SHALL BE RESPONSIBLE FOR CONFORMANCE WITH THE APPLICABLE PROVISIONS OF THE HAWAII ADMINISTRATIVE RULES, TITLE 11, CHAPTER 54, "WATER QUALITY STANDARDS" AND TITLE 11, CHAPTER 55, "WATER POLLUTION CONTROL", AS WELL AS CHAPTER 14 OF THE REVISED ORDINANCES OF HONOLULU, AS AMENDED. BEST MANAGEMENT PRACTICES SHALL BE EMPLOYED AT ALL TIMES DURING CONSTRUCTION.

    THE GENERAL CONTRACTOR/DEVELOPER/OWNER OF THE PROJECT SHALL OBTAIN NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT COVERAGE(S) FOR THE FOLLOWING:

    1. STORM WATER DISCHARGES ASSOCIATED WITH CONSTRUCTION ACTIVITIES THAT DISTURB ONE (1) ACRE OR MORE, AND
    2. DISCHARGES OF HYDROTESTING EFFLUENT, DEWATERING EFFLUENT, AND WELL DRILLING EFFLUENT TO STATE WATERS.

    IN ACCORDANCE WITH STATE LAW, ALL DISCHARGES RELATED TO PROJECT CONSTRUCTION OR OPERATIONS ARE REQUIRED TO COMPLY WITH STATE WATER QUALITY STANDARDS (HAWAII ADMINISTRATIVE RULES, CHAPTER 11-54). BEST MANAGEMENT PRACTICES SHALL BE USED TO MINIMIZE OR PREVENT THE DISCHARGE OF SEDIMENT, DEBRIS, AND OTHER POLLUTANTS TO STATE WATERS. PERMIT COVERAGE IS AVAILABLE FROM DEPARTMENT OF HEALTH, CLEAN WATER BRANCH AT HTTP://HEALTH.HAWAII.GOV/CWB. THE OWNER/DEVELOPER/CONTRACTOR IS RESPONSIBLE FOR OBTAINING OTHER FEDERAL, STATE, OR LOCAL AUTHORIZATIONS AS REQUIRED BY LAW.
12. WHERE APPLICABLE AND FEASIBLE THE MEASURES TO CONTROL EROSION AND OTHER POLLUTANTS SHALL BE IN PLACE BEFORE ANY EARTH MOVING PHASE OF THE GRADING IS INITIATED.
13. TEMPORARY EROSION CONTROLS SHALL NOT BE REMOVED BEFORE PERMANENT EROSION CONTROLS ARE IN-PLACE AND ESTABLISHED.
14. TEMPORARY EROSION CONTROL PROCEDURES SHALL BE SUBMITTED FOR APPROVAL PRIOR TO APPLICATION FOR GRADING PERMIT.
15. IF THE GRADING WORK INVOLVES CONTAMINATED SOIL, THEN ALL GRADING WORK SHALL BE DONE IN CONFORMANCE WITH APPLICABLE STATE AND FEDERAL REQUIREMENTS.
16. BUILDING PERMIT FOR RETAINING WALLS SHALL BE OBTAINED PRIOR TO COMMENCEMENT OF GRADING WORK ON SITE.
17. FOR NON-CITY PROJECTS, THE CONTRACTOR SHALL NOTIFY THE CIVIL ENGINEERING BRANCH, D.P.P. AT 768-8084 TO ARRANGE FOR INSPECTIONAL SERVICES AND SUBMIT TWO (2) SETS OF APPROVED CONSTRUCTION PLANS SEVEN (7) DAYS PRIOR TO COMMENCEMENT OF CONSTRUCTION WORK. FOR CITY PROJECTS, THE CONTRACTOR SHALL COORDINATE CONSTRUCTIONAL SERVICES WITH THE RESPONSIBLE CITY AGENCY.
18. PURSUANT TO CHAPTER 6E, HRS, IN THE EVENT ANY ARTIFACTS OR HUMAN REMAINS ARE UNCOVERED DURING CONSTRUCTION OPERATIONS, THE CONTRACTOR SHALL IMMEDIATELY SUSPEND WORK AND NOTIFY THE HONOLULU POLICE DEPARTMENT, THE STATE DEPARTMENT OF LAND AND NATURAL RESOURCES-HISTORIC PRESERVATION DIVISION (692-8015). IN ADDITION, FOR NON-CITY PROJECTS, THE CONTRACTOR SHALL INFORM THE CIVIL ENGINEERING BRANCH, D.P.P. (768-8084); AND FOR CITY PROJECTS, NOTIFY THE RESPONSIBLE CITY AGENCY.

GRADING NOTES, (CONT'D)

19. FOR ALL PROJECTS, WHICH WILL DISTURB ONE (1) ACRE OR MORE OF LAND, THE CONTRACTOR SHALL NOT START CONSTRUCTION UNTIL A NOTICE OF GENERAL PERMIT COVERAGE (NGPC) IS RECEIVED FROM THE DEPARTMENT OF HEALTH, STATE OF HAWAII, AND HAS SATISFIED ANY OTHER APPLICABLE REQUIREMENTS OF THE NPDES PERMIT PROGRAM. ALSO, FOR NON-CITY AND OTHER NON-GOVERNMENTAL AGENCY PROJECTS, THE CONTRACTOR SHALL PROVIDE A WRITTEN COPY OF THE NGPC TO THE PERMITTING AND INSPECTION SECTION, CIVIL ENGINEERING BRANCH, D.P.P., AT LEAST SEVEN (7) CALENDAR DAYS BEFORE THE START OF THE CONSTRUCTION. FOR CITY OR OTHER GOVERNMENTAL PROJECTS, THE CONTRACTOR SHOULD PROVIDE A WRITTEN COPY OF THE NGPC TO THE APPROPRIATE CITY DEPARTMENT OR GOVERNMENTAL AGENCY PER THEIR REQUIREMENTS.
20. ALL GRADING AND CONSTRUCTION WORK SHALL IMPLEMENT MEASURES TO ENSURE THAT THE DISCHARGE OF POLLUTANTS FROM THE CONSTRUCTION SITE WILL BE REDUCED TO THE MAXIMUM EXTENT PRACTICABLE AND WILL NOT CAUSE OR CONTRIBUTE TO AN EXCEEDANCE OF WATER QUALITY STANDARDS.
21. NON-COMPLIANCE TO ANY OF THE ABOVE REQUIREMENTS SHALL MEAN IMMEDIATE SUSPENSION OF ALL WORK, AND REMEDIAL WORK SHOULD COMMENCE IMMEDIATELY. ALL COSTS INCURRED SHALL BE BILLED TO THE VIOLATORS. FURTHERMORE, VIOLATORS SHALL BE SUBJECTED TO ADMINISTRATIVE, CIVIL AND/OR CRIMINAL PENALTIES.
22. FOR BENCH MARK, SEE SHEET C001.

DUST CONTROL NOTES:

1. THE CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR THE MEASURES IT WILL TAKE FOR THE CONTROL OF FUGITIVE DUST FROM THE WORKSITE. THE MEASURES MAY INCLUDE BUT ARE NOT LIMITED TO WATERING OF THE SITE AND FILL MATERIAL BEING PLACED, AND DELAYING WORK IN THE WEEK THAT PREVAILING WIND DIRECTION SHOULD SHIFT. THE CONTRACTOR, AT HIS OWN EXPENSE SHALL KEEP THE PROJECT AREA AND SURROUNDING AREA FREE FROM DUST NUISANCE. THE WORK SHALL BE IN CONFORMANCE WITH THE AIR POLLUTION STANDARDD CONTAINED IN THE HAWAII ADMINISTRATIVE RULES: CHAPTER 11-60, "AIR POLLUTION CONTROL". DUST SHALL BE KEPT WITHIN ACCEPTABLE LEVELS AT ALL TIMES, INCLUDING NON-WORKING HOURS, WEEKENDS AND HOLIDAYS IN CONFORMANCE WITH TITLE 11, CHAPTER 60.1-AIR POLLUTION CONTROL, AS AMENDED, OF THE STATE DEPT. OF HEALTH, PUBLIC HEALTH REGULATIONS. THE METHOD OF DUST CONTROL, AND ALL COSTS INCURRED THEREFORE SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL DUST DAMAGE CLAIMS.
2. CONSTRUCTION ACTIVITIES SHALL COMPLY W/PROVISIONS OF HAR CH. 11-60-1 "AIR POLLUTION CONTROL" SECTION 11-60-1-33, FUGITIVE DUST. THE CONTRACTOR SHALL PROVIDE ADEQUATE MEASURES TO CONTROL DUST FROM ROAD AREAS AND DURING VARIOUS PHASES OF CONSTRUCTION WHICH SHALL INCLUDE, BUT ARE NOT LIMITED TO:
    - A. PLAN THE DIFFERENT PHASES OF CONSTRUCTION, FOCUSING ON MINIMIZING THE AMOUNT OF DUST GENERATING MATERIALS AND ACTIVITIES, CENTRALIZING ON-SITE VEHICULAR TRAFFIC ROUTES, AND LOCATING POTENTIALLY DUSTY EQUIP. IN AREAS OF LEAST IMPACT.
    - B. PROVIDE ADEQUATE WATER SOURCE AT THE SITE PRIOR TO START UP OF CONSTRUCTION ACTIVITIES.
    - C. LANDSCAPE AND PROVIDE RAPID COVERING OF BARE AREAS, INCLUDING SLOPES, STARTING FROM THE INITIAL GRADING PHASE.
    - D. MINIMIZE DUST FROM SHOULDERS & ACCESS ROADS.
    - E. PROVIDE ADEQUATE DUST CONTROL MEASURES DURING WEEKENDS, AFTER HOURS, AND PRIOR TO DAILY START-UP OF CONSTRUCTION ACTIVITIES.
    - F. CONTROL DUST FROM DEBRIS BEING HAULED AWAY FROM PROJECT SITE.

AS BUILT
HENRY'S EQUIPMENT RENTAL & SALES, INC.
SIGNATURE 3/1/22 DATE

APPROVED:

for CHIEF, CIVIL ENGINEERING BRANCH, DPP 2/26/19 DATE

REVISION NO.	SYM.	DESCRIPTION	SHT./OF	DATE	APPROVED

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION AND CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY OBSERVATION.

SIGNATURE
LICENSE EXP.: 4/30/20

LICENSED PROFESSIONAL ENGINEER
DAVID B. BILLS
No. 4516-C
HAWAII, U.S.A.

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF BOATING AND OCEAN RECREATION

HEEIA KEA SMALL BOAT HARBOR WASTEWATER TREATMENT SYSTEM IMPROVEMENTS

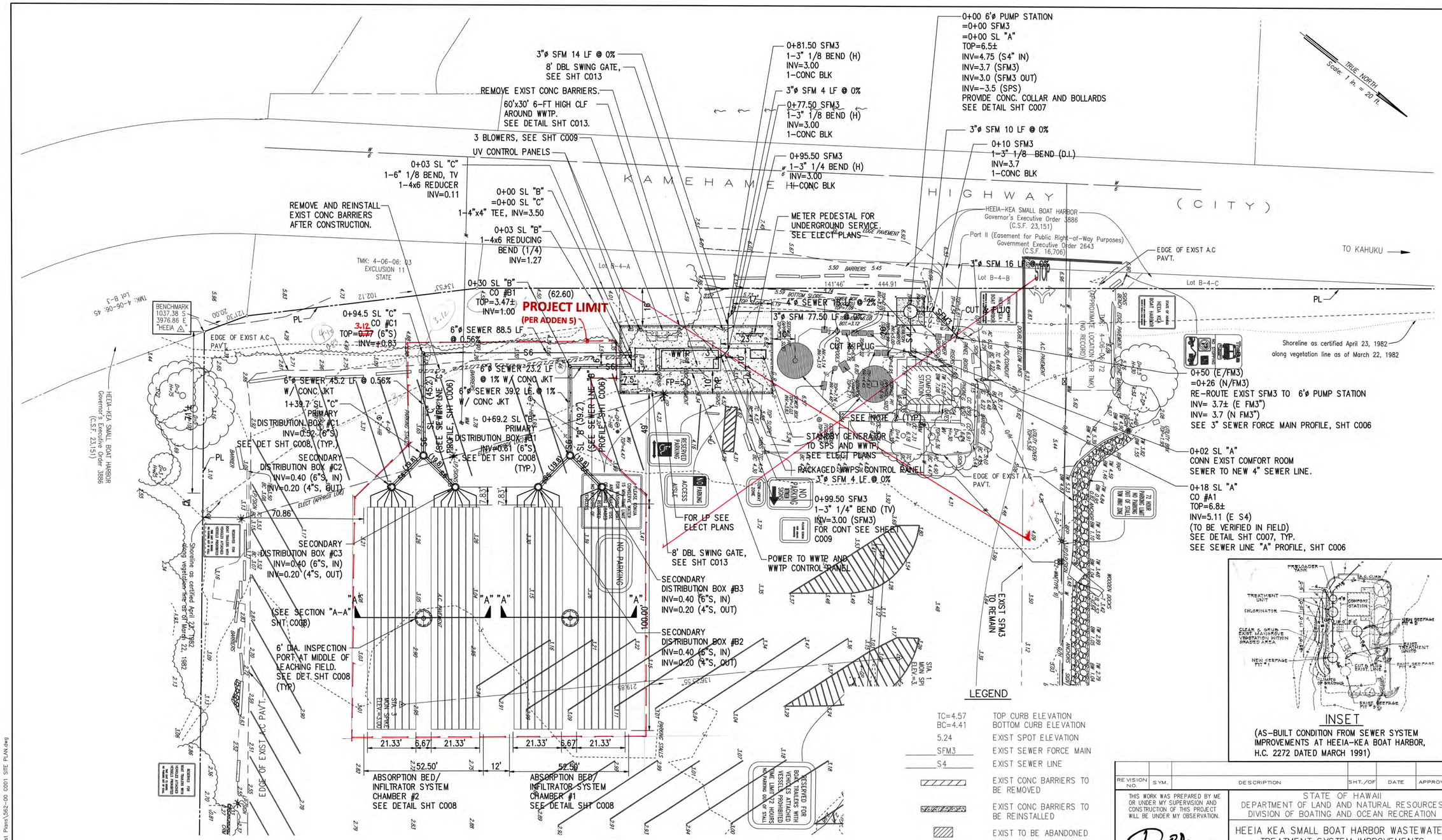
GRADING NOTES

BILLS ENGINEERING, INC.

DESIGNED: DB	SUBMITTED: BEI
DRAWN: RE/SI	DATE:
CHECKED: DB	SCALE: AS SHOWN
APPROVED: CHIEF ENGINEER DATE	DRAWING NO. T003

JOB NO. B78C074A SHEET NO. 3 OF 29 SHEETS

Mon, 25 Feb 2019 - 9:25am
N:\Projects\562-00 HEEIA KEA WWTP\Const Plans\562-00 T003 GRADING NOTES.dwg



LEGEND

TC=4.57 BC=4.41	TOP CURB ELEVATION BOTTOM CURB ELEVATION
5.24	EXIST SPOT ELEVATION
SFM3	EXIST SEWER FORCE MAIN
S4	EXIST SEWER LINE
	EXIST CONC BARRIERS TO BE REMOVED
	EXIST CONC BARRIERS TO BE REINSTALLED
	EXIST TO BE ABANDONED
	EXIST EDGE OF AC PAVEMENT
SFM3	NEW SEWER FORCE MAIN
S4	NEW SEWER LINE
	NEW SEWER CLEANOUT
	DISTRIBUTION BOX
	NEW CHAIN LINK FENCE
	CUT AND PLUG

INSET

(AS-BUILT CONDITION FROM SEWER SYSTEM IMPROVEMENTS AT HEEIA-KEA BOAT HARBOR, H.C. 2272 DATED MARCH 1991)

NOTES:

1. PROPER CARE SHOULD BE TAKEN DURING EXCAVATION AROUND EXISTING WATERLINE SO AS NOT TO CAUSE ANY BREAKAGE TO THE EXISTING LINE.
2. CRUSH OR REMOVE TOP OF EXISTING CESSPOOLS AND FILL WITH GRANULAR MATERIAL AND ABANDON. ALL OTHER EXISTING COMPONENTS OF THE WASTEWATER SYSTEM TO BE ADANDONED AFTER CONNECTION TO THE NEW WASTEWATER TREATMENT PLANT IS COMPLETE AND OPERATIONAL.

SITE PLAN

20 10 0 20 40

Scale in Feet

AS BUILT
HENRY'S EQUIPMENT RENTAL & SALES, INC.
SIGNATURE 3/1/20 DATE

REVISION NO.	SYM.	DESCRIPTION	SHT./OF	DATE	APPROVED

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LICENSE EXP.: 4/30/20

DAVID B. BILLS
LICENSED PROFESSIONAL ENGINEER
No. 4516-C
HAWAII, U.S.A.

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF BOATING AND OCEAN RECREATION

HEEIA KEA SMALL BOAT HARBOR WASTEWATER TREATMENT SYSTEM IMPROVEMENTS

SITE PLAN

BILLS ENGINEERING, INC.

DESIGNED: DB	SUBMITTED: BEI
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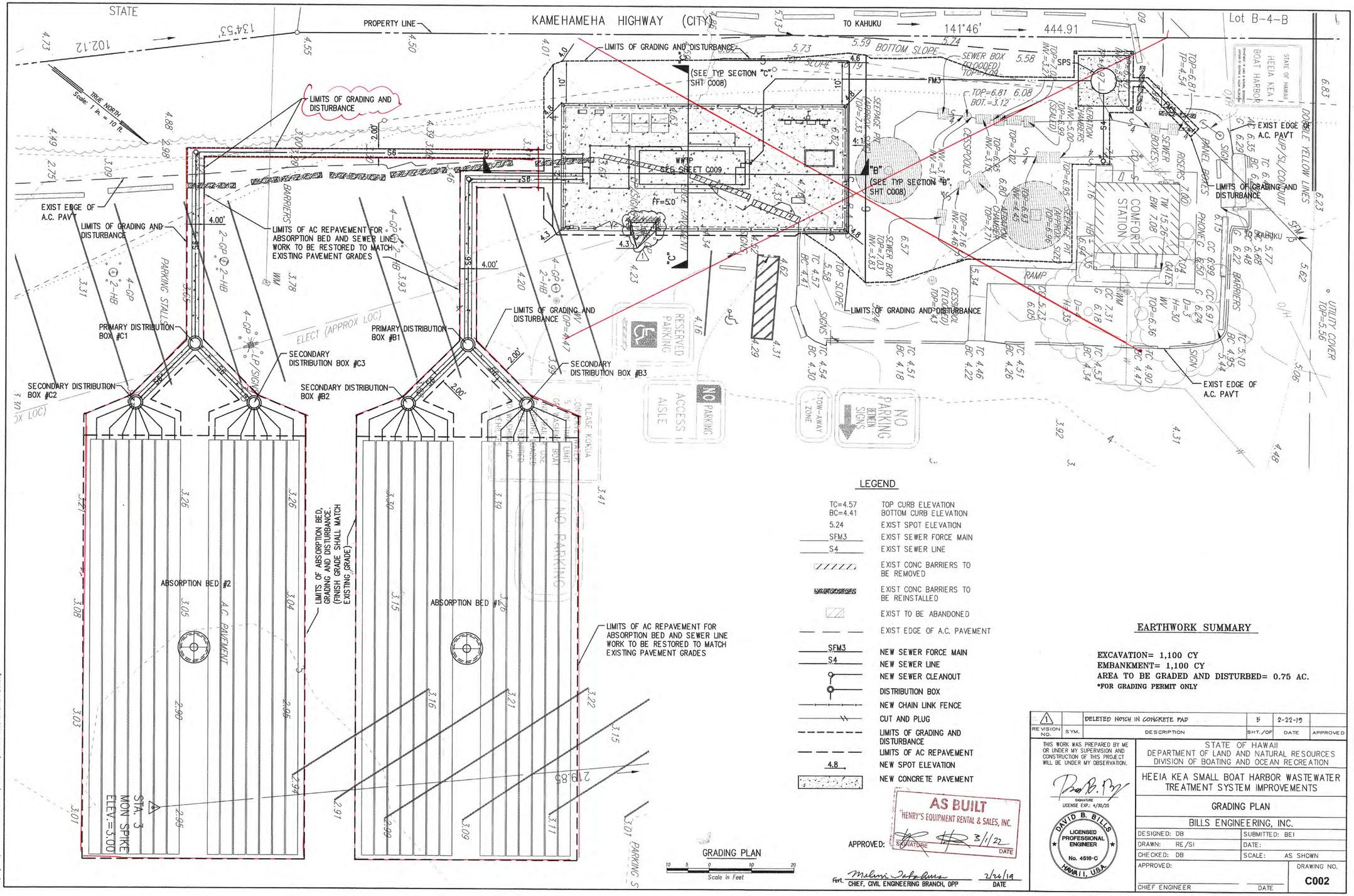
CHECKED: DB	SCALE: AS SHOWN
APPROVED:	DRAWING NO. C001
CHIEF ENGINEER	DATE

Thu, 18 Apr 2019 - 8:29am
N:\Projects\062-00 HEEIA KEA WWTP\Const Plans\062-00 C001 SITE PLAN.dwg



LEGEND

TC=4.57 BC=4.41	TOP CURB ELEVATION BOTTOM CURB ELEVATION
5.24	EXIST SPOT ELEVATION
SFM3	EXIST SEWER FORCE MAIN
S4	EXIST SEWER LINE
	EXIST CONC BARRIERS TO BE REMOVED
	EXIST CONC BARRIERS TO BE REINSTALLED
	EXIST TO BE ABANDONED
	EXIST EDGE OF A.C. PAVEMENT
SFM3	NEW SEWER FORCE MAIN
S4	NEW SEWER LINE
	NEW SEWER CLEANOUT
	DISTRIBUTION BOX
	NEW CHAIN LINK FENCE
	CUT AND PLUG
	LIMITS OF GRADING AND DISTURBANCE
	LIMITS OF AC REPAVEMENT
4.8	NEW SPOT ELEVATION
	NEW CONCRETE PAVEMENT

EARTHWORK SUMMARY

EXCAVATION= 1,100 CY
EMBANKMENT= 1,100 CY
AREA TO BE GRADED AND DISTURBED= 0.75 AC.
***FOR GRADING PERMIT ONLY**

AS BUILT
"HENRY'S EQUIPMENT RENTAL & SALES, INC."

