TETRA TECH

Operations and Maintenance Manual

Chesterfield Inlet Water Transmission Line and Pioneer PP64C14L71 Pump

Rev	Date (yyyy-mm-dd)	Prepared By	Insert Name	Reviewed By	Insert Name	Approved By	Insert Name
00	2020-10-16		Marc Lau		Mike Lam		David Moschini

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APPENDICES

1.0 PURPOSE

The purpose of this document is to provide the Government of Nunavut (GN) and the Hamlet of Chesterfield Inlet (the Hamlet) an Operation & Maintenance (O&M) Manual for the Water Transmission Line and Pioneer PP64C14L71 Pump System. The Water Transmission Line and Pioneer Pump System were installed in the summer of year 2020 by Inukshuk Construction Limited (ICL) and designed by Tetra Tech Canada Inc. (Tetra Tech) for the Government of Nunavut (GN) and the Hamlet of Chesterfield Inlet (Hamlet).

This O&M Manual will provide figures and site photographs where applicable to demonstrate acceptable installation conditions, operating conditions, start-up and shut-down procedures, troubleshooting of typical problems, and recommendations on maintenance. This O&M Manual also includes appendixes of the system's record drawings, manufacturer's manuals, shop drawings and suppliers' contact information.

Prior to operating the pump system, it is important for the operator to be familiar with the pump system and its control panel. Tetra Tech recommends any operator to review and familiarize him or herself with the manufacturer's manuals attached with this document. This document is not intended to replace the materials and procedures described in the manufacturer's manuals. This document is intended to guide operator on site set-up, connections and specific maintenance items that may not have been covered by the manufacturer's manuals.

2.0 SCOPE AND INTRODUCTION

The record drawings based on Contractor's as-built survey are included in Appendix A for reference. A list of suppliers and their contact information are included in Appendix B. Pioneer's pump O&M Manual is included in Appendix C. The manufacturers' manuals for the flow meter and air release valve are included in Appendix D and E.

In Section 3.0 - Installation, this guide will provide step-by-step instructions on how to assemble and disassemble the pump system between each of Chesterfield Inlet's annual pumping periods.

In Section 4.0 - Operation, this guide will provide recommendations for pumping speed, re-fueling, signs of issues, and troubleshooting of common problems.

In Section 5.0 - Maintenance, this guide will provide recommendations for upkeep of the pumping system, including the pump itself, the pumping pad, and the pipeline.

3.0 SET-UP AND INSTALLATION

3.1 TRANSPORTATION TO PUMP PAD

The Pioneer Pump PP64C14L71 system is mounted on a single-axle, rubber tire trailer with a towing hitch. It is recommended that a light-duty pickup truck be used to tow the trailer from the Hamlet Garage to the pumping pad. By nature, the gravel service road leading to the pumping pad is rough with occasional dips and boulders to be avoided, if possible. Towing at a low speed (i.e. less than 30 km/hour) will lower the risk of the pump suffering internal damage due to road vibrations.

Upon nearing the pumping pad, the truck and trailer will have to be reversed into place. The nearest turnaround point is an access road located on the south side of Detroit Road. From here, a three-point turn can be performed to turn the trailer around and reversed into place to the pumping pad. If more turning space is required, a wider access road is located on the north side of Detroit Road, approximately 100 meters to the east; however, this will require driving with the trailer in reverse over a longer distance. The turnaround locations and routes are shown in Figure 3-1 and Figure 3-2 respectively.

Precaution should be taken not to drive the truck on top of the pad if possible while delivering the pump, as this may cause ruts on the pad due to the loading of the tires.

Figure 3-1: Turnaround Locations

Figure 3-2: Turnaround Routes

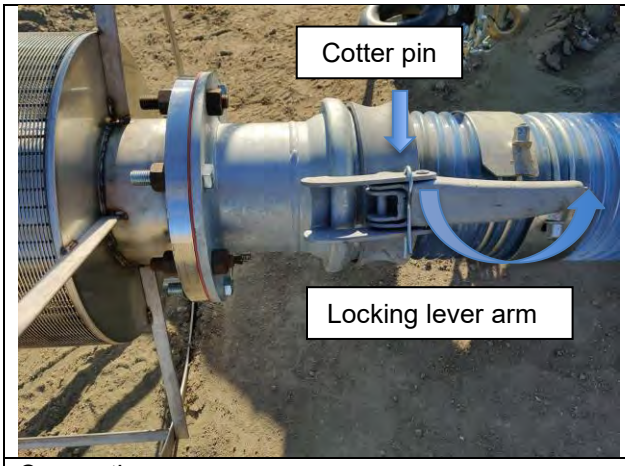
3.2 SUCTION HOSE INSTALLATION

A 200 mm diameter, clear flexible hose connects the suction end of the pump to the stainless-steel screen placed in the lake. The hose uses a Camlock connection on either ends. The Camlock fitting has been pre-installed on the flexible hose, allowing for quick-release of the connection without the need of bolting flanges.