APPROVED: SIGNATURE 3/1/22 DATE

For CHIEF, CIVIL ENGINEERING BRANCH, DPP — 2/24/19 DATE

REVISION NO.	SYM.	DESCRIPTION	SHT./OF	DATE	APPROVED
1		DELETED NOTCH IN CONCRETE PAD	5	2-22-19	

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SIGNATURE
LICENSE EXP.: 4/30/20

DAVID B. BILLS — LICENSED PROFESSIONAL ENGINEER — No. 4516-C — HAWAII, USA

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF BOATING AND OCEAN RECREATION

HEEIA KEA SMALL BOAT HARBOR WASTEWATER TREATMENT SYSTEM IMPROVEMENTS

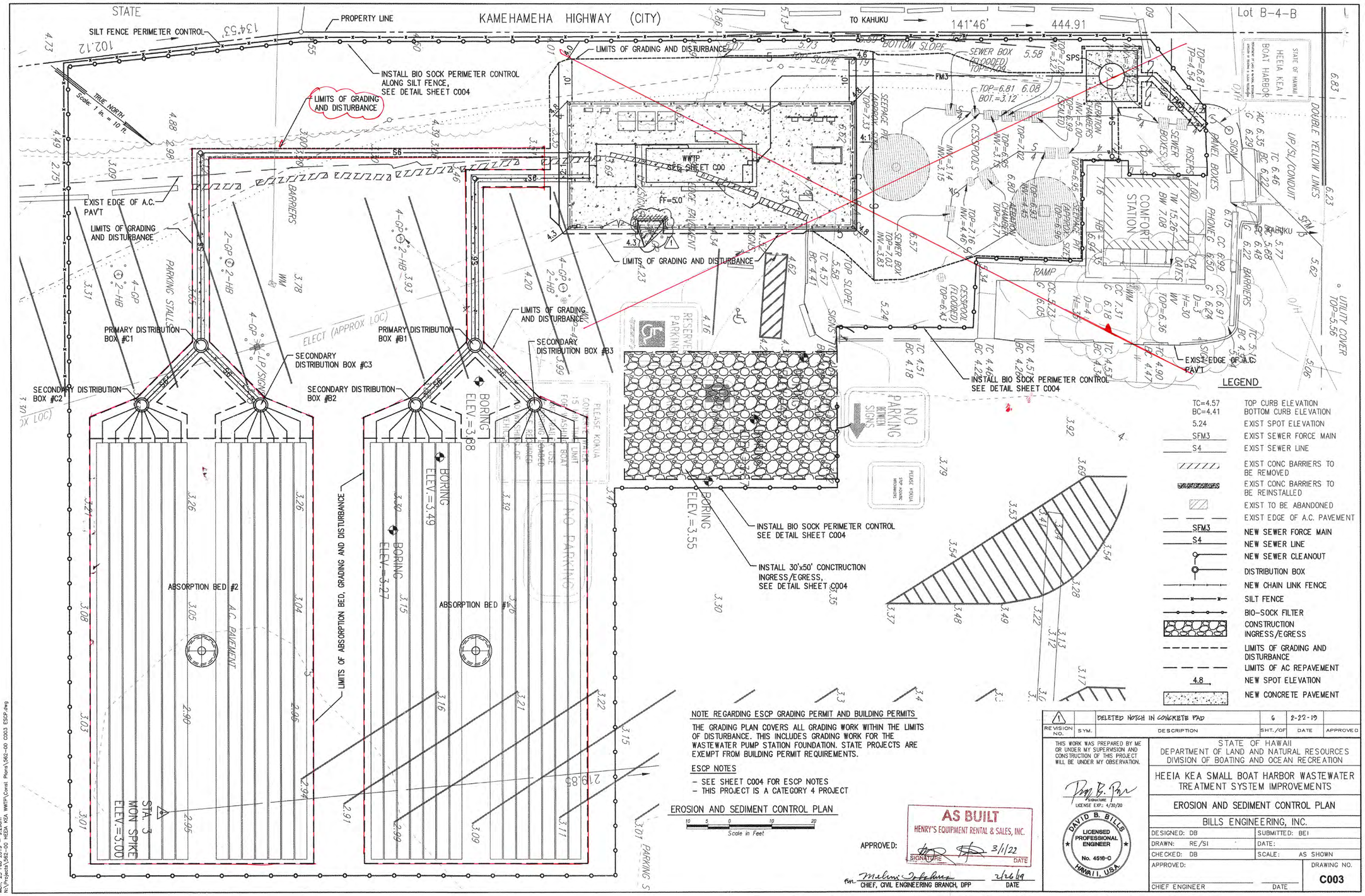
GRADING PLAN

BILLS ENGINEERING, INC.

DESIGNED: DB	SUBMITTED: BEI
DRAWN: RE/SI	DATE:
CHECKED: DB	SCALE: AS SHOWN
APPROVED:	DRAWING NO. C002
CHIEF ENGINEER — DATE	

JOB NO. B78C074A SHEET NO. 5 OF 29 SHEETS

Fri, 08 Feb 2019 - 11:11am
N:\Projects\562-00 HEEIA KEA WWTP\Const Plans\562-00 C002 GRADING PLAN.dwg



NOTE REGARDING ESCP GRADING PERMIT AND BUILDING PERMITS

THE GRADING PLAN COVERS ALL GRADING WORK WITHIN THE LIMITS OF DISTURBANCE. THIS INCLUDES GRADING WORK FOR THE WASTEWATER PUMP STATION FOUNDATION. STATE PROJECTS ARE EXEMPT FROM BUILDING PERMIT REQUIREMENTS.

ESCP NOTES

- SEE SHEET C004 FOR ESCP NOTES
- THIS PROJECT IS A CATEGORY 4 PROJECT

EROSION AND SEDIMENT CONTROL PLAN

10 5 0 10 20
Scale in Feet

APPROVED:

AS BUILT
HENRY'S EQUIPMENT RENTAL & SALES, INC.

SIGNATURE 3/1/22 DATE

for CHIEF, CIVIL ENGINEERING BRANCH, DPP 2/16/19 DATE

REVISION NO.	SYM.	DESCRIPTION	SHT./OF	DATE	APPROVED
1		DELETED NOTCH IN CONCRETE PAD	6	2-22-19	

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SIGNATURE LICENSE EXP.: 4/30/20

DAVID B. BILLS LICENSED PROFESSIONAL ENGINEER No. 4516-C HAWAII, U.S.A.

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF BOATING AND OCEAN RECREATION

HEEIA KEA SMALL BOAT HARBOR WASTEWATER TREATMENT SYSTEM IMPROVEMENTS

EROSION AND SEDIMENT CONTROL PLAN

BILLS ENGINEERING, INC.

DESIGNED: DB	SUBMITTED: BEI
DRAWN: RE/SI	DATE:
CHECKED: DB	SCALE: AS SHOWN
APPROVED:	DRAWING NO. C003
CHIEF ENGINEER	DATE

Mon, 25 Feb 2019 – 9:26am
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JOB NO. B78C074A SHEET NO. 6 OF 29 SHEETS

GOOD HOUSEKEEPING BMPS NOTES:

1. STREET SWEEPING, VACUUMING. ALL POLLUTANTS DISCHARGED FROM CONSTRUCTION SITE TO OFFSITE AREAS MUST BE SWEPT OR VACUUMED EACH DAY BEFORE LEAVING THE JOB SITE.
2. MATERIALS DELIVERY, STORAGE AND USE MANAGEMENT. PREVENT, REDUCE OR ELIMINATE THE DISCHARGE OF POLLUTANTS FROM MATERIAL DELIVERY, STORAGE AND USE TO THE STORM WATER SYSTEM OR WATERCOURSES BY MINIMIZING THE STORAGE OF HAZARDOUS MATERIALS ONSITE, STORING MATERIALS IN A DESIGNATED AREA, INSTALLING SECONDARY CONTAINMENT. CONSTRUCTION MATERIALS, WASTE, TOXIC AND HAZARDOUS SUBSTANCES, STOCKPILES AND OTHER SOURCES OF POLLUTANT SHALL NOT BE STORED IN BUFFER AREAS, NEAR AREAS OF CONCENTRATED FLOW, OR AREAS ABUTTING THE MS4, RECEIVING WATERS, OR DRAINAGE IMPROVEMENTS THAT DISCHARGE OFFSITE. PRIMARY AND SECONDARY CONTAINMENT CONTROLS AND COVERS SHALL BE IMPLEMENTED TO THE MEP.
3. SPILL PREVENTION AND CONTROL. CREATE AND IMPLEMENT SPILL PREVENTION AND RESPONSE PLAN TO ELIMINATE AND MINIMIZE THE DISCHARGE OF POLLUTANTS TO THE MS4 AND RECEIVING WATERS FROM LEAKS AND SPILLS BY REDUCING THE CHANCE FOR SPILLS, ABSORBING, CONTAINING, AND CLEANING UP SPILLS AND PROPERLY DISPOSING OF SPILL MATERIALS. AT A MINIMUM, ALL PROJECTS SHALL CLEANUP ALL LEAKS AND SPILLS IMMEDIATELY.
4. HAZARDOUS MATERIALS. PREVENT OR REDUCE THE DISCHARGE OF POLLUTANTS TO STORM WATER FROM HAZARDOUS WASTE THROUGH PROPER MATERIAL USE AND WASTE DISPOSAL. IN THE EVENT THAT HAZARDOUS MATERIALS ARE DISCHARGED TO THE MS4, THE PROPERTY OWNER OR ESCP COORDINATOR SHALL IMMEDIATELY NOTIFY THE DEPARTMENT OF FACILITIES MAINTENANCE, HONOLULU FIRE DEPARTMENT, AND HONOLULU POLICE DEPARTMENT OF THE DISCHARGE BY TELEPHONE. A WRITTEN REPORT DESCRIBING THE POLLUTANTS THAT WERE DISCHARGED, THE REASONS FOR THE DISCHARGE, AND THE MEASURES THAT HAVE BEEN TAKEN OR WILL BE TAKEN TO PREVENT A REOCCURRENCE OF THE DISCHARGE SHALL BE SUBMITTED TO THE DIRECTOR NO LESS THAN 3 DAYS AFTER NOTIFICATION BY PHONE.
5. NONHAZARDOUS MATERIALS. IN THE EVENT THAT NONHAZARDOUS MATERIALS ARE DISCHARGE TO THE MS4, THE PROPERTY OWNER OR ESCP COORDINATOR SHALL NOTIFY THE CITY DEPARTMENT OF FACILITIES MAINTENANCE BY TELEPHONE NO LATER THAN THE NEXT BUSINESS DAY. A WRITTEN REPORT DESCRIBING THE POLLUTANTS THAT WERE DISCHARGED, THE REASONS FOR THE DISCHARGE AND THE MEASURES THAT HAVE BEEN TAKEN OR WILL BE TAKEN TO PREVENT A REOCCURRENCE OF THE DISCHARGE SHALL BE SUBMITTED TO THE DIRECTOR NO LESS THAN 3 DAYS AFTER NOTIFICATION BY PHONE.
6. VEHICLE AND EQUIPMENT CLEANING. ELIMINATE AND MINIMIZE THE DISCHARGE OF POLLUTANTS TO STORM WATER FROM VEHICLE AND EQUIPMENT CLEANING OPERATIONS BY USING OFFSITE FACILITIES WHEN FEASIBLE, WASHING IN DESIGNATED, CONTAINED AREAS ONLY, AND ELIMINATING DISCHARGES TO THE STORM DRAIN SYSTEM BY EVAPORATING AND/OR TREATING WASH WATER, AS APPROPRIATE OR INFILTRATING WASH WATER FOR EXTERIOR CLEANING ACTIVITIES THAT USE WATER ONLY.
7. VEHICLE AND EQUIPMENT FUELING. PREVENT FUEL SPILLS AND LEAKS BY USING OFFSITE FACILITIES, FUELING ONLY IN DESIGNATED AREAS, ENCLOSING OR COVERING STORED FUEL, AND IMPLEMENTING SPILL CONTROLS SUCH AS SECONDARY CONTAINMENT AND ACTIVE MEASURES USING SPILL RESPONSE KITS.
8. VEHICLE AND EQUIPMENT MAINTENANCE. ELIMINATE AND MINIMIZE THE DISCHARGE OF POLLUTANTS TO STORM WATER FROM VEHICLE AND EQUIPMENT MAINTENANCE OPERATIONS BY USING OFFSITE FACILITIES WHEN FEASIBLE, PERFORMING WORK IN DESIGNATED AREAS ONLY, USING SPILL PADS UNDER VEHICLES AND EQUIPMENT, CHECKING FOR LEAKS AND SPILLS, AND CONTAINING AND CLEANING UP SPILLS IMMEDIATELY.
9. SOLID WASTE MANAGEMENT. PREVENT OR REDUCE DISCHARGE OF POLLUTANTS TO THE LAND, GROUNDWATER, IN STORM WATER, FROM SOLID WASTE OR CONSTRUCTION AND DEMOLITION WASTE, BY PROVIDING DESIGNATED WASTE COLLECTION AREAS. COLLECT SITE TRASH DAILY, AND ENSURE THAT CONSTRUCTION WASTE IS COLLECTED, REMOVED, AND DISPOSED OF, ONLY AT AUTHORIZED DISPOSAL AREAS.
10. SANITARY/SEPTIC WASTE MANAGEMENT. TEMPORARY AND PORTABLE SANITARY AND SEPTIC WASTE SYSTEMS SHALL BE MOUNTED OR STAKED IN, WELL-MAINTAINED, AND SCHEDULED FOR REGULAR WASTE DISPOSAL AND SERVICING. SOURCES OF SANITARY AND/OR SEPTIC WASTE SHALL NOT BE STORED NEAR THE MS4 OR RECEIVING WATERS.
11. STOCKPILE MANAGEMENT. STOCKPILES SHALL NOT BE LOCATED IN DRAINAGE WAYS, WITHIN 50-FEET FROM AREAS OF CONCENTRATED FLOWS, AND ARE NOT ALLOWED IN THE CITY RIGHT-OF-WAY. SEDIMENT BARRIERS OR SILT FENCES SHALL BE USED AROUND THE BASE OF ALL STOCKPILES. STOCKPILES SHALL NOT EXCEED 15 FEET IN HEIGHT. STOCKPILES GREATER THAN 15 FEET IN HEIGHT SHALL REQUIRE 8 FOOT WIDE BENCHING IN ACCORDANCE WITH ROH CHAPTER 14, ARTICLE 15. STOCKPILES MUST BE COVERED WITH PLASTIC SHEETING OR A COMPARABLE MATERIAL IF THEY WILL NOT BE ACTIVELY USED WITHIN 7 DAYS.
12. LIQUID WASTE MANAGEMENT. LIQUID WASTE SHALL BE CONTAINED IN A CONTROLLED AREA SUCH AS A HOLDING PIT, SEDIMENT BASIN, ROLL-OFF BIN, OR PORTABLE TANK, OF SUFFICIENT VOLUME AND TO CONTAIN THE LIQUID WASTES GENERATED. CONTAINMENT AREAS OR DEVICES MUST BE IMPERMEABLE AND LEAK FREE AND SHOULD NOT BE LOCATED WHERE ACCIDENTAL RELEASE OF THE CONTAINED LIQUID CAN DISCHARGE TO WATER BODIES, CHANNEL OR STORM DRAINS.
13. CONCRETE WASTE MANAGEMENT. PREVENT OR REDUCE THE DISCHARGE OF POLLUTANTS TO STORM WATER FROM CONCRETE WASTE BY CONDUCTING WASHOUT OFFSITE OR PERFORMING ONSITE WASHOUT, IN A DESIGNATED AREA CONSTRUCTED AND MAINTAINED IN SUFFICIENT QUANTITY AND SIZE TO CONTAIN ALL LIQUID AND CONCRETE WASTE GENERATED BY WASHOUT OPERATIONS. PLASTIC LINING MATERIAL SHALL BE A MINIMUM OF 10 MILLIMETER POLYETHYLENE SHEETING AND SHALL BE FREE OF HOLES, TEARS, OR OTHER DEFECTS THAT COMPROMISE THE IMPERMEABILITY OF THE MATERIAL. CONTAINMENT AREAS AND DEVICES SHALL NOT BE LOCATED WHERE ACCIDENTAL RELEASE OF THE CONTAINED LIQUID CAN DISCHARGE TO WATER BODIES, CHANNELS, OR STORM DRAINS. WASHOUT FACILITIES MUST BE CLEANED, OR NEW FACILITIES MUST BE CONSTRUCTED AND READY FOR USE ONCE THE WASHOUT IS 75 PERCENT FULL. ONCE CONCRETE WASTES ARE WASHED INTO DESIGNATED AREA AND ALLOWED TO HARDEN, THE CONCRETE SHALL BE BROKEN UP, REMOVED, AND DISPOSED OF AS SOLID WASTES.
14. CONTAMINATED SOIL MANAGEMENT. AT A MINIMUM, CONTAIN CONTAMINATED MATERIAL SOIL BY SURROUNDING WITH IMPERMEABLE LINED BERMS OR COVER EXPOSED CONTAMINATED MATERIAL WITH PLASTIC SHEETING. CONTAMINATED SOIL SHALL BE DISPOSED OF PROPERLY IN ACCORDANCE WITH ALL APPLICABLE REGULATIONS.
15. DUST CONTROL. FOLLOW DUST CONTROL NOTES ON T003 OF THESE PLANS.
16. BMP AND SITE MAINTENANCE. FOLLOW ALL GOOD HOUSE KEEPING BMP NOTES, EROSION PREVENTION/SEDIMENT CONTRIL NOTES, EROSION AND SEDIMENT CONTROL PLAN NOTES AND RAIN RESPONSE PLAN NOTES AND DETAILS OF THIS SHEET (C004).

EROSION PREVENTION/SEDIMENT CONTROL NOTES:

1. THE CONTRACTOR SHALL FOLLOW THE GUIDELINES IN THE CITY & COUNTY OF HONOLULU'S "RULES RELATING TO WATER QUALITY".
2. MEASURES TO CONTROL EROSION AND OTHER POLLUTANTS SHALL BE IN PLACE BEFORE ANY EARTHWORK IS INITIATED.
3. SLOPE PROTECTION IS REQUIRED ON AREAS WITH SLOPES GREATER THAN 15% AND ON AREAS OF MODERATE SLOPE THAT ARE PRONE TO EROSION UNLESS THEY ARE BEING ACTIVELY WORKED. USE DIVERSION UPSTREAM OF SLOPE (DIKES, SWALES, SLOPE DRAINS) TO DIVERT WATER AROUND THE SLOPE. PROVIDE A 10-FT BUFFER ZONE AT THE TOE OF SLOPE. ONLY 5 ACRES MAYBE DISTURBED AT ANYTIME ON SLOPES GREATER THAN 15%.
4. TEMPORARY STABILIZATION IS REQUIRED ON DISTURBED AREAS WHICH ARE AT FINAL GRADE OR WHEN THE DISTURBED AREA WILL NOT BE WORKED FOR 14 CONSECUTIVE DAYS OR MORE.
5. PERMANENT STABILIZATION. ALL DISTURBED AREAS SHALL BE PERMANENTLY STABILIZED USING VEGETATIVE COVERING, PAVEMENT, OR EQUIVALENT, PRIOR TO REMOVING EROSION AND SEDIMENT MEASURES. TRAPPED SEDIMENT AND AREAS OF DISTURBED SOIL WHICH RESULT FROM THE REMOVAL OF THE TEMPORARY MEASURES SHALL BE IMMEDIATELY AND PERMANENTLY STABILIZED.
6. PRESERVE EXISTING VEGETATION. CLEARLY MARK THE AREAS TO BE PRESERVED WITH FLAGS OR TEMPORARY FENCING. WHERE TEMPORARY FENCING IS USED, FENCING SHALL BE ADEQUATELY SUPPORTED BY POSTS AND MAINTAINED IN AN UPRIGHT POSITION.
7. MINIMIZE SOIL COMPACTION AREAS. WHERE FINAL STABILIZATION OR INFILTRATION PRACTICES ARE TO BE INSTALLED, AREA SHALL BE PROTECTED FROM EXCESSIVE COMPACTION DURING CONSTRUCTION. VEHICLE AND EQUIPMENT USE SHALL BE RESTRICTED OR TECHNIQUES TO CONDITION THE SOILS TO SUPPORT VEGETATION SHALL BE IMPLEMENTED IN THE AREAS THAT HAVE BEEN COMPACTED AND ARE DESIGNATED TO REMAIN VEGETATIVE OR POST-CONSTRUCTION INFILTRATION AREAS. CLEARLY MARK THE AREAS TO BE AVOIDED WITH FLAGS OR TEMPORARY FENCING. WHERE TEMPORARY FENCING IS USED, FENCING SHALL BE ADEQUATELY SUPPORTED BY POSTS AND MAINTAINED IN AN UPRIGHT POSITION.
8. PERIMETER CONTROLS ARE REQUIRED DOWN SLOPE OF ALL DISTURBED AREAS. MAINTAIN DOWNSTREAM VEGETATED BUFFER AREA.
9. TRACKING CONTROL
   A) MINIMIZE SEDIMENT TRACK-OUT ONTO OFFSITE STREETS, OTHER PAVED AREAS, AND SIDEWALKS FROM VEHICLES EXITING THE CONSTRUCTION SITE BY RESTRICTING VEHICLE TRAFFIC TO PROPERLY DESIGNATED AREAS AND USING ADDITIONAL CONTROLS TO REMOVE SEDIMENT FROM VEHICLE TIRES PRIOR TO EXITING THE SITE.
   B) VEHICULAR PARKING AND MOVEMENTS ON PROJECT SITE SHALL BE CONFINED TO PAVED SURFACES OF PREDEFINED PARKING AREAS AND VEHICLE PATHS, WHICH SHALL BE MARKED WITH FLAGS OR BOUNDARY FENCING.
   C) ALL POLLUTANTS AND MATERIALS THAT ARE DROPPED, WASHED, TRACKED, SPILLED OR OTHERWISE DISCHARGED FROM A PROJECT TO OFFSITE STREETS, OTHER PAVED AREAS, SIDEWALKS OR THE MS4 SHALL BE CLEANED USING DRY METHODS SUCH AS SWEEPING OR VACUUMING.
   D) WASHING POLLUTANTS AND MATERIALS THAT ARE DISCHARGED FROM THE PROJECT SITE TO THE MS4 INTO DRAIN INLETS OR CATCH BASINS IS PROHIBITED UNLESS THE MATERIAL IS SEDIMENT AND THE INLETS ARE DIRECTED TO A SEDIMENT BASIN OR SEDIMENT TRAP.
10. BEST MANAGEMENT PRACTICES (BMPS) SHALL NOT BE REMOVED UNTIL FINAL STABILIZATION IS COMPLETE FOR THAT PHASE.
11. REFER TO CITY & COUNTY OF HONOLULU BEST MANAGEMENT PRACTICES MANUAL - CONSTRUCTION, FOR MORE INFORMATION ON BMPS.
12. THE FOLLOWING BMPS WERE DETERMINED TO BE NOT APPLICABLE BASED ON THE SPECIFIC SITE CONDITIONS:
   A) VELOCITY DISSIPATION DEVICES
   B) DIVERSION BMPS TO DIVERT RUNOFF FROM UPSTREAM AREAS AROUND DISTURBED AREAS OF THE SITE
   C) STORM DRAIN INLET PROTECTION
   D) SEDIMENT BARRIERS

   AS CONSTRUCTION PROGRESSES, REVISIONS MAY BE NECESSARY AND SHALL BE PROVIDED TO DPP INSPECTORS. A BRIEF EXPLANATION OF WHY EACH OMITTED BMP IS UNNECESSARY OR IMPRACTICABLE HAS BEEN PROVIDED UNDER SEPARATE DOCUMENTATION TO DPP.
13. THE CONTRACTOR SHALL COMPLY WITH THE PROJECT SCHEDULE REQUIREMENTS OF THE CITY'S RULES RELATING TO STORM WATER QUALITY AND SUBMIT THE SCHEDULED START DATE TWO WEEKS PRIOR.
14. THE CONTRACTOR SHALL SUBMIT THE ESCP COORDINATOR DESIGNATION USING THE FORM FROM APPENDIX A TO THE CITY'S RULES RELATING TO WATER QUALITY AT THE TIME OF APPLICATION FOR THE GRADING PERMIT.
15. THIS PROJECT IS A CATEGORY 4 PROJECT.
16. SEE SHEET T001 FOR WATER BODY NAME, CLASSIFICATION AND COORDINATE.

GOOD HOUSEKEEPING BMPS NOTES (CONT'D):

17. DEWATERING HOUSE KEEPING NOTES:

A: THE ABSORPTION BED SHALL BE PARTIALLY INSTALLED INTO THE WATER TABLE. IT IS INTENDED THAT THE ABSORPTION BEDS BE INSTALLED IN PHASES AND ACTIVE INSTALLATION BE DEWATERED BY USE OF COFFERDAMS (OR EQUAL) TO ISOLATE THE WORK AREA AND DEWATERING BE ACCOMPLISHED BY PUMPING TO INACTIVE AREAS OF THE ABSORPTION BED AREA. DEWATERING FROM ACTIVE AREAS OF ABSORPTION BED INSTALLATION INTO A COMPLETED ABSORPTION BED IS ALSO ALLOWED AS LONG AS EXCESSIVE SOLIDS ARE NOT DISCHARGED INTO A COMPLETED ABSORPTION BED. THIS MAY REQUIRE A ZONE OF INTERMEDIATE SETTLING BEFORE DISCHARGE INTO A COMPLETED ABSORPTION BED. THE CONTRACTOR SHALL PREPARE AND SUBMIT ITS PROPOSED ABSORPTION BED INSTALLATION/PHASING PLAN FOR ENGINEER APPROVAL SHOWING ACTIVE CONSTRUCTION WORK AREAS AND AREAS THAT WILL BE USED FOR DEWATERING. ONCE APPROVED THE CONTRATOR CAN COMMENCE ABSORPTION BED INSTALLATION PER CONTRACT DRAWINGS. SHOULD THE PHASING PLAN NOT EFFECTIVELY PROVIDE INADEQUATE DEWATERING AREAS PER INSTALLATION PHASE THE CONTRACTOR SHALL MODIFY THE PHASING PLAN UNTIL EFFECTIVE BY THE CONTRACTOR'S GEOTECHNICAL AND STRUCTURAL PROFESSIONAL ENGINEERS.

B: SHOULD THE CONTRACTOR SELECT AN ALTERNATIVE METHOD OF DEWATERING NON-STORM WATER, SUCH FILTERING AND DISCHARGING TO STATE WATERS THAT NON-STORM CANNOT BE DISCHARGED FROM THE SITE WITHOUT PRIOR NOTICE TO AND APPROVAL FROM DOH (NPDES FORM G).

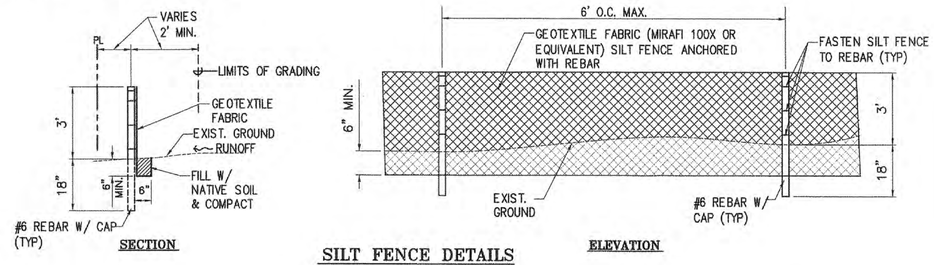
EROSION AND SEDIMENT CONTROL PLAN NOTES:

PROJECT SEQUENCE:

1. INSTALL STABILIZED CONSTRUCTION ENTRANCES AND TEMPORARY SILT FENCING/FILTER SOCK FOR PROTECTED AREAS, CLEARING AND GRUBBING AS NECESSARY FOR THE INSTALLATION OF THESE BMPS.
2. PROCEED WITH CONSTRUCTION AND GRADING WITH LEAST POSSIBLE DISTURBANCE OF VEGETATIVE AREAS AND TEMPORARY STRUCTURES.
3. INITIATE STABILIZATION OF STEEP SLOPES (>15%) WITH HYDROSEEDING AS SOON AS GRADING IS COMPLETED ON THOSE AREAS. INSTALL PERMANENT IRRIGATION SYSTEM PRIOR TO PERMANENT SEEDING.
4. REMOVE OR DISMANTLE TEMPORARY EROSION CONTROL STRUCTURES AFTER FULL ESTABLISHMENT OF PERMANENT VEGETATIVE COVER.
5. PRACTICE GOOD HOUSEKEEPING MEASURES THROUGHOUT THE DURATION OF CONSTRUCTION.
6. INSPECTIONS SHALL BE PERFORMED WEEKLY.

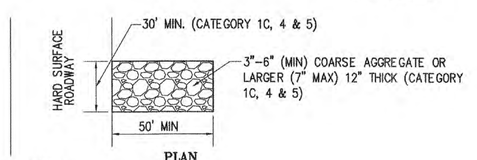
RAIN RESPONSE PLAN NOTES:

1. THE FOLLOWING SHALL BE PERFORMED WHEN HEAVY RAIN, TROPICAL STORM OR HURRICANE IS IMMINENT, OR IS FORECASTED IN THE NEXT 48 HOURS.
2. TEMPORARILY SUSPEND ACTIVE GRADING.
3. INSPECT ALL SILT FENCES, AND MAINTAIN AS NEEDED. REINSTALL ANY FENCES THAT WERE REMOVED DUE TO ACTIVE WORK IN THE AREA.
4. COVER OR RELOCATE MATERIAL STOCKPILES AND LIQUID MATERIAL CONTAINERS TO AVOID CONTACT WITH RAINWATER.
5. PLACE SPILL PANS OR OIL-ONLY SPILL PADS UNDER CONSTRUCTION VEHICLES TO PREVENT RUNOFF FROM CONTACTING ANY SPILLED PETROLEUM PRODUCTS. PROPERLY DISPOSE OF ANY ACCUMULATED OILY WATER AFTER THE RAIN EVENT.
6. RE-INSPECT AFTER THE APPROACHING HEAVY RAINS, TROPICAL STORM OR HURRICANE, AND REPLACE OR MAINTAIN BMPS AS NEEDED.



SILT FENCE DETAILS

NOT TO SCALE



NOTE:
8" COARSE AGGREGATE LAYER SHALL BE REMOVED IMMEDIATELY PRIOR TO INSTALLATION OF ROADWAY BASE COURSE.

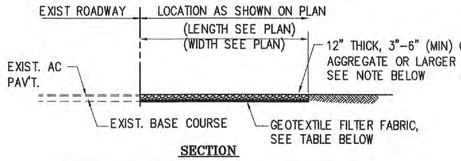
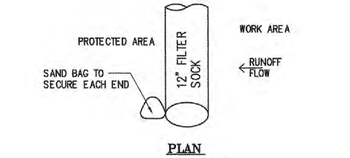


TABLE A GEOTEXTILE REQUIREMENTS	
PHYSICAL PROPERTY	REQUIREMENTS
GRAB TENSILE STRENGTH	220 LB (ASTM D1682)
ELONGATION FAILURE	60% (ASTM D1682)
MULLEN BURST STRENGTH	430 LB (ASTM D3768)
PUNCTURE STRENGTH	125 LB (ASTM D751, MODIFIED)
EQUIVALENT OPENING	SIZE 40-80 (U.S. STD SIEVE, CW-02215)

CONSTRUCTION INGRESS/EGRESS DETAILS

NOT TO SCALE



FILTER SOCK DETAILS

NOT TO SCALE

PRE-CONSTRUCTION, DURING CONSTRUCTION AND POST CONSTRUCTION BMP TABLE

PRE-CONSTRUCTION	DURING CONSTRUCTION	POST CONSTRUCTION
INSTALL, BIO-SOCK, SILT FENCE PER DETAILS OF ESCP OF PROJECT PLANS	MONITOR ESCP'S PER PROJECT PLAN ESCP EROSION AND SEDIMENT CONTROL NOTES AND GOOD HOUSEKEEPING NOTES	MAINTAIN PERMANENT VEGETATION (GRASS) PROVIDED ON ALL DISTURBED AREAS AS APPLICABLE
INSTALL STABILIZED CONSTRUCTION ENTRANCE PER DETAILS ESCP OF PROJECT PLANS	TEMPORARY STABILIZATION	PERMANENT STABILIZATION

APPROVED:

For Melvin Ishikawa
CHIEF, CIVIL ENGINEERING BRANCH, DPP
2/26/19
DATE

AS BUILT
HENRY'S EQUIPMENT RENTAL & SALES, INC.
SIGNATURE
3/1/22
DATE

REVISION NO.	SYM.	DESCRIPTION	SHT./OF	DATE	APPROVED

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION AND CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY OBSERVATION.

SIGNATURE
LICENSE EXP.: 4/30/20

DAVID B. BILLS
LICENSED PROFESSIONAL ENGINEER
No. 4518-C
HAWAII, U.S.A.

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF BOATING AND OCEAN RECREATION

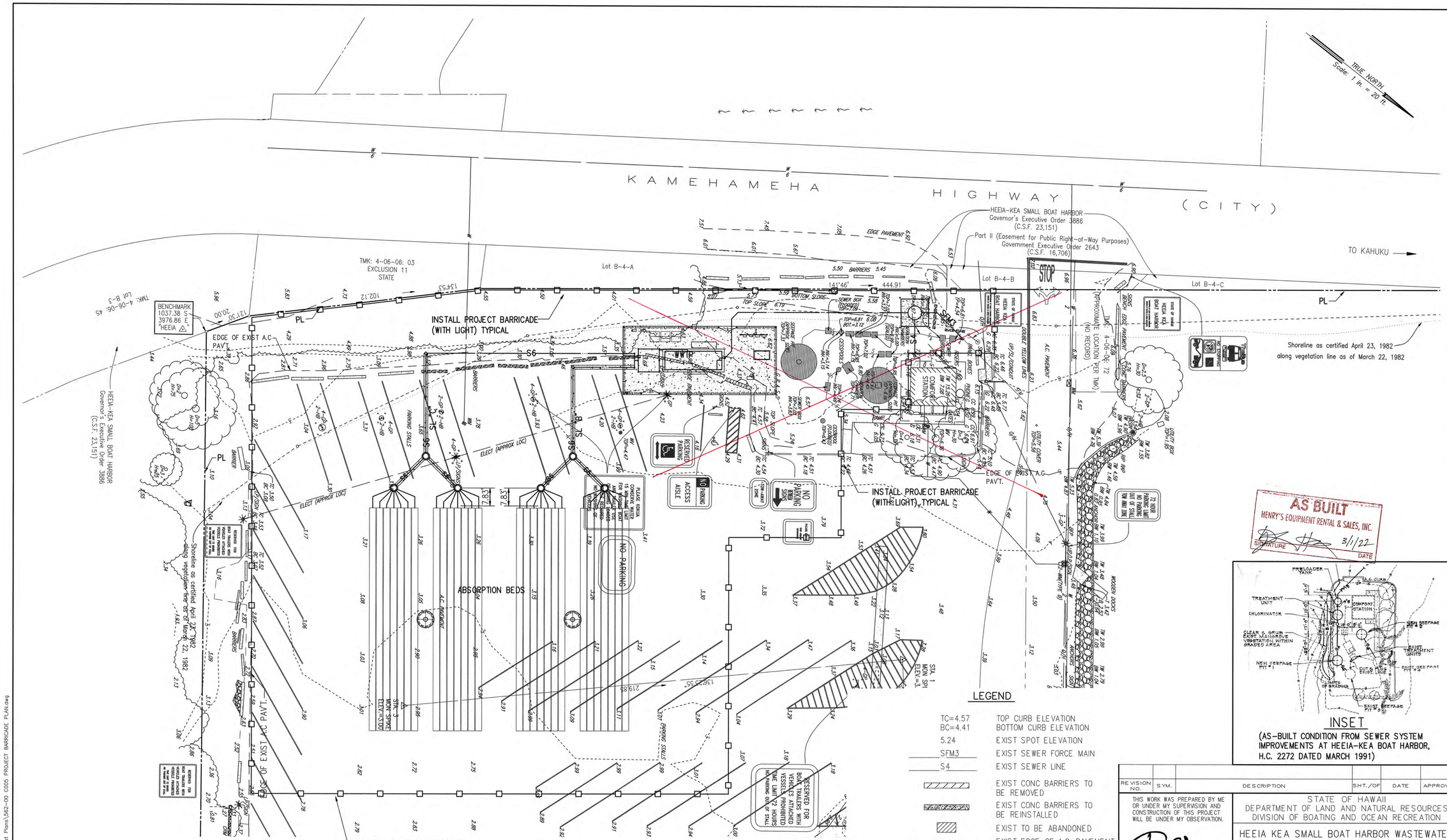
HEEIA KEA SMALL BOAT HARBOR WASTEWATER TREATMENT SYSTEM IMPROVEMENTS

EROSION AND SEDIMENT CONTROL NOTES & DETAILS

BILLS ENGINEERING, INC.

DESIGNED: DB	SUBMITTED: BEI
DRAWN: RE/SI	DATE:
CHECKED: DB	SCALE: AS SHOWN
APPROVED:	DRAWING NO. C004
CHIEF ENGINEER	DATE

Mon, 25 Feb 2019 - 8:36am
N:\Projects\562-00 HEEIA KEA WWTP\Const Plans\562-00 C004 ESCP NOTES DET.dwg



PROJECT BARRICADE PLAN

20 10 0 20 40

Scale in Feet

LEGEND

TC=4.57 BC=4.41	TOP CURB ELEVATION BOTTOM CURB ELEVATION
5.24	EXIST SPOT ELEVATION
SFM3	EXIST SEWER FORCE MAIN
S4	EXIST SEWER LINE
	EXIST CONC BARRIERS TO BE REMOVED
	EXIST CONC BARRIERS TO BE REINSTALLED
	EXIST TO BE ABANDONED
	EXIST EDGE OF A.C. PAVEMENT
SFM3	NEW SEWER FORCE MAIN
S4	NEW SEWER LINE
	NEW SEWER CLEANOUT
	DISTRIBUTION BOX
	NEW CHAIN LINK FENCE
	CUT AND PLUG
	BARRICADE

AS BUILT
HENRY'S EQUIPMENT RENTAL & SALES, INC.
SIGNATURE 3/1/22 DATE

INSET

(AS-BUILT CONDITION FROM SEWER SYSTEM IMPROVEMENTS AT HEEIA-KEA BOAT HARBOR, H.C. 2272 DATED MARCH 1991)

REVISION NO.	SYM.	DESCRIPTION	SHT./OF	DATE	APPROVED

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION AND CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY OBSERVATION.

SIGNATURE
LICENSE EXP.: 4/30/20

DAVID B. BILLS
LICENSED PROFESSIONAL ENGINEER
No. 4516-C
HAWAII, U.S.A.

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF BOATING AND OCEAN RECREATION

HEEIA KEA SMALL BOAT HARBOR WASTEWATER TREATMENT SYSTEM IMPROVEMENTS

PROJECT BARRICADE PLAN

BILLS ENGINEERING, INC.

DESIGNED: DB	SUBMITTED: BEI
DRAWN: RE/SI	DATE:
CHECKED: DB	SCALE: AS SHOWN
APPROVED:	DRAWING NO. C005
CHIEF ENGINEER DATE	

JOB NO. B78C074A SHEET NO. 8 OF 29 SHEETS

Thu, 18 Apr 2019 - 8:25am
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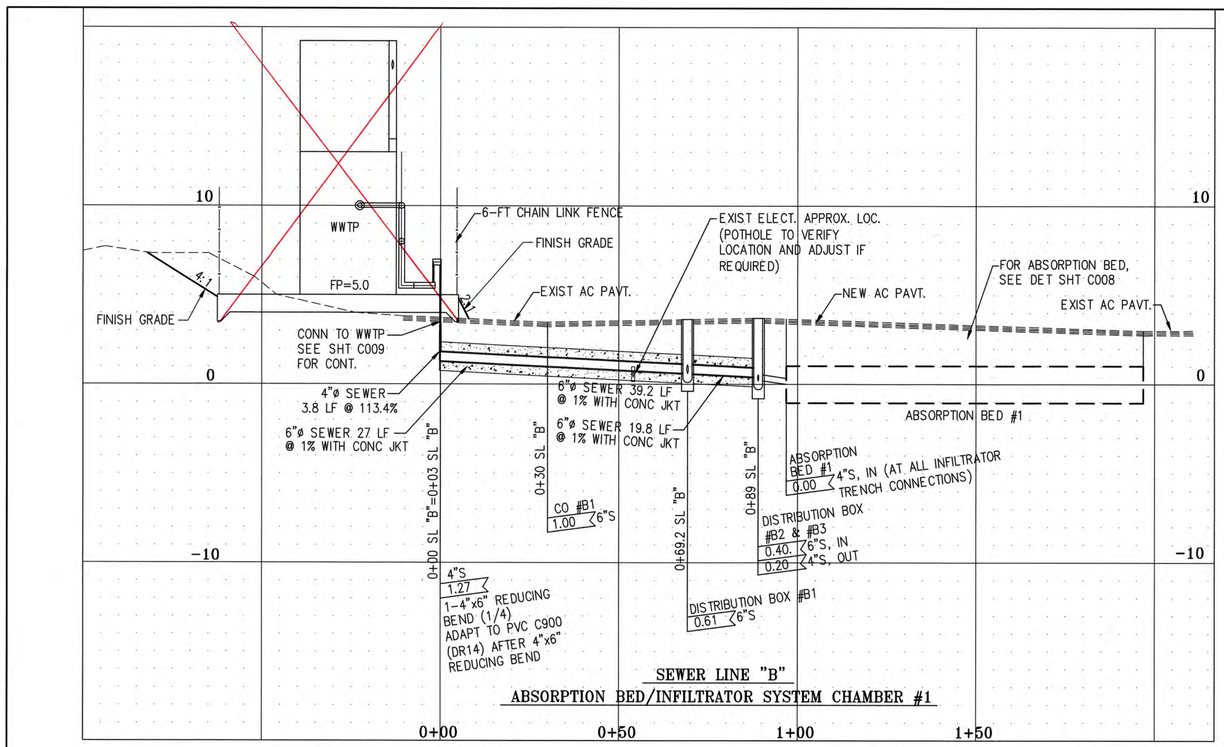
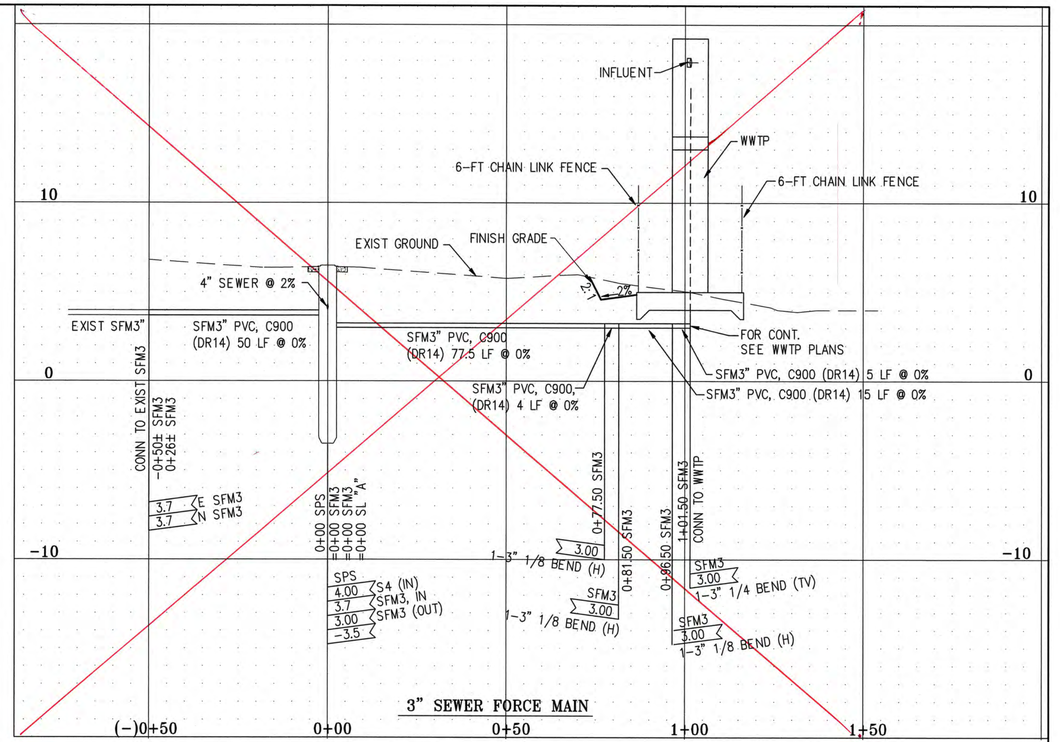
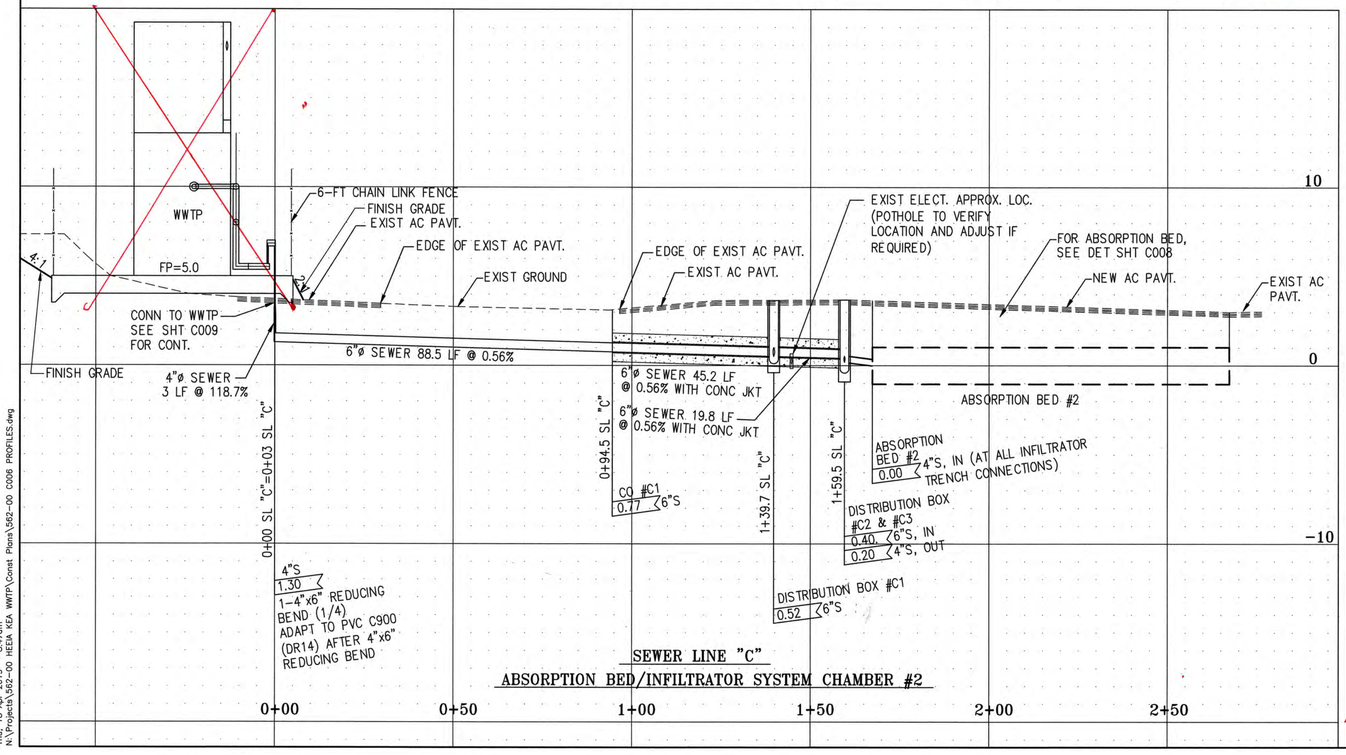


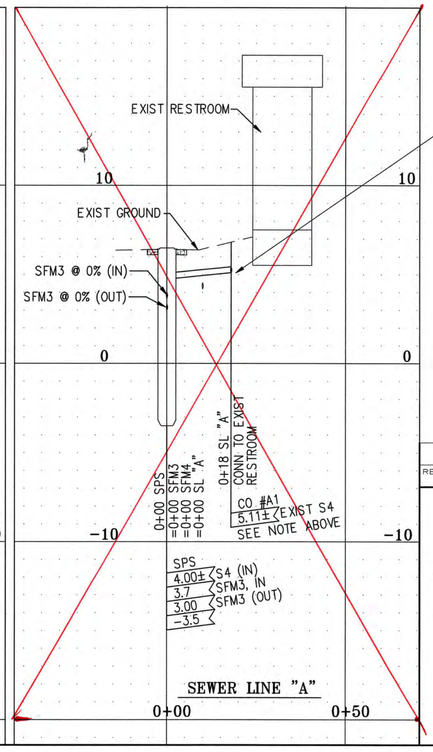
SEWER LINE "B"
ABSORPTION BED/INFILTRATOR SYSTEM CHAMBER #1



3" SEWER FORCE MAIN



SEWER LINE "C"
ABSORPTION BED/INFILTRATOR SYSTEM CHAMBER #2



SEWER LINE "A"

NOTE:
POTHOLE AND EXPOSE EXISTING S4" FROM RESTROOM TO EXISTING TREATMENT SYSTEM. INSTALL CLEAN-OUT TO GRADE AND RUN NEW S4" (PVC, C900, DR18) AT 2% TO NEW SPS. (ABANDON EXISTING S4" TO EXISTING WWTP BE FLUSHING AND FILLING WITH CLSM).