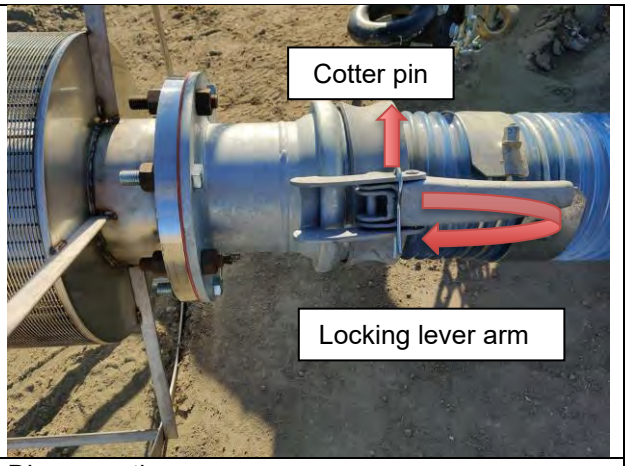
3.2.1 Connection and Disconnection

Ensure pressure is released and pipe is drained before disconnecting the suction hose. To release the Camlock connection, remove the cotter pin holding the locking lever arms in place. This cotter pin should be left in place during normal operation to prevent accidental disconnection as shown in Figure 3-3.

Once removed, pull down with equal force on each of the two locking lever arms to release the hose. It is recommended that two staff are on hand to release the lever arms, since considerable force is required to release the connection as shown in Figure 3-3.



Connection



Disconnection

Figure 3-3: Suction Hose Connection

The same procedure described for the suction end is applicable to the pump intake end of the hose. Note that the locking lever arm assembly is on the pump intake flange, rather than on the hose as shown in Figure 3-4.

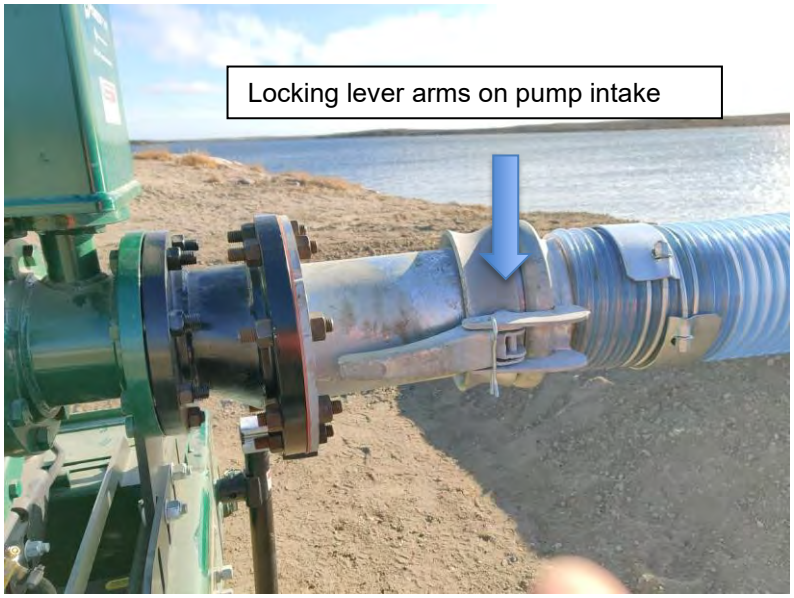


Figure 3-4: Locking Level Arms on Pump Intake

3.2.2 Placement of Intake Hose into Water Source

As per manufacturer recommendations, the suction intake hose should be submerged in water to a depth at least 5 times the diameter of the hose. For the installed 200 mm suction hose, this will be a minimum submerged depth of 1 m.

To place the hose into the source lake, a boat may be used to carry the intake end of the suction hose offshore to deeper water. A motorized boat would be preferable due to the weight of the suction hose and screen assembly. Before inserting the screen and hose into the water, a sturdy rope should be tied to either a buoy, or a tie-off onshore to allow the Hamlet to retrieve the screen and intake at the end of pumping as shown in Figure 3-5. Retrieval from the shore of the intake screen should be done gently to avoid damaging the screen.

Figure 3-5: Submerged Pump with Attached Rope for Retrieval

3.3 CENTERING AND LEVELING OF PUMP

It is essential to center and level the pump on the pad before connecting the pump with the pipeline as shown in Figure 3-7. This will ensure that flow through the pump remains smooth without cavitation (discussed in 4.0 – Operation), and the intake and outlet to the pipeline are properly aligned. This will reduce overall strain on the 150 mm discharge pipe.

Figure 3.7: Pump Centered within the Pumping Pad

The trailer footings should be extended to the ground, and their heights should be adjusted using the cranks to level the pump trailer. There is one footing on the hitch end of the trailer, and two footings on the intake end of the trailer. Both trailer wheels should also be blocked with wheel blocks to prevent the pump from rolling during operation. A Steel Flex Connector with flanged ends was supplied to allow for more flexible connections between the pump and the HDPE water line as shown in Figure 3-4.

Figure 3-4: Steel Flex Connector

As explained later in Section 4.5.3 – Troubleshooting, the trailer can be moved as far as the toe of the confining embankment in the case that the pump is having difficulty producing adequate suction.