HORI 20 10 0 20 40
VERT 4 2 1 4 8
SCALE IN FEET

AS BUILT
HENRY'S EQUIPMENT RENTAL & SALES, INC.
SIGNATURE
8/1/22
DATE

REVISION NO.	SYM.	DESCRIPTION	SHT./OF	DATE	APPROVED

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION AND CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY OBSERVATION.

SIGNATURE
LICENSE EXP.: 4/30/20

DAVID B. BILLS
LICENSED PROFESSIONAL ENGINEER
No. 4516-C
HAWAII, U.S.A.

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF BOATING AND OCEAN RECREATION

HEEIA KEA SMALL BOAT HARBOR WASTEWATER TREATMENT SYSTEM IMPROVEMENTS

PROFILES

BILLS ENGINEERING, INC.

DESIGNED: DB	SUBMITTED: BEI
DRAWN: RE/SI	DATE:
CHECKED: DB	SCALE: AS SHOWN
APPROVED:	DRAWING NO. C006
CHIEF ENGINEER	DATE

JOB NO. B78C074A SHEET NO. 9 OF 29 SHEETS

Thu, 18 Apr 2019 - 8:47am
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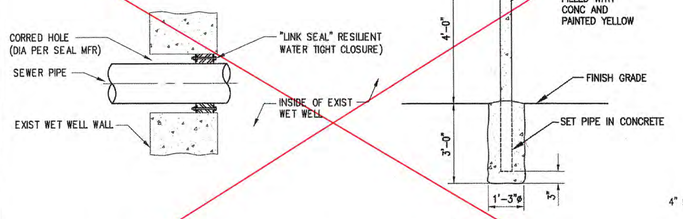
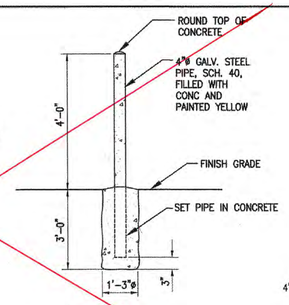


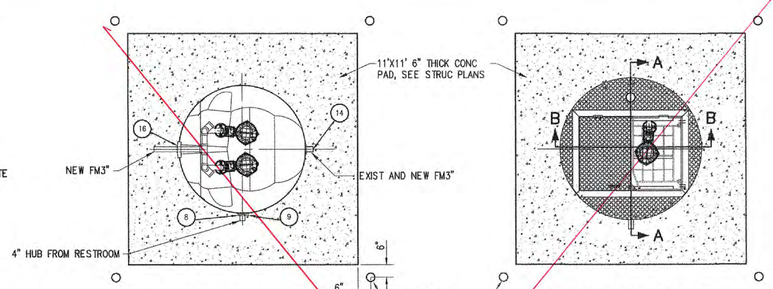
PIPE PENETRATION DETAIL

SCALE: 1" = 0'-6"



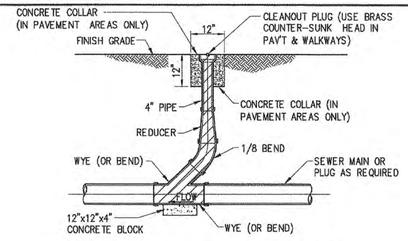
BOLLARD DETAIL

NOT TO SCALE



PLAN LESS COVER

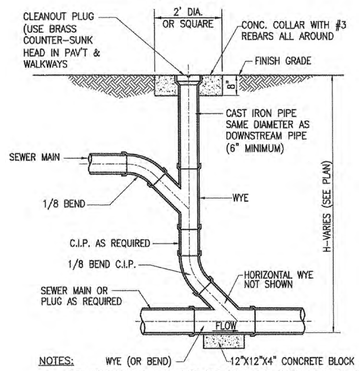
PLAN WITH COVER



NOTE: CROSS HATCHING SHOWS UNITS OF CAST IRON PIPE (CIP).

CLEANOUT DETAIL

NOT TO SCALE

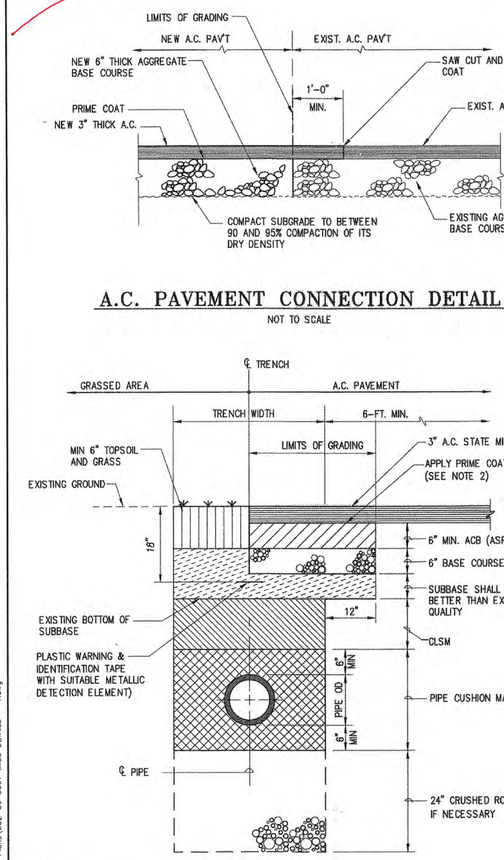


NOTES:

1. THE ENDS OF THE CAST IRON CLEANOUT PIPE SHALL HAVE AN INNER PIPE THREAD TO RECEIVE EITHER RAISED CLEANOUT PLUG OR COUNTERSUNK BRASS PLUG AS INDICATED.
2. APPLY GREASE TO CLEANOUT PLUG THREADS PRIOR TO INSTALLATION.

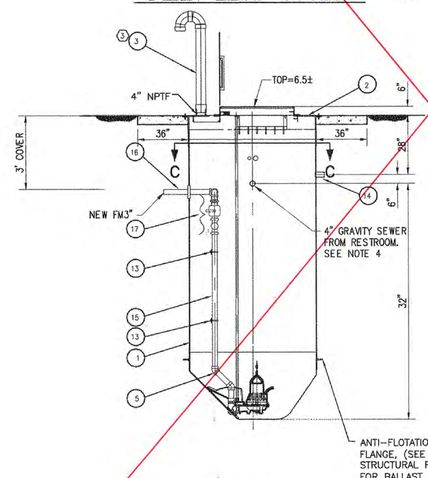
DROP CLEANOUT DETAIL

NOT TO SCALE

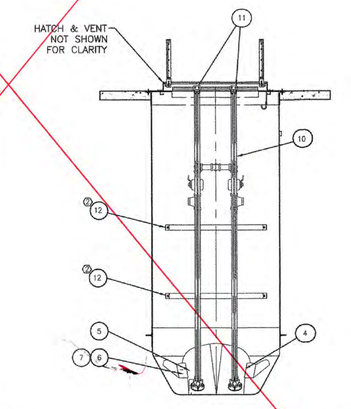


A.C. PAVEMENT CONNECTION DETAIL

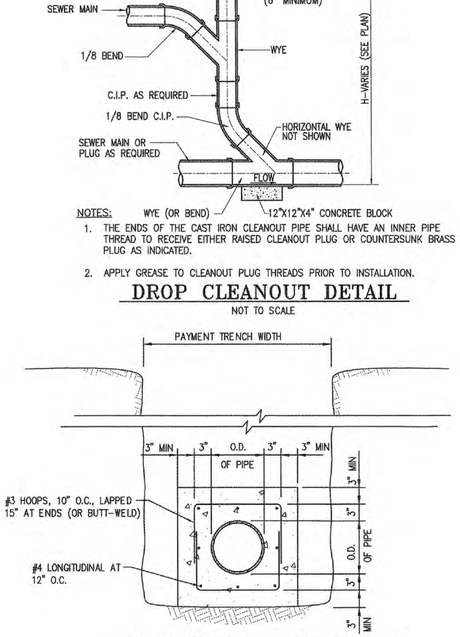
NOT TO SCALE



SECTION A-A



SECTION B-B



CONCRETE JACKET DETAIL

NOT TO SCALE

REPAVING NOTES

1. PAVEMENT STRUCTURE SHALL BE EQUAL TO OR BETTER THAN EXISTING IN THICKNESS AND QUALITY.
2. FOR ROAD GRADES 0% TO 7.99% PRIME COAT IS NOT REQUIRED.
3. ALL DISTURBED PAVEMENT MARKINGS SHALL BE REPLACED AND ALL REQUIRED UTILITY ADJUSTMENTS SUCH AS MANHOLE COVERS ETC. SHALL BE DONE BY THE CONTRACTOR.
4. LENGTH OF REPAIRED TRENCH SHALL BE REPAVED TWO FEET IN ADDED LENGTH TO EACH END OF TRENCH.

TYPICAL SEWER TRENCH DETAIL (STATE)

SCALE: 3/4" = 1'-0"

PUMP STATION DATA

ITEM	DESCRIPTION	PART NUMBER	QTY
1	BASIN/CYLINDER ASSEMBLY, 5'		1
2	COVER, 5'		1
3	VENT PIPE, 4" (OPTIONAL)	14-68 22 02	1
4	DISCHARGE CONNECTION, 3"	619 95 00	2
5	PIPING KIT, JOG OVER FOR 4"		2
6	NUT, 3/4-10, 316 SST	94805A135	4
* 7	WASHER, 13/16 ID. 1 1/2 OD, GENERAL PURPOSE, 316 SST	91950A036	4
8	SEAL, CABLE WALL, LEVEL SENSOR	1860SCF125P	1
9	SEAL, CABLE WALL, PUMP		1
10	GUIDE BAR, 3/4", 316 SST		4
11	UPPER GUIDE BAR KIT, 3/4"		2
12	BRACING, DISCHARGE PIPE		2
* 13	U-BOLT 3/8-16 OD, 4 1/2", 4" PIPE	2950S76	4
14	HUB FOR 3" FORCE MAIN CONNECTION		1
15	PIPE, 4", SCH 40, PVC SST		FT
16	PIPING KIT, 3"		1
17	THREADED PIPING KIT, 4"		2

* McMASTER CARR

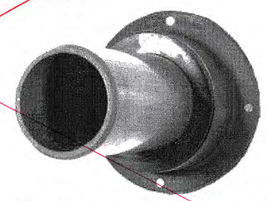
NOTES

1. STATION DEPTH: MAX. 6ft., AVAILABLE IN 1ft INCREMENTS.
2. ALL BOLT PENETRATIONS THRU WALLS MUST BE SEALED WITH SILICONE SEALANT.
3. OPTIONAL PVC CANDY CANE STYLE VENT SHOWN. MUSHROOM STYLE VENT ALSO AVAILABLE.
4. EXPOSE GRAVITY SEWER AND MEASURE DEPTH FOR APPROPRIATE SEWER CONNECTION TO WET WELL. PUNCTURE WET WELL WALL WITH JIG SAW AND DRILL BIT, OR EQUAL. USE FLYGHT SEALING JOINT TO MAKE CONNECTION TO WET WELL. SEE DET BELOW.

THE SEWAGE PUMP STATION SHALL BE A TOPS SEWAGE PUMP STATION AS MANUFACTURED BY FLYGT USING FLYGT PUMPS OR ENGINEER APPROVED EQUAL.

SEWAGE PUMP STATION DETAIL

NOT TO SCALE



INFLUENT PIPE SEALING DETAIL

AS BUILT
HENRY'S EQUIPMENT RENTAL & SALES, INC.
SIGNATURE
3/1/22
DATE

APPROVED:

For Melvin Tokahara
CHIEF, CIVIL ENGINEERING BRANCH, DPP
(FOR GRADING ONLY)

2/16/19
DATE

REVISION NO.	SYM.	DESCRIPTION	SHT./OF	DATE	APPROVED

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION AND CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY OBSERVATION.

SIGNATURE
LICENSE EXP.: 4/30/20

DAVID B. BILLS
LICENSED PROFESSIONAL ENGINEER
No. 4616-C
HAWAII, U.S.A.

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF BOATING AND OCEAN RECREATION

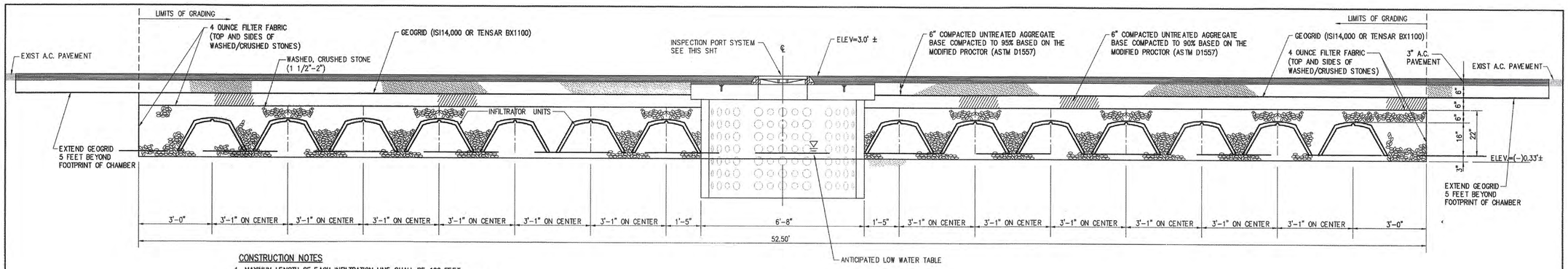
HEEIA KEA SMALL BOAT HARBOR WASTEWATER TREATMENT SYSTEM IMPROVEMENTS

MISCELLANEOUS DETAILS - 1

BILLS ENGINEERING, INC.

DESIGNED: DB	SUBMITTED: BEI
DRAWN: RE/SI	DATE:
CHECKED: DB	SCALE: AS SHOWN
APPROVED:	DRAWING NO. C007
CHIEF ENGINEER	DATE

Fri, 25 Jan 2019 - 8:37am
N:\Projects\562-00 HEEIA KEA WWTP\Const Plans\562-00 C007 MISC DETAILS - 1.dwg



CONSTRUCTION NOTES

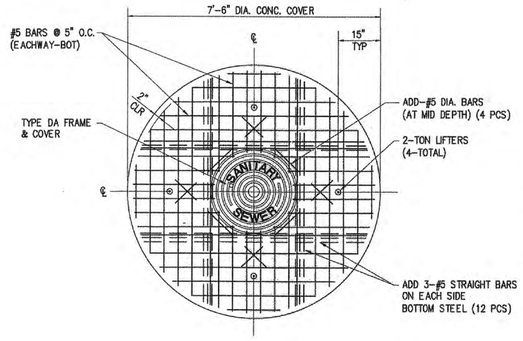
1. MAXIMUM LENGTH OF EACH INFILTRATION LINE SHALL BE 100 FEET.
2. INFILTRATION LINES SHALL BE UNIFORMLY SPACED AT A MAXIMUM OF 3'-1" APART.
3. INFILTRATION LINES SHALL BE LEVEL.
4. THE FLOOR OF THE ABSORPTION BED SHALL BE LEVEL.
5. WHERE NOT OTHERWISE SPECIFIED, THE CONSTRUCTION OF THE ADSORPTION BED SHALL CONFORM TO HAWAII ADMINISTRATIVE RULES, TITLE 11, CHAPTER 62, SECTION 34.
6. THE INFILTRATOR BEDS SHALL BE INFILTRATOR WATER TECHNOLOGIES HIGH CAPACITY INFILTRATOR CHAMBER H-20 OR ENGINEER APPROVED EQUAL. THE LAYOUT IS GENERIC. CONTRACTOR SHALL FOLLOW INSTALLATION DETAILS OF SPECIFIC INFILTRATION SYSTEM.

SECTION "A-A"

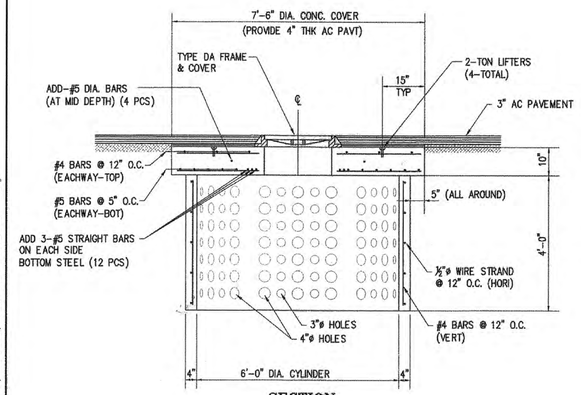
ABSORPTION BED/INFILTRATOR CHAMBER DETAIL

NOT TO SCALE

(TOTAL AREA PER BED = 5,250 SQ. FT., EFFECTIVE AREA PER BED = 4,267 SQ. FT. EFFECTIVE AREA IS BED AREA LESS ZONE (6'-8") FOR INSPECTION PORT)



PLAN



SECTION

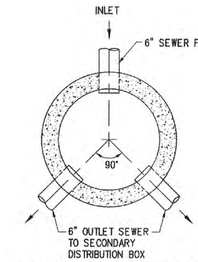
INSPECTION PORT SYSTEM DETAIL

NOT TO SCALE

(INSPECTION PORT SYSTEM SHALL BE PRICE CESSPOOL RING OR ENGINEER APPROVED EQUAL)

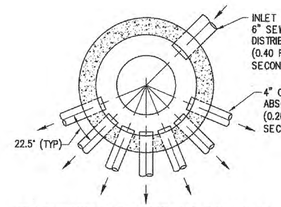
NOTES

1. ALL CONCRETE AND REINFORCED CONCRETE WORK SHALL BE DONE IN ACCORDANCE WITH APPLICABLE PROVISIONS OF THE AMERICAN CONCRETE INSTITUTE'S BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE (ACI 318-LATEST) AS SPECIFIED HEREIN.
2. CONCRETE COMPRESSIVE STRENGTH: 4000 PSI IN 28 DAYS
3. CEMENT SHALL CONFORM TO THE REQUIREMENTS OF THE CURRENT "STANDARD SPECIFICATION FOR PORTLAND CEMENT" ASTM DESIGNATION C-150.
4. MIXING: READY MIXED ASTM C-94
5. REINFORCING STEEL SHALL BE DEFORMED, INTERMEDIATE GRADE, CONFORMING TO THE CURRENT "STANDARD SPECIFICATIONS FOR BILLET-STEEL BARS FOR CONCRETE REINFORCEMENTS", ASTM A 615, GRADE 60
6. WIRE STRAND SHALL CONFORM TO ASTM A-416 AND HAVE A STRENGTH OF 270 KSI

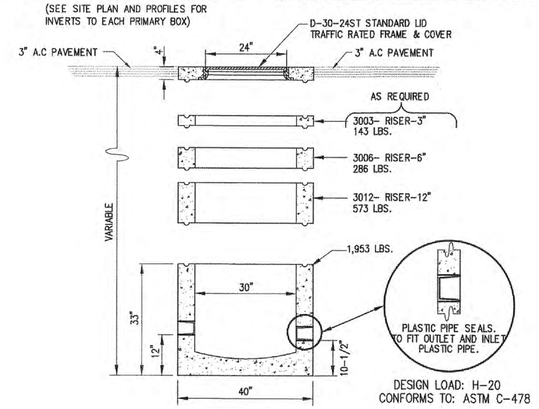


PRIMARY DISTRIBUTION BOX PLAN

(SEE SITE PLAN AND PROFILES FOR INVERTS TO EACH PRIMARY BOX)



SECONDARY DISTRIBUTION BOX PLAN



DESIGN LOAD: H-20
CONFORMS TO: ASTM C-478

NOTE:
INVERTS OF ALL OUTLETS ARE AT SAME ELEVATION.

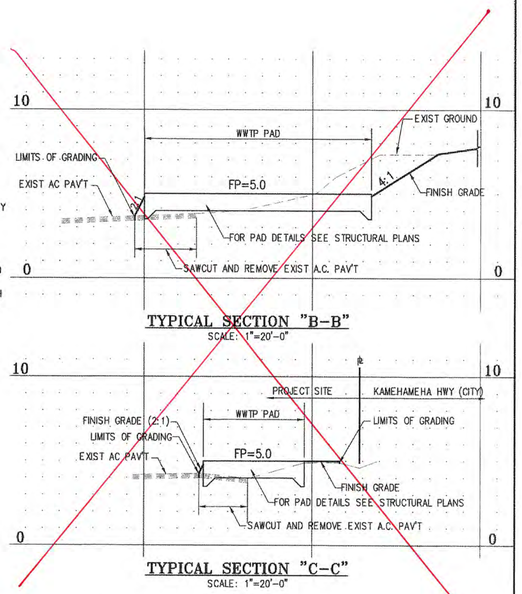
ELEVATION

DISTRIBUTION BOX DETAILS

NOT TO SCALE

(DISTRIBUTION BOX SHALL BE PRE-CAST COMMERCIAL DISTRIBUTION BOX OR ENGINEER APPROVED EQUAL)

AS BUILT
HENRY'S EQUIPMENT RENTAL & SALES, INC.
SIGNATURE DATE



TYPICAL SECTION "B-B"

SCALE: 1"=20'-0"

TYPICAL SECTION "C-C"

SCALE: 1"=20'-0"

APPROVED:

For Melvin Tokuyama 7/26/19
CHIEF, CIVIL ENGINEERING BRANCH, DPP (FOR GRADING ONLY) DATE

REVISION NO.	SYM.	DESCRIPTION	SHT./OF	DATE	APPROVED

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION AND CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY OBSERVATION.

SIGNATURE
LICENSE EXP.: 4/30/20

DAVID B. BILLS LICENSED PROFESSIONAL ENGINEER No. 4616-C HAWAII, USA

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF BOATING AND OCEAN RECREATION

HEEIA KEA SMALL BOAT HARBOR WASTEWATER TREATMENT SYSTEM IMPROVEMENTS

MISCELLANEOUS DETAILS - 2

BILLS ENGINEERING, INC.

DESIGNED: DB	SUBMITTED: BEI
DRAWN: RE/SI	DATE:
CHECKED: DB	SCALE: AS SHOWN

APPROVED: _____ DATE
CHIEF ENGINEER

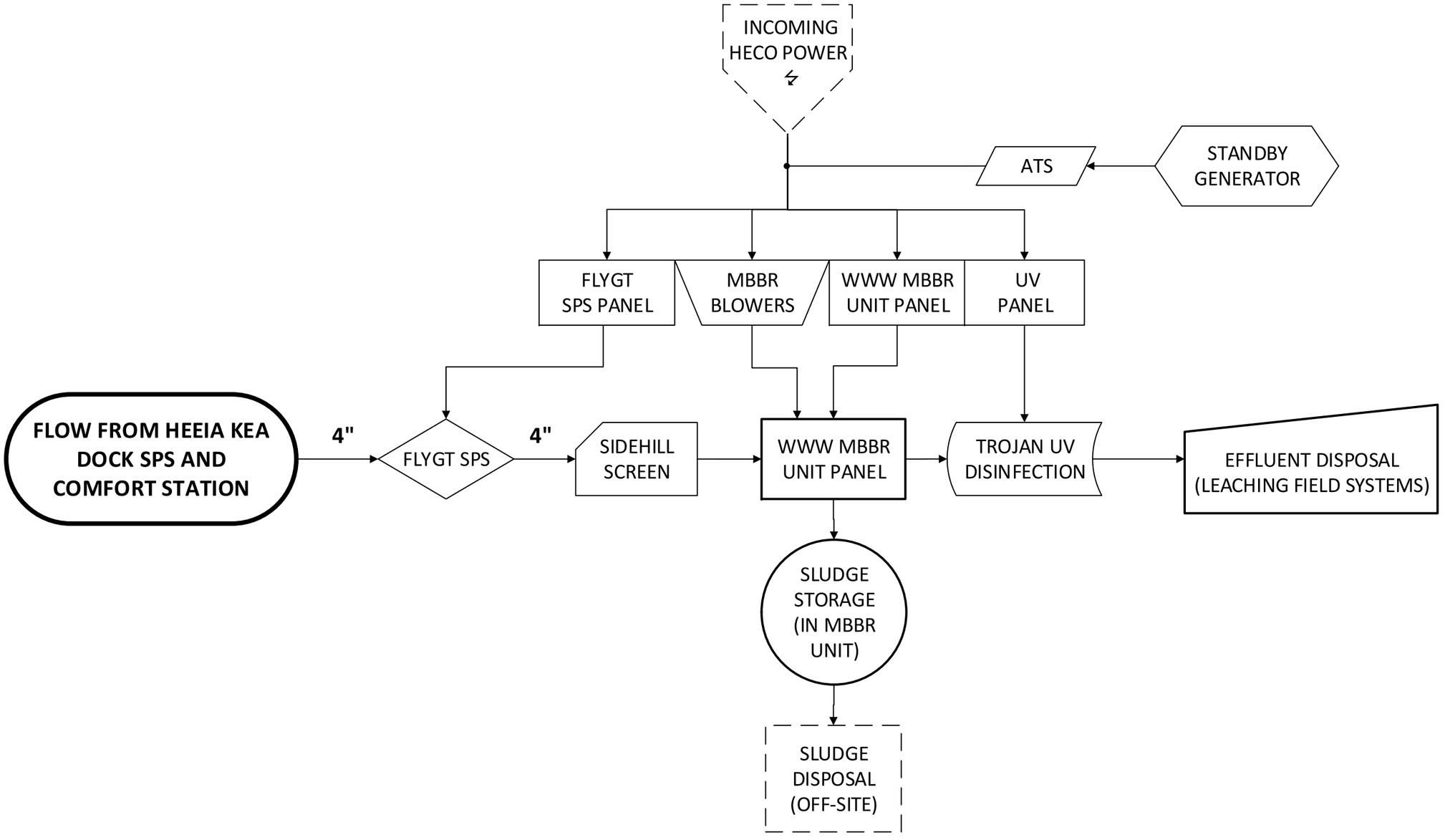
DRAWING NO. C008

Fri, 08 Feb 2019 - 1:29pm
N:\Projects\562-00 HEEIA KEA WWTP\Const Plans\562-00 C008 MISC DETAILS - 2.dwg

APPENDIX B

Wastewater Treatment System Flow Schematic

MBBR Flow Schematic



HEEIA KEA WWTP FLOW AND POWER SCHEMATIC

MBBR PACKAGE PLANT FLOW SCHEMATIC
PROCESS & INSTRUMENTATION DRAWINGS

HEEIA KEA HARBOR

KANEOHE, HI
USA

WORLD WATER WORKS
4000 SOUTHWEST 113TH STREET
OKLAHOMA CITY, OK 73173
USA

REV	DATE	DESCRIPTION	BY
0	2/19/2018	PRELIMINARY	JT
1	5/3/2018	ADDED OVERFLOW AND EFLFUENT	JT

world water works
1-800-607-PURE
4000 SW 113th * OKLAHOMA CITY, OK 73137

CLIENT: HEEIA KEA HARBOR
LOCATION: KANEOHE, HI
FILENAME: Heeia Kea Harbor-KaneoheHI-MBBR Package Plant
DESCRIPTION: MBBR PACKAGE PLANT

PRELIMINARY
P.O.#:
DRAWN BY: JT
CHECKED BY: GP
DATE: 2/17/2018
SCALE: N/A
JOB #:
DRAWING#
0601
SHEET 1
OF 4 SHEETS

06-P&ID

Drawing	Description
01	COVER PAGE
02	Drawing List
03	P&ID KEY
04	SECONDARY CLARIFIER
05	EQUIPMENT LIST

REV	DATE	DESCRIPTION	BY
0	2/19/2018	PRELIMINARY	JT
1	5/3/2018	ADDED OVERFLOW AND EFLFUENT	JT

1-800-607-PURE
World water works
4000 SW 113th • OKLAHOMA CITY, OK 73137

CLIENT: HEEIA KEA HARBOR
LOCATION: KANEOHE, HI
FILENAME: Heeia Kea Harbor-KaneoheHI-MBBR Package Plant
DESCRIPTION: MBBR PACKAGE PLANT

PRELIMINARY
P.O.#:
DRAWN BY: JT
CHECKED BY: GP
DATE: 2/17/2018
SCALE: N/A
JOB #:
DRAWING#: 0602
SHEET: 2 OF 4 SHEETS

LINE IDENTIFICATION

- WASTEWATER / MAIN PROCESS
- WASTEWATER / SLUDGE / AIR
- CHEMICAL / PNEUMATIC TUBING
- FLEXIBLE HOSE / INSTRUMENT CABLE
- ELECTRICAL / CONTROLS
- PROCESS - HEAT TRACED
- PROCESS - INSULATED
- DRAIN / SEWER

CONNECTION / SPECIAL FITTINGS IDENTIFICATION

- FLANGED
- BLIND FLANGE
- HOSE COUPLING
- NPT COUPLING
- SILENCER
- IN-LINE FILTER
- STRAINER
- EXPANSION JOINT

EQUIPMENT SCOPE IDENTIFICATION

WWW EQUIPMENT
BATTERY LIMITS

VALVE IDENTIFICATION & SYMBOLS

- NC — VALVE NORMALLY CLOSED
- KNIFE VALVE
- GATE VALVE
- BALL VALVE
- DIAPHRAGM VALVE
- GLOBE VALVE
- BUTTERFLY VALVE
- NEEDLE VALVE
- CHECK VALVE
- 3-WAY VALVE
- PINCH VALVE
- PLUG VALVE

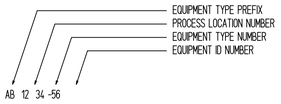
IN-LINE INSTRUMENTS AND ACCESSORIES

- 1A / AFC — DIAPHRAGM ACTUATED CONTROL VALVE WITH ELECTROPNEUMATIC CONVERTOR OR ELECTROPNEUMATIC POSITIONER
- M — ELECTRICAL ACTUATED CONTROL VALVE M=MOTOR S=SOLENOID
- SPRING LOADED / MASS LOADED — RELIEF VALVE, SAFETY VALVE
- VENTURI TUBE, FLOW NOZZLE
- FLOW ORIFICE
- DOUBLE ACTING PNEUMATIC ACTUATOR
- SPRING RETURN PNEUMATIC ACTUATOR

INSTRUMENTATION / CONTROL SYMBOLS

- LICSA 101 — LOCALLY MOUNTED INSTRUMENT
- UCSA — FREEZE PROTECTED INSTRUMENT
- VFDxx xx-xx — VARIABLE FREQUENCY DRIVE
- xIC xx-xx — CONTROL PARAMETER INDICATED CONTROL (PRESSURE, FLOW, LEVEL, ETC)
- 1A — INSTRUMENT AIR CONNECTION POINT
- PW — POTABLE WATER CONNECTION POINT
- CONTROLS INTERLOCK

TAG NUMBER IDENTIFICATION



EQUIPMENT TYPE PREFIX

LETTERS	EQUIPMENT TYPE
AC	AFTER COOLER HEAT EXCHANGER
AE	ANALYSIS METER (pH, DO, TURBIDITY etc.)
AFR	AIR FLOW REGULATOR
AG	AERATION GRID COMPONENTS
BL	BLOWER
BM	BIOMEDIA
C	COMPRESSOR, FAN
CP	CHEMICAL PUMP
CV	CONTROL VALVE
DAF	DISSOLVED AIR FLOTATION UNIT
DP	DISSOLVED AIR GENERATOR PUMP
DW	DE-WATERING UNIT / SLUDGE FILTER PRESS
FE	FLOW METER
FS	FLOW SWITCH
LE	LEVEL TRANSMITTER
LS	LEVEL SWITCH
M	MOTOR
MX	AGITATOR, MIXER
PE	PRESSURE TRANSMITTER
PS	PRESSURE SWITCH
RG	RAKE GEAR
RP	RECIRCULATION PUMP
SM	SOLENOID MANIFOLD
SP	SLUDGE PUMP
SV	SOLENOID VALVE
TK	TANK / BASIN
TP	TRANSFER PUMP
V	MANUAL VALVE
_JT	INSTRUMENT CONTROLLER / TRANSMITTER
__S	SCREEN OR SIEVE

PROCESS /EQ TYPE NUMBER

NUMBER	PROCESS LOCATION	EQ TYPE NUMBER
01		MAJOR EQUIPMENT
02	TRANSFER SYSTEM	TANKS
03	PRE-SCREENING	AERATION GRID COMPONENT
04	TRANSFER SYSTEM	MANUAL VALVES
05	EQUALIZATION	CONTROL VALVES (ON/OFF)
06	TRANSFER SYSTEM	DISCREET OUTPUT
07	PRIMARY SEPARATION	DISCREET INPUT
08	TRANSFER SYSTEM	ANALOG OUTPUT
09	BIOLOGICAL PROCESS	ANALOG INPUT
10	SECONDARY SEPARATION	PUMPS
11	TRANSFER SYSTEM	CHEMICAL PUMPS
12	FILTRATION	BLOWERS
13	TRANSFER SYSTEM	COMPRESSORS
14	WATER REUSE	HEAT EXCHANGERS
15	SLUDGE STORAGE	MIXERS
16	DEWATERING	
17		
18		
19		
20		MISCELLANEOUS

EQUIPMENT SYMBOLS

- CENTRIFUGAL / DAG PUMP
- AERATION BLOWER
- CHEMICAL METERING PUMP
- CHEMICAL PERISTALTIC PUMP
- STATIC MIXER
- DISSOLVED AIR FLOTATION
- ROTARY SCREEN
- SIDEHILL SCREEN
- MIXER
- BAR SCREEN
- BIOMEDIA
- AFTERCOOLER

ELECTRICAL SYMBOLS

- FIELD-MOUNTED START PUSH-BUTTON
- FIELD-MOUNTED STOP PUSH-BUTTON
- SS — FIELD-MOUNTED SAFETY STOP PUSH-BUTTON
- FIELD-MOUNTED START/STOP PUSH BUTTON
- FIELD-MOUNTED SELECTOR SWITCH
- PANEL-MOUNTED PILOT LIGHT "RUNNING"
- PANEL-MOUNTED PILOT LIGHT "ALARM"
- PANEL-MOUNTED START/STOP PUSH-BUTTONS
- PANEL-MOUNTED SELECTOR SWITCH
- M — MOTOR
- G — GENERATOR

REV	DATE	DESCRIPTION	BY
0	2/19/2018	PRELIMINARY	JT
1	5/3/2018	ADDED OVERFLOW AND EFLFUENT	JT

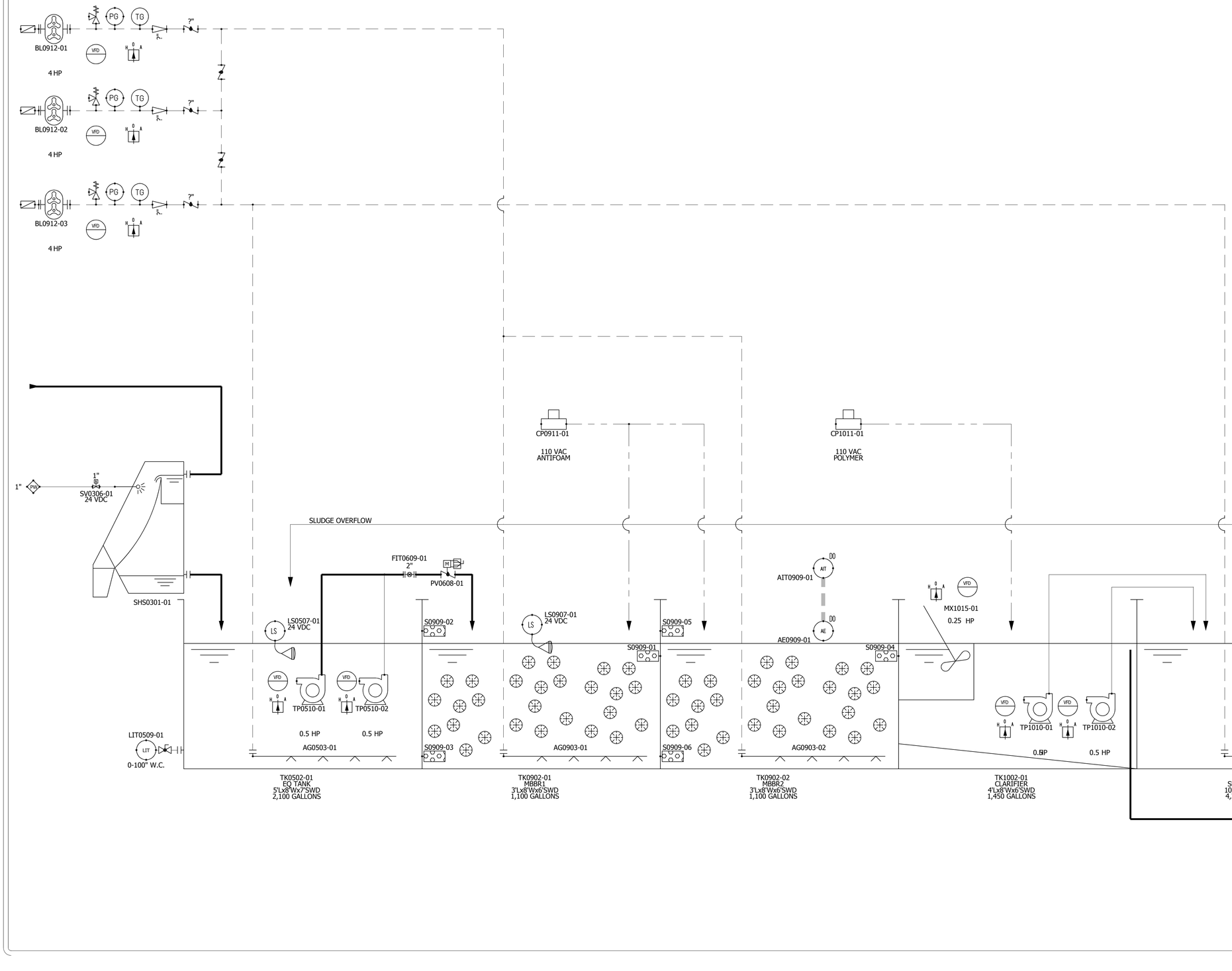
World water works
1-800-607-PURE
4000 SW 113th * OKLAHOMA CITY, OK 73137

CLIENT: HEEIA KEA HARBOR
LOCATION: KANEOHE, HI
FILENAME: Heeia Kea Harbor-KaneoheHI-MBBR Package Plant
DESCRIPTION: MBBR PACKAGE PLANT

PRELIMINARY
PO#:
DRAWNBY: JT
CHECKEDBY: GP
DATE: 2/17/2018
SCALE: N/A
JOB #:
DRAWING# 0603
SHEET 3 OF 4 SHEETS

1. WWW SCOPE DEFINED BY RED DOTTED LINES
2. CUSTOMER PIPING SHALL BE INDEPENDENTLY SUPPORTED

MAIN
SECONDARY
FLEX
AIR
CHEMICAL
ELECTRICAL



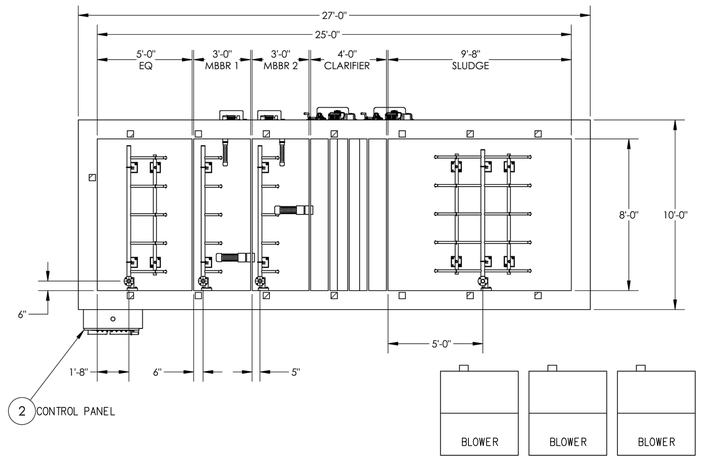
REV	DATE	DESCRIPTION	BY
0	2/19/2018	PRELIMINARY	JT
1	5/3/2018	ADDED OVERFLOW AND EFLFUENT	JT

world water works
1-800-607-PURE
4000 SW 113th * OKLAHOMA CITY, OK 73137

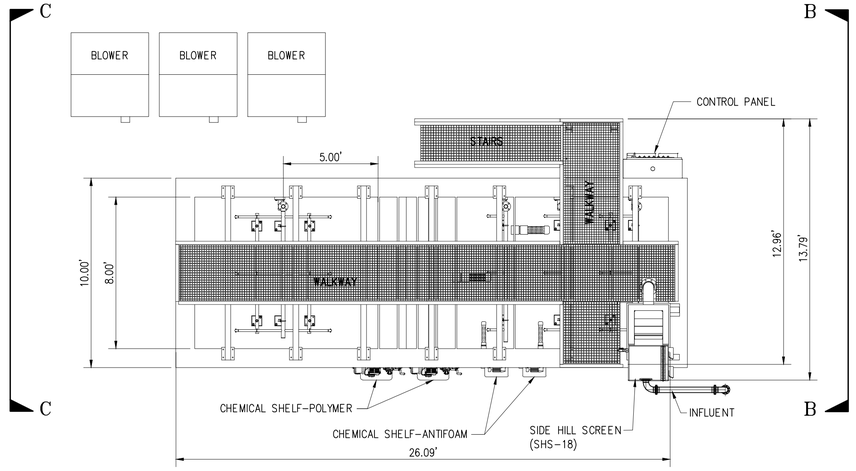
CLIENT: HEEIA KEA HARBOR
LOCATION: KANEOHE, HI
FILENAME: Heeia Kea Harbor-KaneoheHI-MBBR Package Plant
DESCRIPTION: PACKAGE PLANT

PRELIMINARY
P.O.#:
DRAWN BY: JT
CHECKED BY: GP
DATE: 2/17/2018
SCALE: N/A
JOB #:
DRAWING#
0604
SHEET 4
OF 4 SHEETS

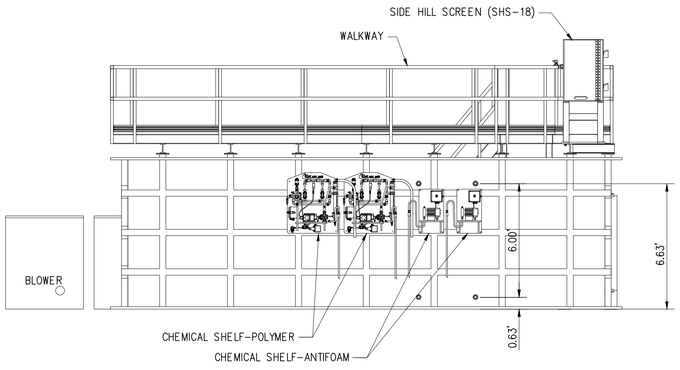
WWW CONFIDENTIAL



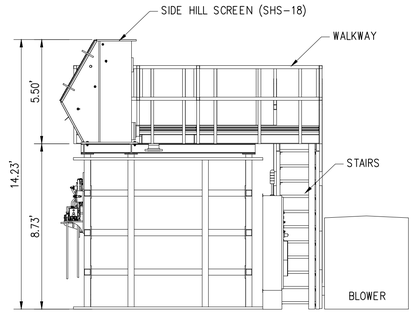
SECTION A–A



PLAN



REAR VIEW



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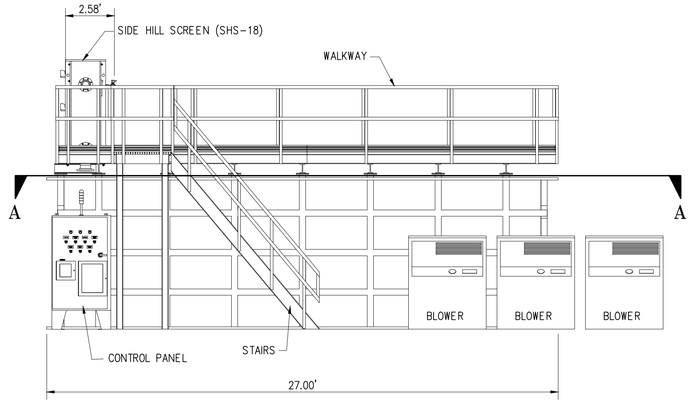

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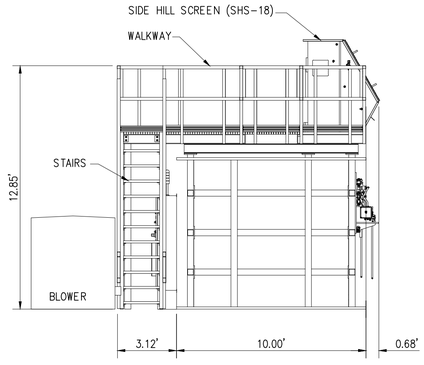


SECTION C–C

WASTEWATER TREATMENT PLANT DETAILS

NOT TO SCALE

REVISION NO.	SYM.	DESCRIPTION	SHT./OF	DATE	APPROVED

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION AND CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY OBSERVATION.

SIGNATURE
LICENSE EXP.: 4/30/20

DAVID B. BILLS
LICENSED PROFESSIONAL ENGINEER
No. 4518-C
HAWAII, U.S.A.

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF BOATING AND OCEAN RECREATION

HEEIA KEA SMALL BOAT HARBOR WASTEWATER TREATMENT SYSTEM IMPROVEMENTS

WWTP DETAILS – 1

BILLS ENGINEERING, INC.

DESIGNED: BU	SUBMITTED: BEI
DRAWN: RE/SI	DATE:
CHECKED: DB	SCALE: AS SHOWN

APPROVED: _____ _____
CHIEF ENGINEER DATE

DRAWING NO. C006

Thu, 12 Apr 2018 – 2:49pm
N:\Projects\562-00 HEEIA KEA WWTP\Const Plans\562-00 C006 WWTP DETAILS – 1.dwg

APPENDIX C

Wastewater Treatment Plans Electrical Diagrams and Wiring

	MANUAL MOTOR PROTECTOR
	TRANSFORMER
	NON FUSED DISCONNECT SWITCH
	CIRCUIT BREAKER
	WALL OUTLET
$	LIGHT SWITCH
	NORMALLY OPEN CONTACT
	NORMALLY CLOSED CONTACT
	LINE REACTOR
	POWER DISTRIBUTION BLOCK
	LIMIT SWITCH

MTR	SINGLE PHASE MOTOR
MTR	THREE PHASE MOTOR
	LIGHT
	PUSH BUTTON
E-STOP	E-STOP
COMBINATION STARTER	COMBO STARTER WITH ADJUSTABLE AMP RATING
333	MANUAL CIRCUIT PROTECTOR WITH ADJUSTABLE AMP RATING
⌀	TERMINAL STRIP
	PRESSURE SWITCH
M	MOTOR STARTER COIL
	TEMPERATURE SWITCH

RADAR TERMINALS (1) GD + −	RADAR LEVEL CONTROL
	CHEMICAL PUMP
L1 L2 L3 T1 T2 T3	DISCONNECT SWITCH
SV-##	SOLENOID VALVE
	3 POLE BREAKER
	1 POLE BREAKER
VFD AC DRIVE	AC DRIVE
	CONTROL VALVE
R	RELAY COIL

HEEIA KEA PRELIMINARY ELECTRICAL PRINTS

TABLE OF CONTENTS

REV. #	DATE	DESCRIPTION	BY

World water works
1-800-607-PURE
4000 SW 113th • OKLAHOMA CITY, OK 73197

CLIENT: TWINCRAFT SKINCARE
LOCATION: ESSEX, VT
FILE NAME: HEEIA KEA BASE PRELIMINARY ELECTRICAL 208V MOTORS.DWG
DRAWING DESCRIPTION: ELECTRICAL PRINTS

FOR APPROVAL

P.O.#: TBD

DRAWN BY: CST

CHECKED BY:

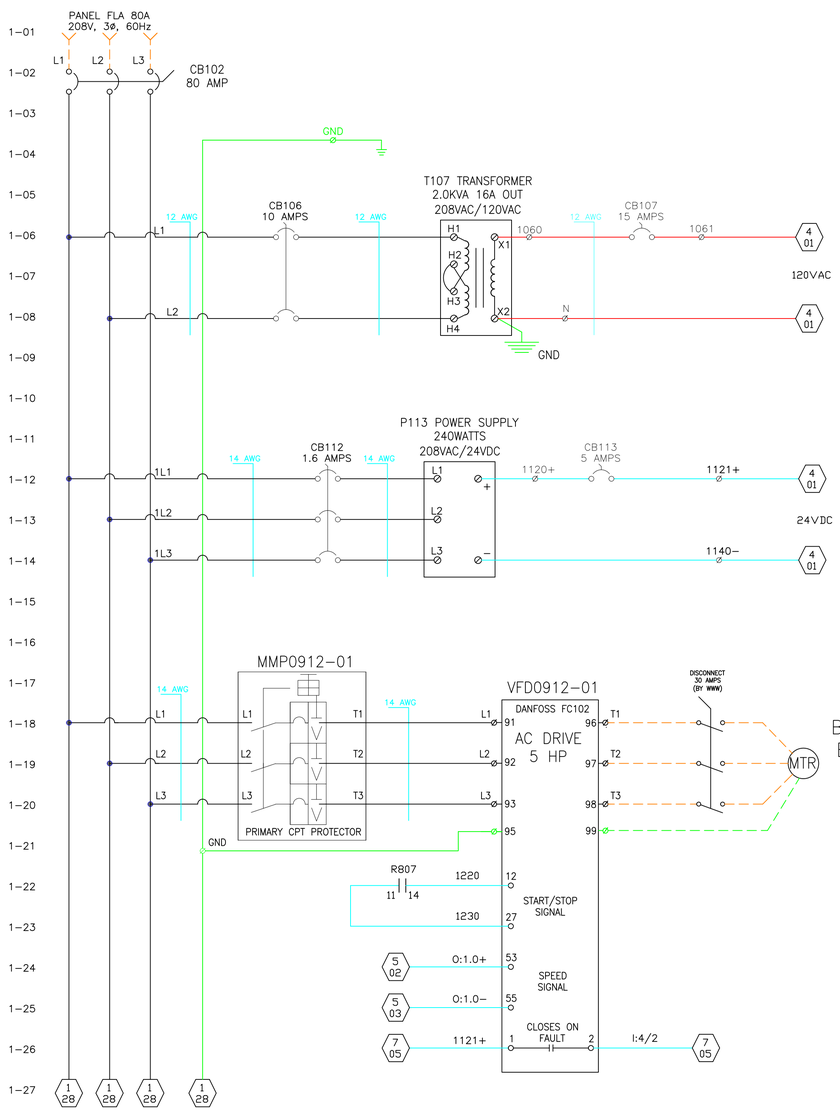
DATE: 02/28/2018

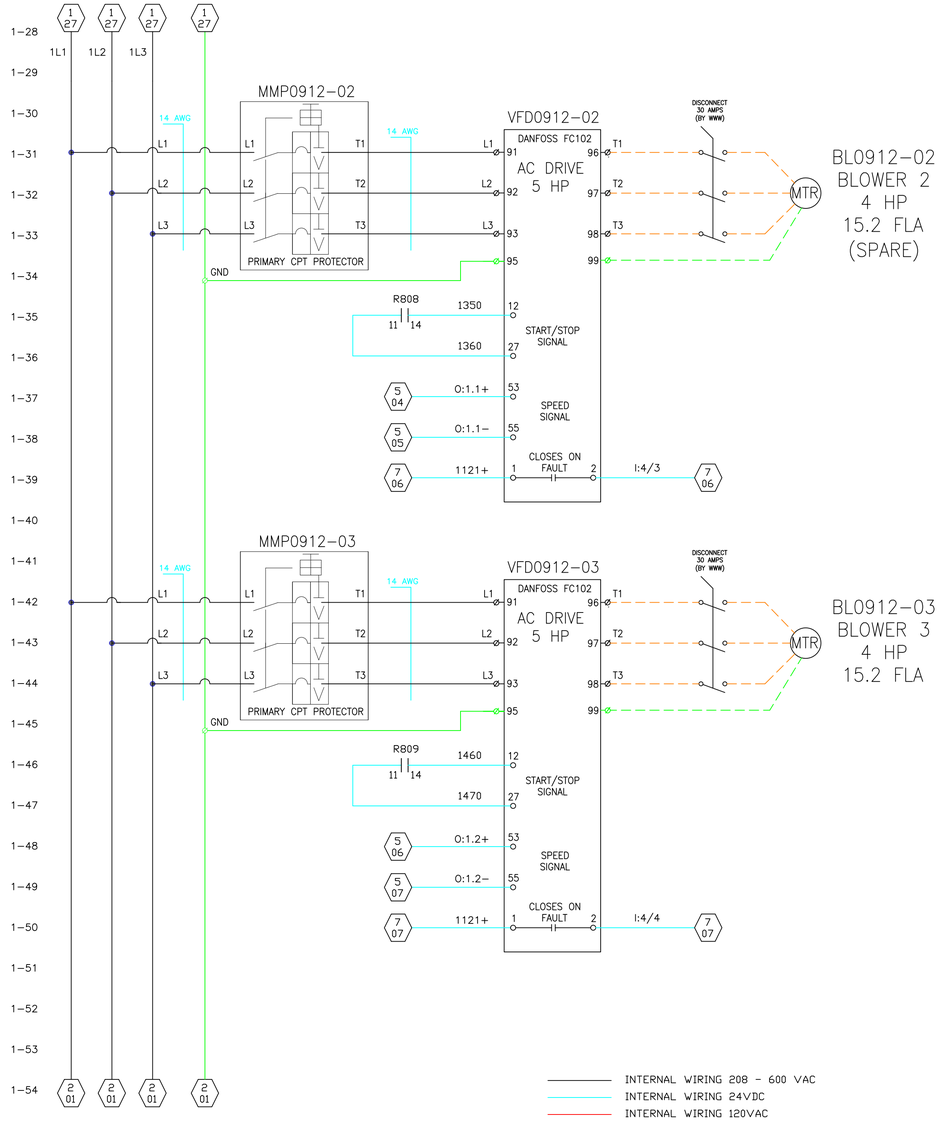
SCALE: NONE

JOB #: TBD

DRAWING # 0801

SHEET: 1 OF 13 SHEETS





INTERNAL WIRING 208 - 600 VAC
INTERNAL WIRING 24VDC
INTERNAL WIRING 120VAC
EXTERNAL WIRING BY WORLD WATER WORKS
FIELD WIRING BY OTHERS

NOTES:
1. ALL CONTROL LINES LEAVING THE PANEL SHOULD BE 12 GAUGE THHN STRANDED.
2. CABLE FOR 4−20MA SHOULD BE BELDEN# 8760−U1000.
3. SYMBOL FOR LINES TO GO TO TERMINAL STRIP. ∅
4. DASH LINES ARE FIELD WIRING.
6. INSIDE DASH LINES ARE FIELD WIRING.

X / Y USED FOR INDEXING TO SHEET −X AND LINE−Y.

WWW CONFIDENTIAL

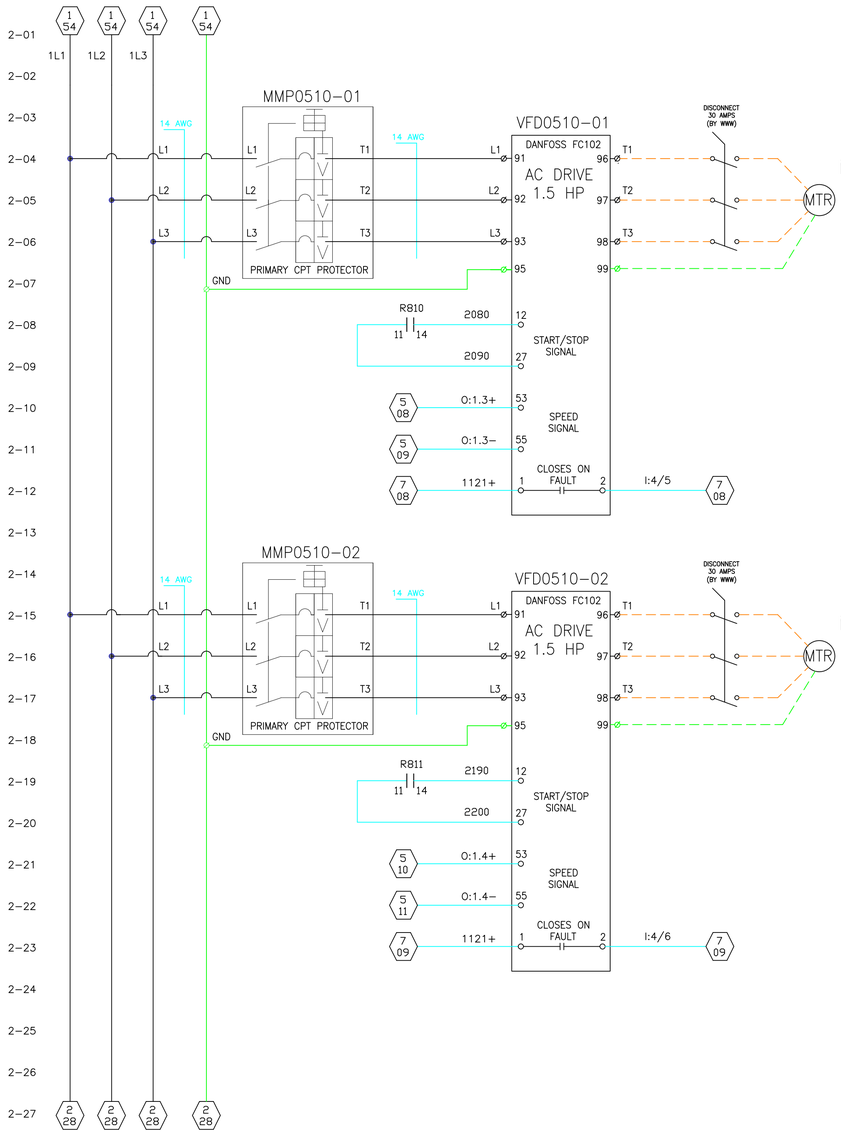
REV. #	DATE	DESCRIPTION	BY

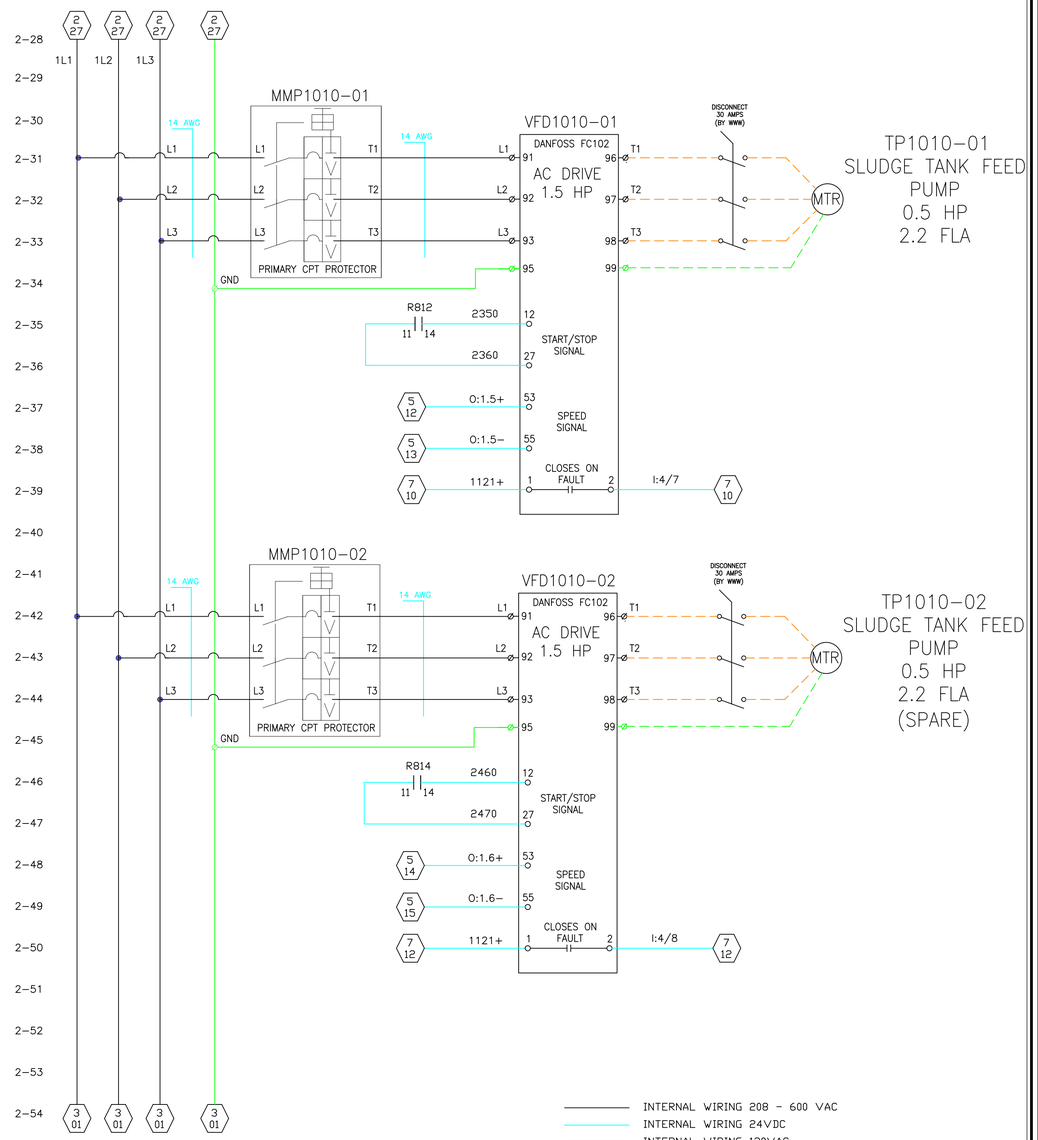
World water works
1-800-607-PURE
4000 SW 113th • OKLAHOMA CITY, OK 73197

CLIENT: TWINCRAFT SKINCARE
LOCATION: ESSEX, VT
FILE NAME: HEIA KEA BASE PRELIMINARY ELECTRICAL 208V MOTORS.DWG
DRAWING DESCRIPTION: ELECTRICAL PRINTS

FOR APPROVAL

P.O.#: TBD
DRAWN BY: CST
CHECKED BY:
DATE: 02/28/2018
SCALE: NONE
JOB #: TBD
DRAWING # 0802
SHEET: 2 OF 13 SHEETS





INTERNAL WIRING 208 - 600 VAC
INTERNAL WIRING 24VDC
INTERNAL WIRING 120VAC
EXTERNAL WIRING BY WORLD WATER WORKS
FIELD WIRING BY OTHERS

NOTES:
1. ALL CONTROL LINES LEAVING THE PANEL SHOULD BE 12 GAUGE THHN STRANDED,
2. CABLE FOR 4-20MA SHOULD BE BELDEN# 8760-U1000.
3. SYMBOL FOR LINES TO GO TO TERMINAL STRIP. ∅
4. DASH LINES ARE FIELD WIRING.
6. INSIDE DASH LINES ARE FIELD WIRING.

(X/Y) USED FOR INDEXING TO SHEET -X AND LINE-Y.

WWW CONFIDENTIAL

REV. #	DATE	DESCRIPTION	BY

World water works
1-800-607-PURE
4000 SW 113th • OKLAHOMA CITY, OK 73197

CLIENT: TWINCRAFT SKINCARE
LOCATION: ESSEX, VT
FILE NAME: HECIA KEA BASE PRELIMINARY ELECTRICAL 208V MOTORS.DWG
DRAWING DESCRIPTION: ELECTRICAL PRINTS

FOR APPROVAL

P.O.#: TBD
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CHECKED BY:
DATE: 02/28/2018
SCALE: NONE
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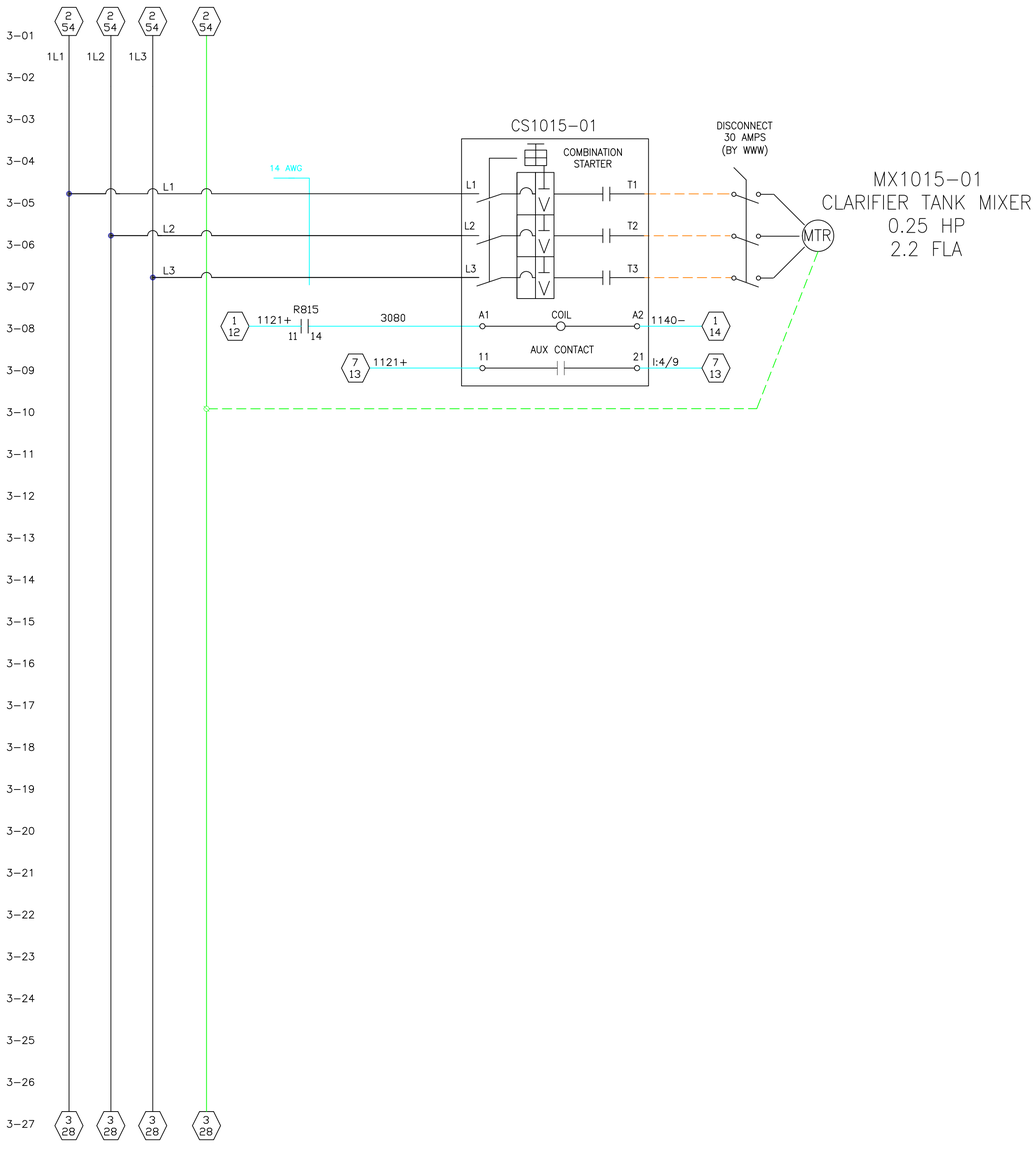
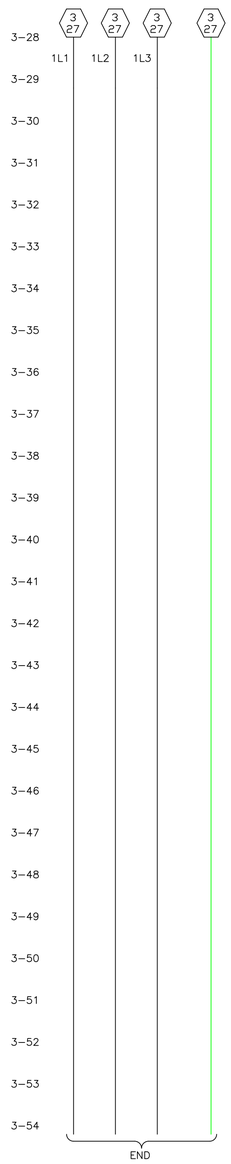
SHEET: 3 OF 13 SHEETS





INTERNAL WIRING 208 - 600 VAC
INTERNAL WIRING 24VDC
INTERNAL WIRING 120VAC
EXTERNAL WIRING BY WORLD WATER WORKS
FIELD WIRING BY OTHERS

NOTES:
1. ALL CONTROL LINES LEAVING THE PANEL SHOULD BE 12 GAUGE THHN STRANDED.
2. CABLE FOR 4-20MA SHOULD BE BELDEN# 8760-U1000.
3. SYMBOL FOR LINES TO GO TO TERMINAL STRIP. ∅
4. DASH LINES ARE FIELD WIRING.
6. INSIDE DASH LINES ARE FIELD WIRING.

X / Y — USED FOR INDEXING TO SHEET -X AND LINE-Y.

WWW CONFIDENTIAL

REV. #	DATE	DESCRIPTION	BY

World water works
1-800-467-PURE
4000 SW 119th • OKLAHOMA CITY, OK 73197

CLIENT: TWINCRAFT SKINCARE
LOCATION: ESSEX, VT
FILE NAME: SHEIA KEA BASE PRELIMINARY ELECTRICAL 208V MOTORS.DWG
DRAWING DESCRIPTION: ELECTRICAL PRINTS

FOR APPROVAL

P.O.#: TBD
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CHECKED BY:
DATE: 02/28/2018
SCALE: NONE
JOB #: TBD
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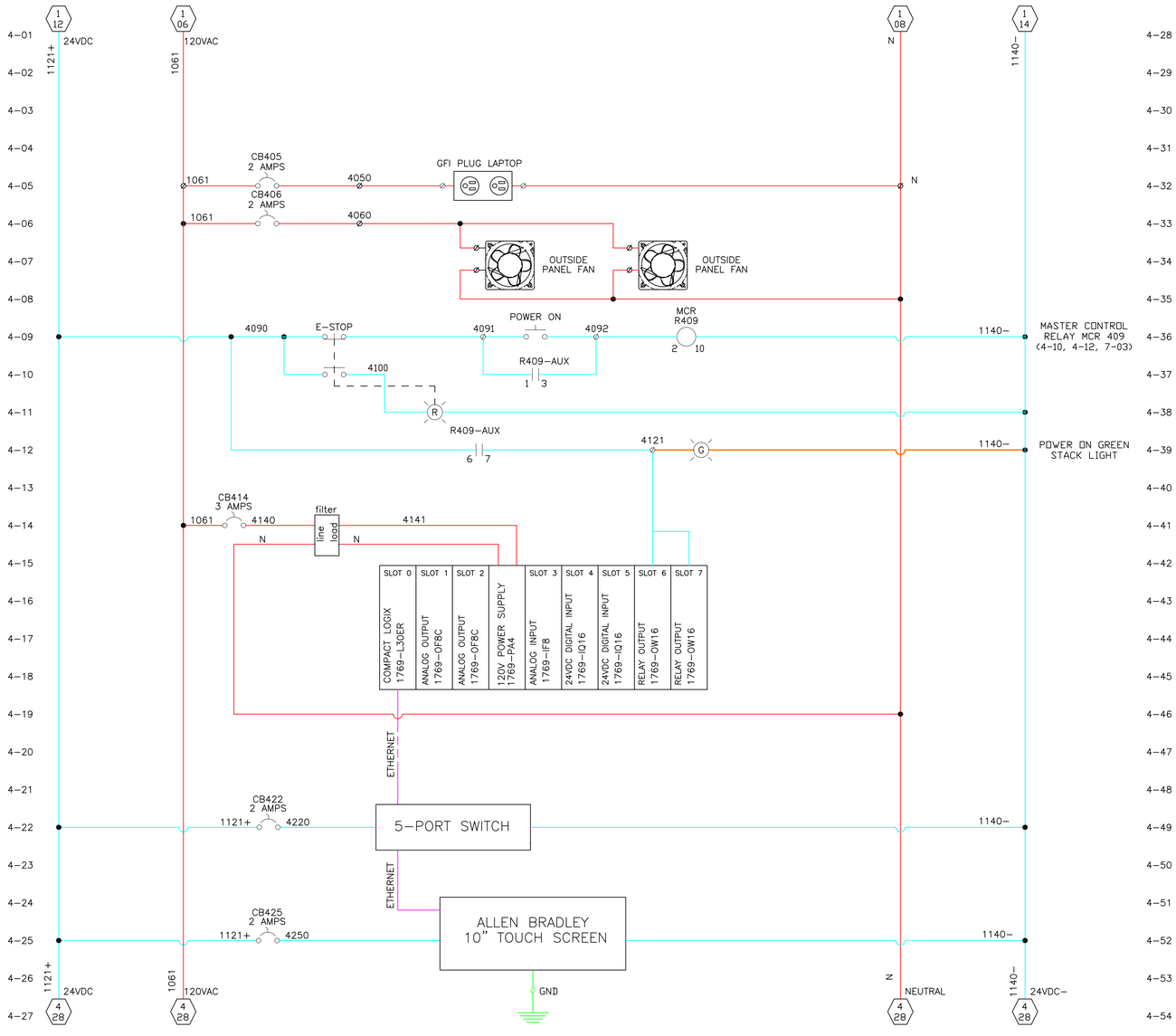
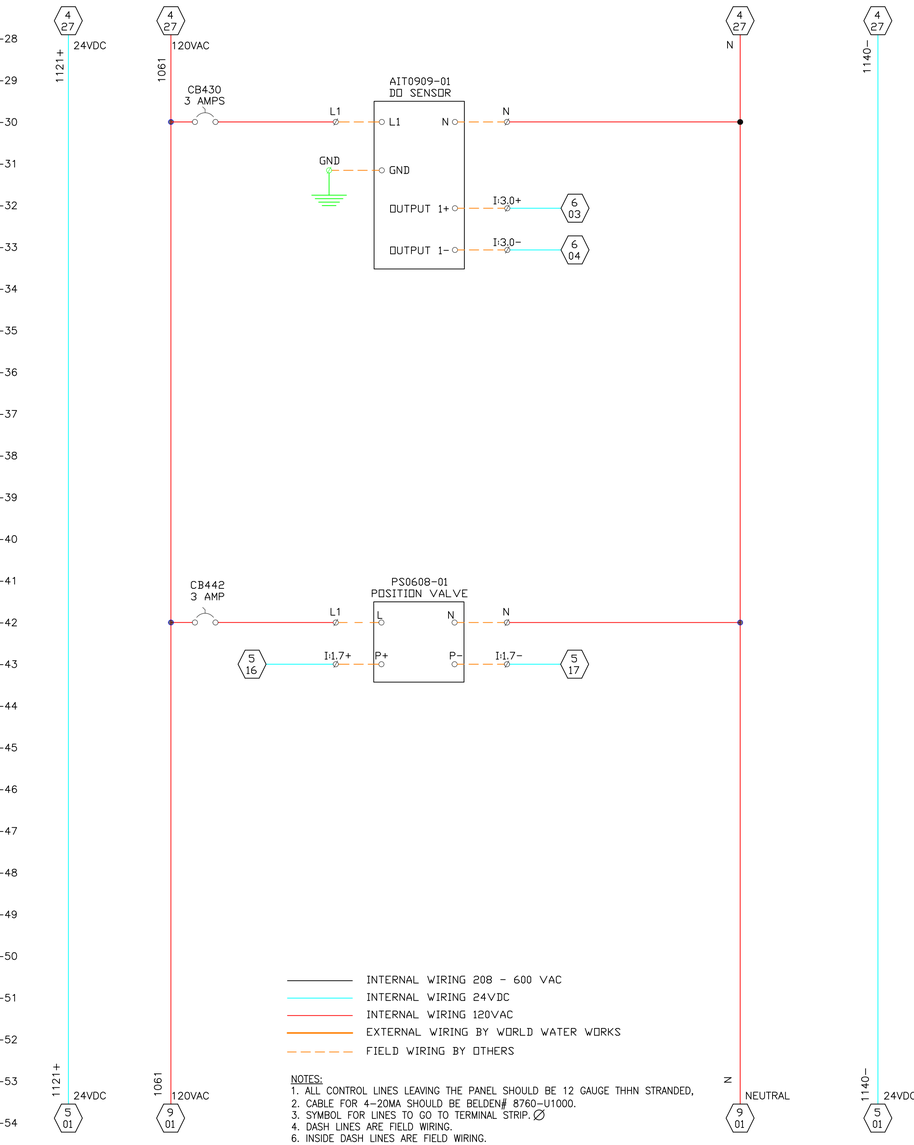
SHEET: 4 OF 13 SHEETS





INTERNAL WIRING 208 - 600 VAC
INTERNAL WIRING 24VDC
INTERNAL WIRING 120VAC
EXTERNAL WIRING BY WORLD WATER WORKS
FIELD WIRING BY OTHERS

NOTES:
1. ALL CONTROL LINES LEAVING THE PANEL SHOULD BE 12 GAUGE THHN STRANDED,
2. CABLE FOR 4-20MA SHOULD BE BELDEN# 8760-U1000.
3. SYMBOL FOR LINES TO GO TO TERMINAL STRIP. ∅
4. DASH LINES ARE FIELD WIRING.
6. INSIDE DASH LINES ARE FIELD WIRING.

X/Y USED FOR INDEXING TO SHEET -X AND LINE-Y.

REV.	DATE	DESCRIPTION	BY

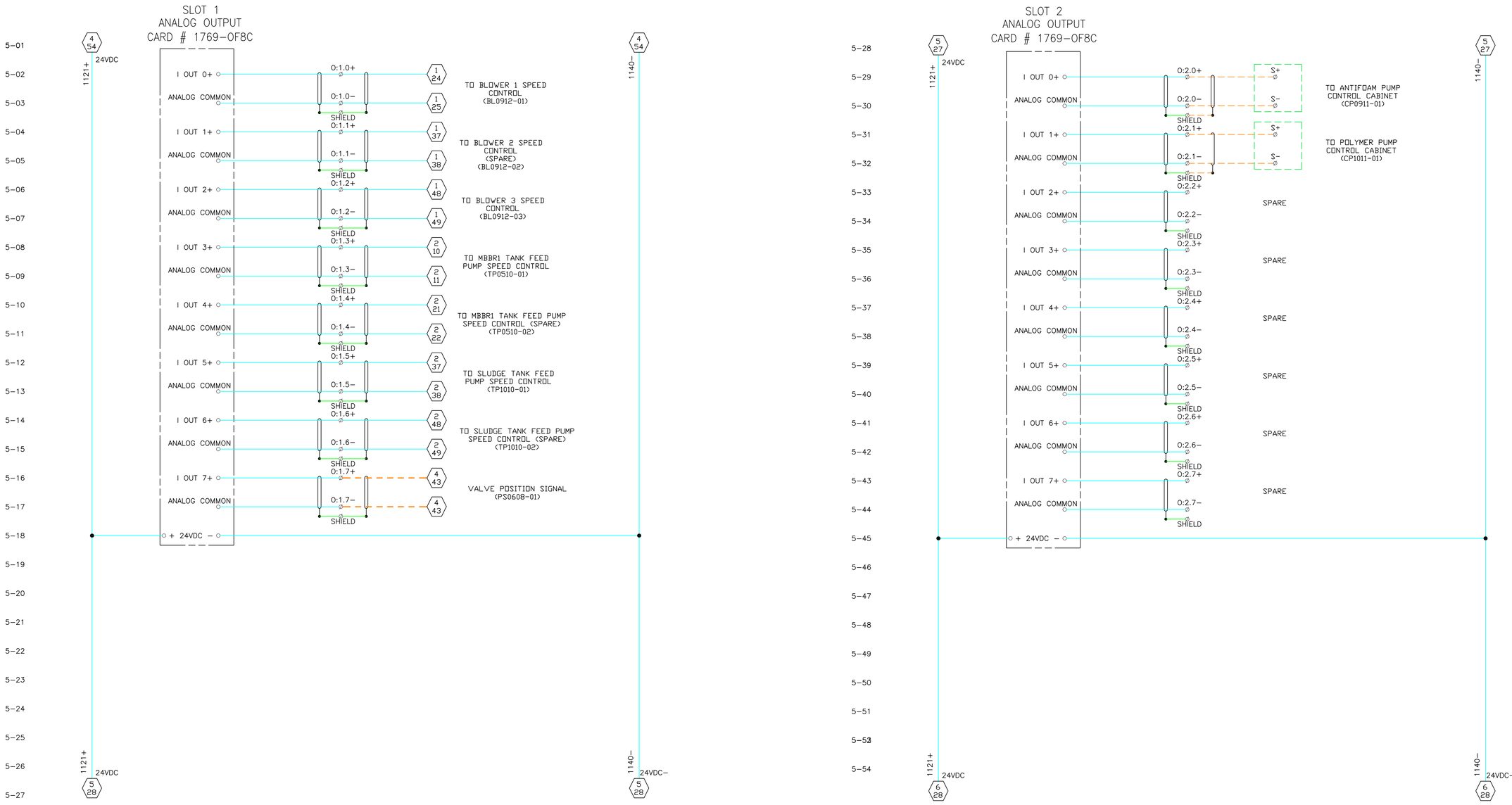
World water works
1-800-607-PURE
4000 SW 113th • OKLAHOMA CITY, OK 73197

CLIENT: TWINCRAFT SKINCARE
LOCATION: ESSEX, VT
FILE NAME: HEEIA KEA BASE PRELIMINARY ELECTRICAL 208V MOTORS.DWG
DRAWING DESCRIPTION: ELECTRICAL PRINTS

FOR APPROVAL

P.O.#: TBD
DRAWN BY: CST
CHECKED BY:
DATE: 02/28/2018
SCALE: NONE
JOB #: TBD
DRAWING # 0805
SHEET: 5 OF 13 SHEETS

WWW CONFIDENTIAL



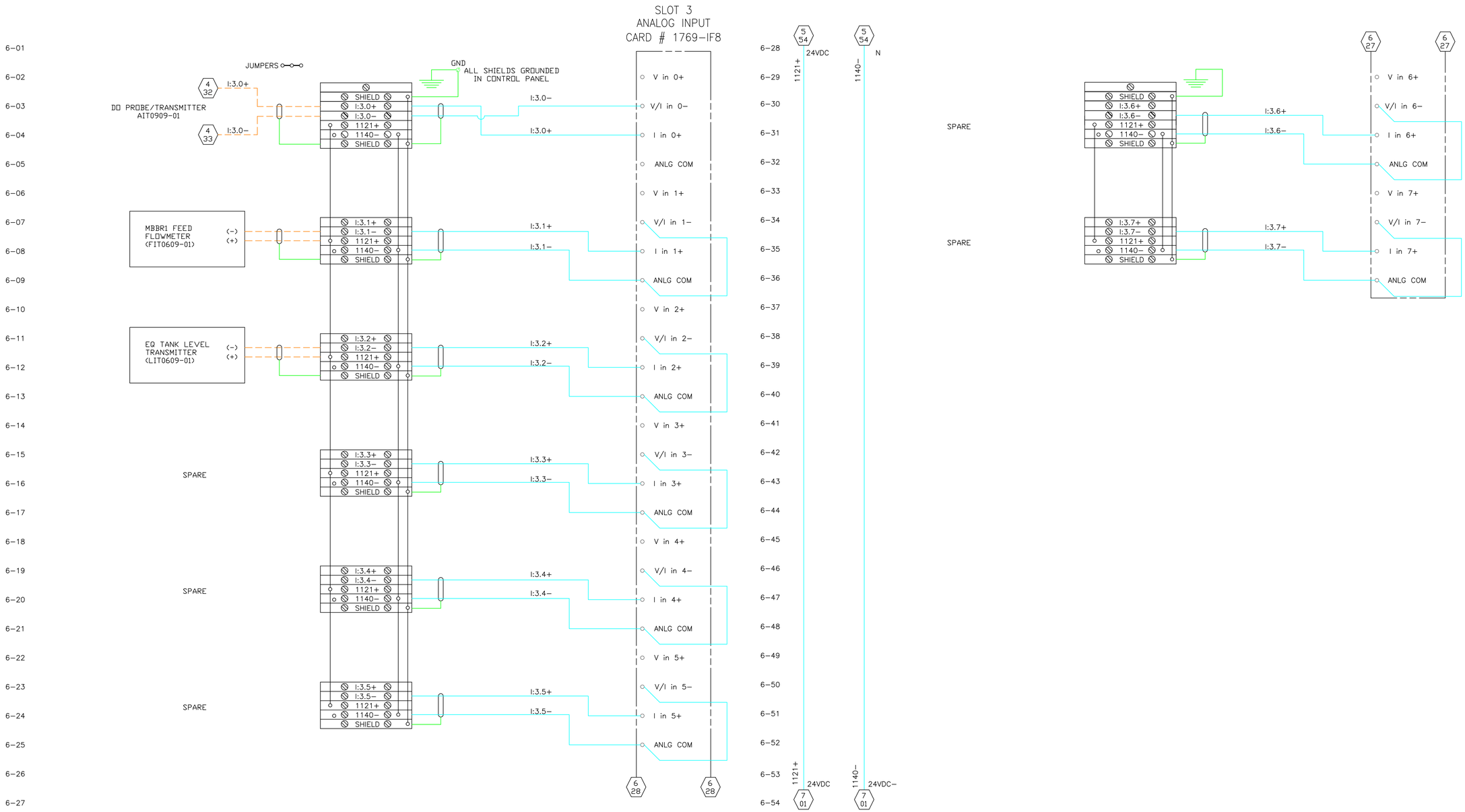
REV. #	DATE	DESCRIPTION	BY

World water works
1-800-607-PURE
4000 SW 119th • OKLAHOMA CITY, OK 73197

CLIENT: TWINCRAFT SKINCARE
LOCATION: ESSEX, VT
FILE NAME: HEIA KEA BASE PRELIMINARY ELECTRICAL 208V MOTORS.DWG
DRAWING DESCRIPTION: ELECTRICAL PRINTS

FOR APPROVAL

P.O.#: TBD
DRAWN BY: CST
CHECKED BY:
DATE: 02/28/2018
SCALE: NONE
JOB #: TBD
DRAWING # 0806
SHEET: 6 OF 13 SHEETS



INTERNAL WIRING 208 - 600 VAC
INTERNAL WIRING 24VDC
INTERNAL WIRING 120VAC
EXTERNAL WIRING BY WORLD WATER WORKS
FIELD WIRING BY OTHERS

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X Y USED FOR INDEXING TO SHEET -X AND LINE-Y.

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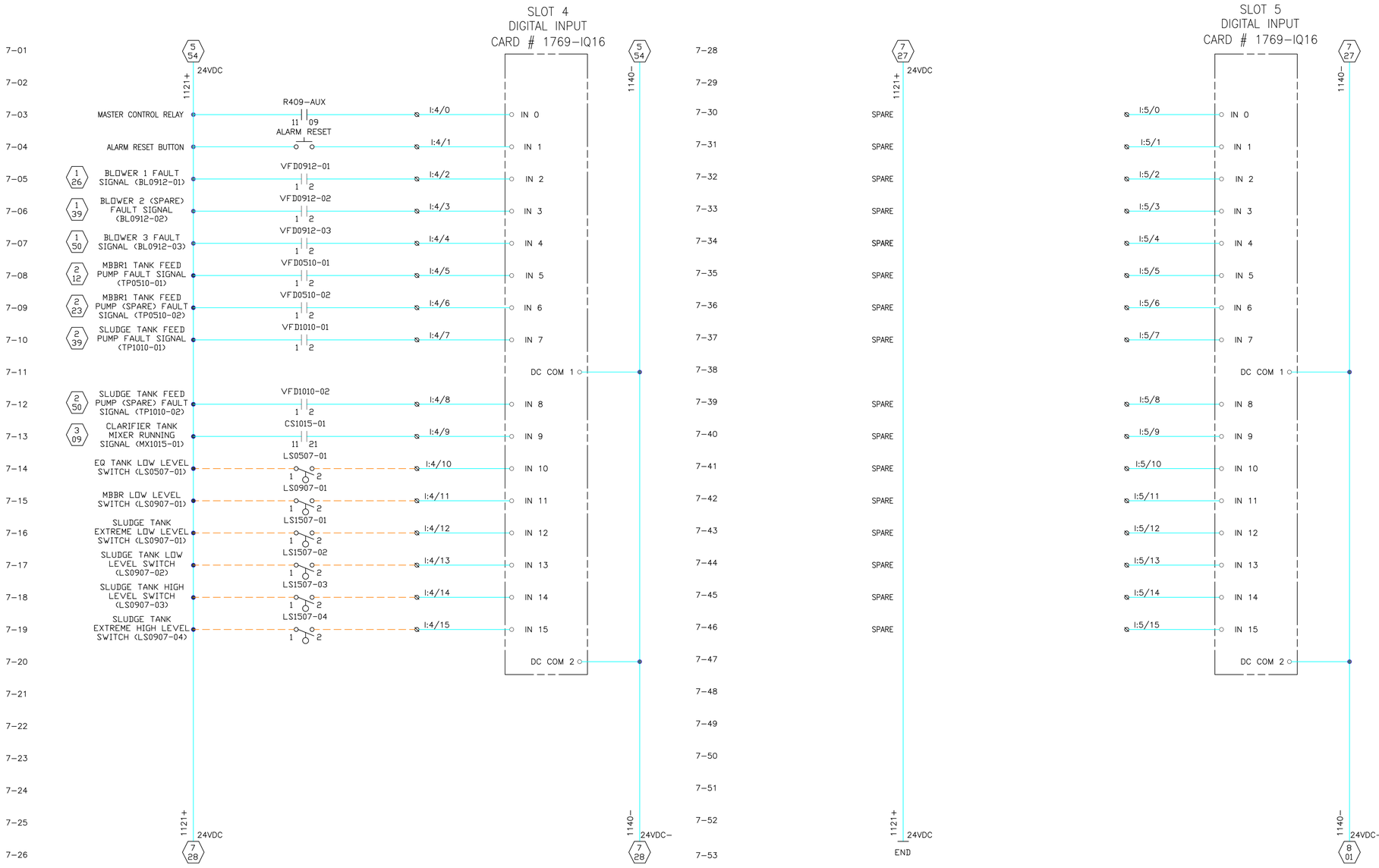
REV. #	DATE	DESCRIPTION	BY

World water works
1-800-607-PURE
4000 SW 119th • OKLAHOMA CITY, OK 73197

CLIENT: TWINCRAFT SKINCARE
LOCATION: ESSEX, VT
FILE NAME: HECIA KEA BASE PRELIMINARY ELECTRICAL 208V MOTORS.DWG
DRAWING DESCRIPTION: ELECTRICAL PRINTS

FOR APPROVAL

P.O.#: TBD
DRAWN BY: CST
CHECKED BY:
DATE: 02/28/2018
SCALE: NONE
JOB #: TBD
DRAWING # 0807
SHEET: 7 OF 13 SHEETS



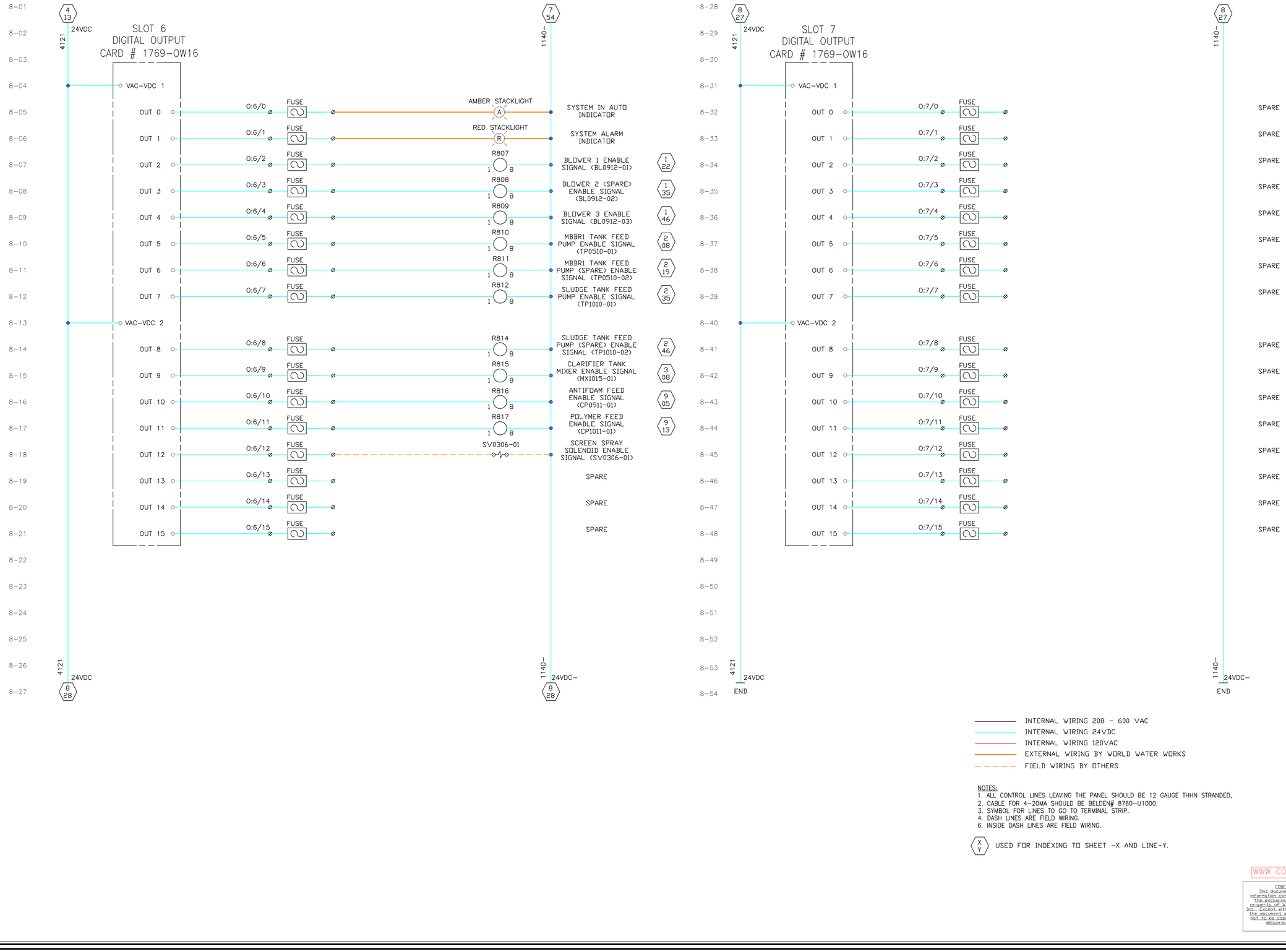
REV. #	DATE	DESCRIPTION	BY

World water works
1-800-607-PURE
4000 SW 113th • OKLAHOMA CITY, OK 73197

CLIENT: TWINCRAFT SKINCARE
LOCATION: ESSEX, VT
FILE NAME: HEIA KEA BASE PRELIMINARY ELECTRICAL 208V MOTORS.DWG
DRAWING DESCRIPTION: ELECTRICAL PRINTS

FOR APPROVAL

P.O.#: TBD
DRAWN BY: CST
CHECKED BY:
DATE: 02/28/2018
SCALE: NONE
JOB #: TBD
DRAWING # 0808
SHEET: 8 OF 13 SHEETS



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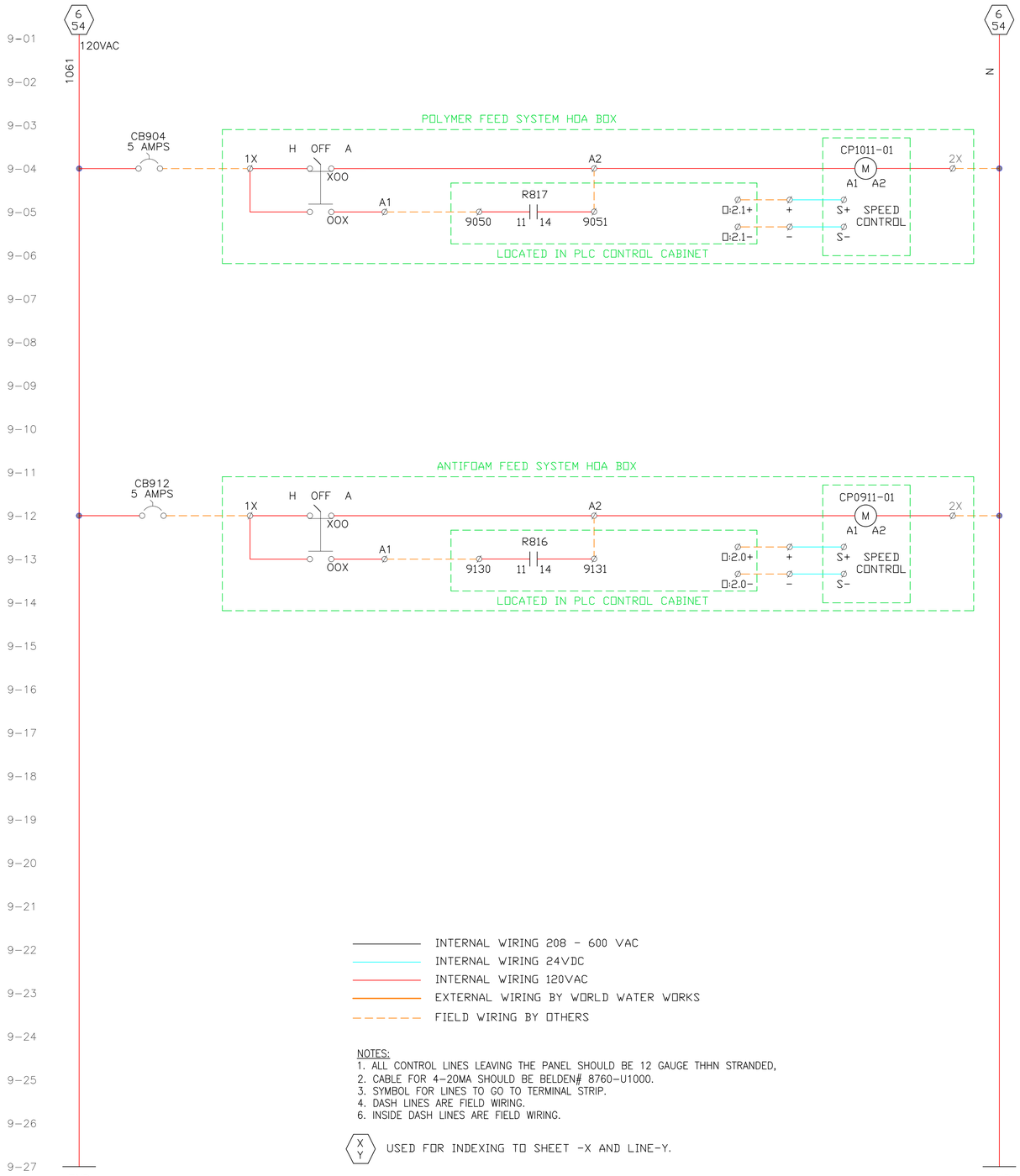
REV. #	DATE	DESCRIPTION	BY

World water works
1-800-467-PURE
4000 SW 113th • OKLAHOMA CITY, OK 73197

CLIENT: TWINCRAFT SKINCARE
LOCATION: ESSEX, VT
FILE NAME: HEEIA KEA BASE PRELIMINARY ELECTRICAL 208V MOTORS.DWG
DRAWING DESCRIPTION: ELECTRICAL PRINTS

FOR APPROVAL	
P.O.#:	TBD
DRAWN BY:	CST
CHECKED BY:	
DATE:	02/28/2018
SCALE:	NONE
JOB #:	TBD
DRAWING #	0809
SHEET:	9 OF 13 SHEETS



INTERNAL WIRING 208 - 600 VAC
INTERNAL WIRING 24VDC
INTERNAL WIRING 120VAC
EXTERNAL WIRING BY WORLD WATER WORKS
FIELD WIRING BY OTHERS

NOTES:
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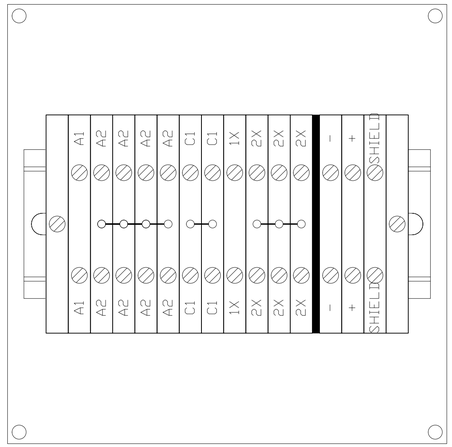
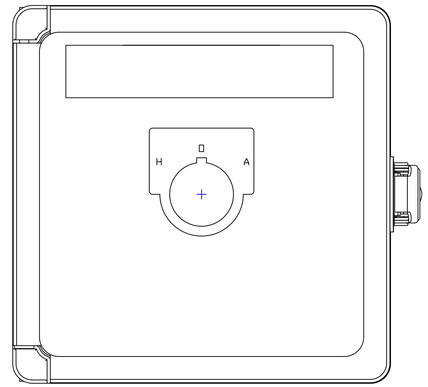
6. INSIDE DASH LINES ARE FIELD WIRING.

X / Y — USED FOR INDEXING TO SHEET -X AND LINE-Y.

CHEMICAL SYSTEM CABINET LAYOUT



BACK PLATE



CONTROL BOX

LAYOUT FOR CHEMICAL PUMPS
CP0911-01 AND CP1011-01
(2 TOTAL JUNCTION BOXES)

WWW CONFIDENTIAL

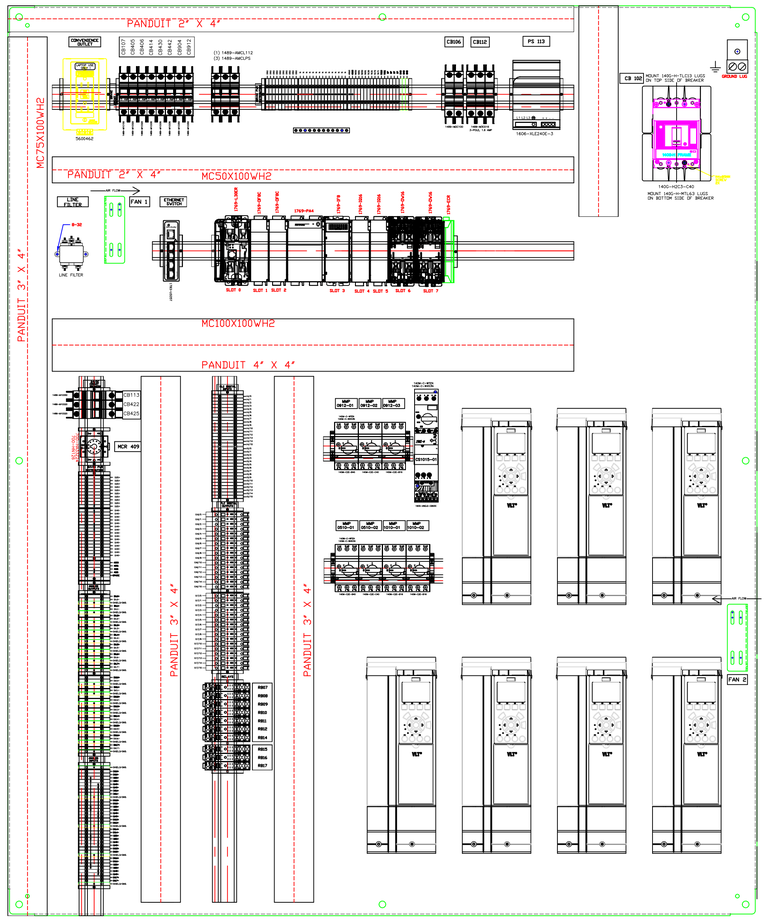
REV. #	DATE	DESCRIPTION	BY

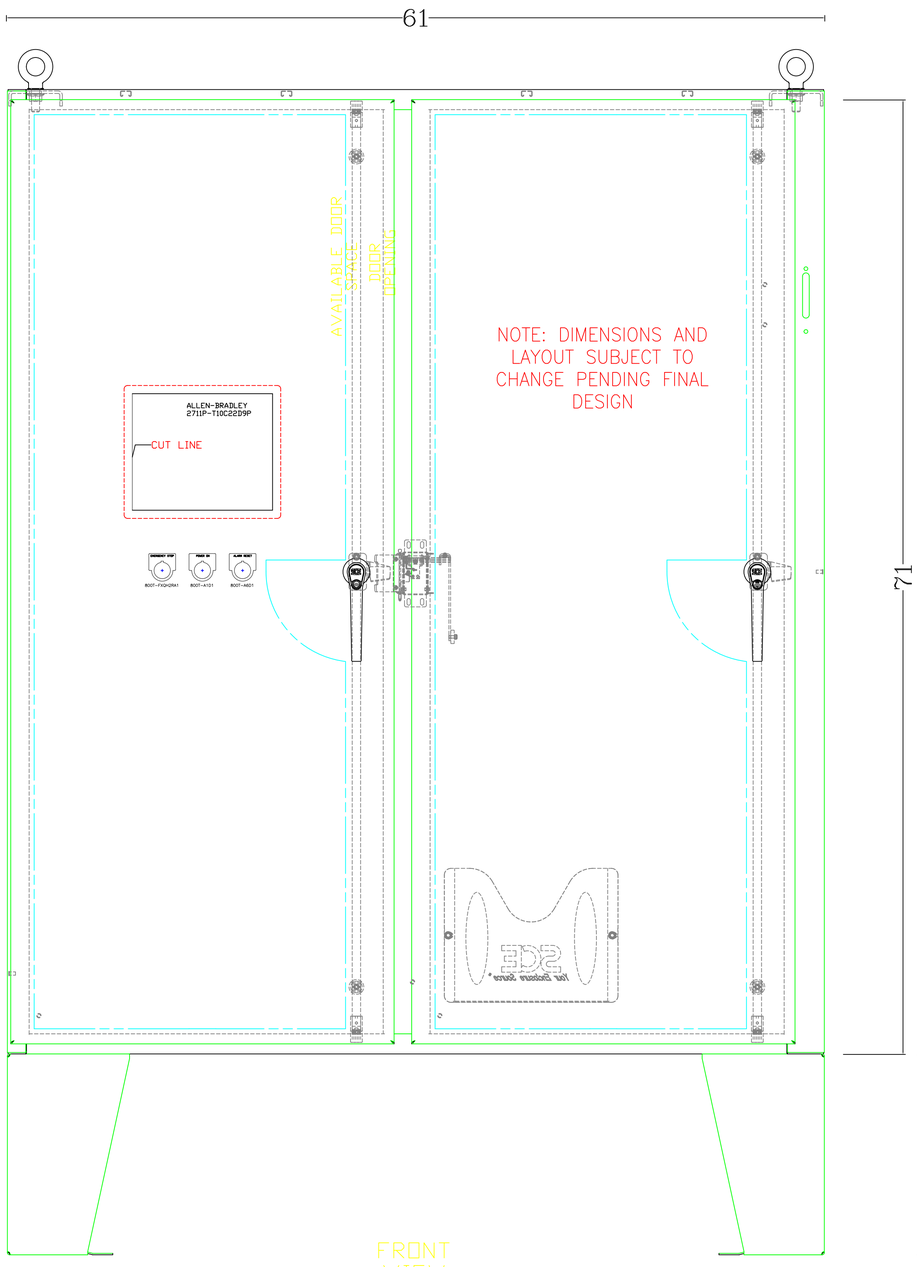
World water works
1-800-467-PURE
4000 SW 113th • OKLAHOMA CITY, OK 73197

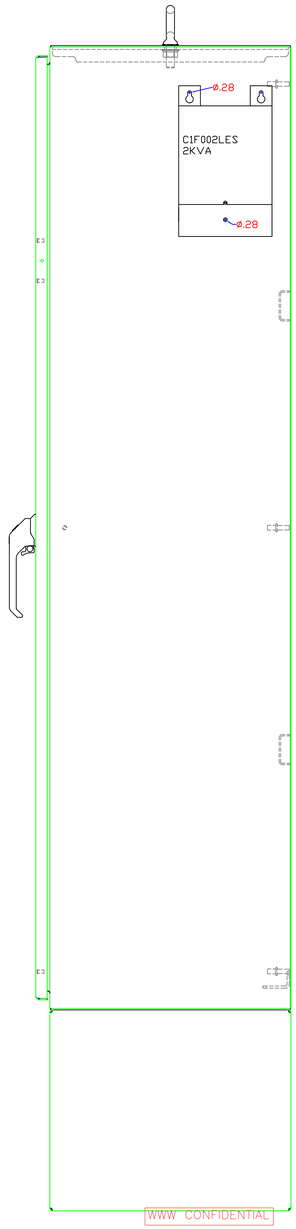
CLIENT: TWINCRAFT SKINCARE
LOCATION: ESSEX, VT
FILE NAME: HEIA KEA BASE PRELIMINARY ELECTRICAL 208V MOTORS.DWG
DRAWING DESCRIPTION: ELECTRICAL PRINTS

FOR APPROVAL

P.O.#: TBD
DRAWN BY: CST
CHECKED BY:
DATE: 02/28/2018
SCALE: NONE
JOB #: TBD
DRAWING # 0810
SHEET: 10 OF 13 SHEETS







REV.	DATE	DESCRIPTION	BY

World water works
1-800-607-PURE
4000 SW 113th • OKLAHOMA CITY, OK 73157

CLIENT: TWINCRAFT SKINCARE
LOCATION: ESSEX, VT
FILE NAME: HEIA KEA BASE PRELIMINARY ELECTRICAL 208V MOTORS.DWG
DRAWING DESCRIPTION: ELECTRICAL PRINTS

FOR APPROVAL

P.O.#: TBD
DRAWN BY: CST
CHECKED BY:
DATE: 02/28/2018
SCALE: NONE
JOB #: TBD
DRAWING # 0811
SHEET: 11 OF 13 SHEETS

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BILL OF MATERIALS IS TO BE DETERMINED

REV. #	DATE	DESCRIPTION	BY

World Water Works
1-800-607-PURE
4000 SW 113th • OKLAHOMA CITY, OK 73197

CLIENT: TWINCRAFT SKINCARE
LOCATION: ESSEX, VT
FILE NAME: HEEIA KEA BASE PRELIMINARY ELECTRICAL 208V MOTORS.DWG
DRAWING DESCRIPTION: ELECTRICAL PRINTS

FOR APPROVAL

P.O.#: TBD

DRAWN BY: CST

CHECKED BY:

DATE: 02/28/2018

SCALE: NONE

JOB #: TBD

DRAWING # 0812

SHEET: 12 OF 13 SHEETS

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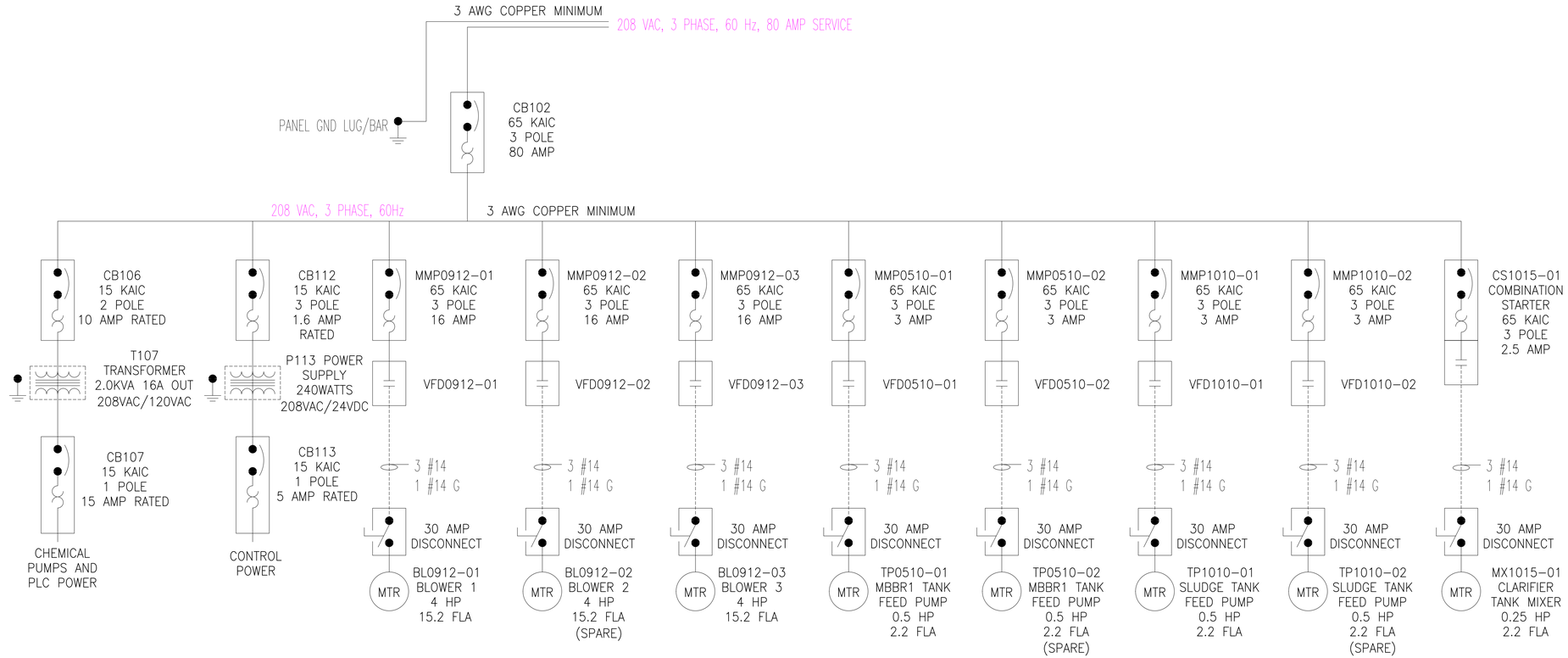

NOTES:

1. PROPERLY SIZED EQUIPMENT GROUNDING CONDUCTORS SHALL BE INSTALLED IN ALL CONDUITS INCLUDING SINGLE AND THREE PHASE.
2. ALL WIRE SIZE MUST BE VERIFIED FOR FINAL INSTALLATION.

REV. #	DATE	DESCRIPTION	BY

World water works
1-800-467-PURE
4000 SW 113th • OKLAHOMA CITY, OK 73197

CLIENT: TWINCRAFT SKINCARE
LOCATION: ESSEX, VT
FILE NAME: HEIA KEA BASE PRELIMINARY ELECTRICAL 208V MOTORS.DWG
DRAWING DESCRIPTION: ELECTRICAL PRINTS

FOR APPROVAL

P.O.#: TBD
DRAWN BY: CST
CHECKED BY:
DATE: 02/28/2018
SCALE: NONE
JOB #: TBD
DRAWING # 0813
SHEET: 13 OF 13 SHEETS