Each relocation of the pump should be followed by a check for levelling. Extend trailer footings to ground surface and use cranks to level the pump at the front and back. Block both wheels to prevent trailer from rolling. Figure 3-6 below shows the adjustable height footings and wheel blocks for the pump.

Figure 3.6: Pump Trailers with Footings and Wheel Blocks

4.0 SYSTEM OPERATION AND MAINTENANCE

Prior to operating the pump system, it is important for the operator to be familiar with the pump system and its control panel. The pump operator must review and familiarize him or herself with the manufacturer's manual attached in Appendix C prior to operating the system.

Figure 4-1 below shows the MPC-10 Engine Controller and TEC-10 Panel, which is the main keypad for engine ignition and throttle adjustments. The operator shall refer to the manual for this keypad attached in Appendix C for further details.

Figure 4-1: Descriptions of Engine Control Keypad

4.1 PRE-STARTUP CHECK

4.1.1 Checklist Before Day of Pumping

1. Remove flange cover plates from both ends of the HDPE pipeline (the one close to the pump pad and the one close to the reservoir).
2. Disconnect the bolted flange connection located just before the final length of HDPE pipe at the reservoir fence. Then, attach the flexible hose to the end of the pipeline (see Figure 4-2).
3. Remove the concrete covers over the pipeline valves and air-release valves allowing for a visual inspection.
4. Ensure all drain valves are open allowing to flush the pipeline following the starting procedure.
5. Make sure the end of the pipeline is pointed away from the reservoir to allow for the initial flushing of the pipeline.
6. Install equipment heater on pump if ambient air temperatures are below freezing.
7. Perform a walkthrough along the pipeline, pump, and pad as described in Section 4.1.2 and 4.1.3. below.

4.1.2 Pipeline Walkthrough

Before starting the pump, a walkthrough should be conducted along the entire length of the pipeline to check for the following:

1. Visible damage or evidence of damage to the pipeline (e.g. cracks, leaks, abrasion, vehicle tracks over pipeline, animal scratch or bite markings)
2. Pipeline off original alignment (e.g. due to seasonal expansion/contraction, vehicles driving over pipeline, erosion of pad)
3. New sag points or high points without accompanying drain or air-release valves
4. Loose bolts and/or damaged O-rings at flange connections
5. Warping or deformation of pipe shape at any point
6. Frost and/or ice formation on or around the pipe and/or joints
7. Flooding or debris in valve boxes

Any of these items should be addressed before starting the pump, as pressurizing the line will exacerbate these existing issues.

4.1.3 Pump and Pad Walkaround

At the pumping pad, an inspection should be performed to check the following items:

1. Signs of erosion of the pumping pad and/or its surrounding embankment
2. Signs of oil or fuel deposit on the pumping pad
3. Signs of water ponding on the pumping pad
4. Exposed geotextile or impermeable plastic liner, and signs of damage on the geotextile or liner
5. Sunken spots on the pumping pad due to loading of trailer or vehicles

It is recommended that these issues are addressed before delivering the pump to the pad to allow equipment to maneuver and perform repairs.

4.1.4 Adequate Conditions for Pumping

Timing of the annual pumping period may depend on the height of reservoir level and the needs of the Hamlet. However, operating the pump while the ambient air temperature is above freezing (i.e. higher than 0 °C) will reduce the risk of ice forming and creating clogs in the pipeline. It is also optimal if pumping does not occur during a heavy rain period, as erosion of the banks at the intake source may create some turbidity in the water and also potentially create sediment clogs in the pipeline.

The pump system should not be operated when the ambient temperature is below 0°C. If pumping must be performed while the ambient temperature is close to freezing temperature (i.e. less than 3 °C), an equipment heater should be used to ensure the pump is free of ice before starting, and the suction hose intake should be submerged well below any surface ice formation as shown in Figure 4-3. Heater may have to be used for over 4 hours to ensure pump is free of ice.

Figure 4-2: Flexible Hose Attached to End of Pipeline During Flushing

Figure 4-3: Equipment Heater Covering Pump System for Ice Melting

4.2 STARTUP PROCEDURE

4.2.1 Suction Phase

The Pioneer Pump PP64C14L71 operation pad is located next to the suction hose intake. There is a turn-key activation switch which will unlock the pump's ignition. Ensure that the suction chamber valve is open before starting the pump. Before pumping can begin, the pump must remove air from the suction hose and pump to generate a vacuum to draw water into the intake (i.e. priming). To do this, the priming valve must be open so that air trapped in the suction hose can be evacuated as shown in Figure 4-4. The priming valve should be open while priming the pump and closed during normal pump operation.

Figure 4-4: Suction Chamber Discharge Valve

Once turned to the "On" position (clockwise), the operator shall hold down the green ignition button until the pump engine starts as shown in Figure 4-5. The engine will start and level off by default at the idling minimum speed of approximately 800 Revolutions Per Minute (RPM). The pump should be left at this speed while the vacuum pump generates suction. Observe the clear suction hose until water can clearly be seen entering the pump. Once the suction hose has been fully filled with water, and the pump has been given time to fill with water (approximately 10 seconds after the water reaches the pump intake), the priming valve may be closed.

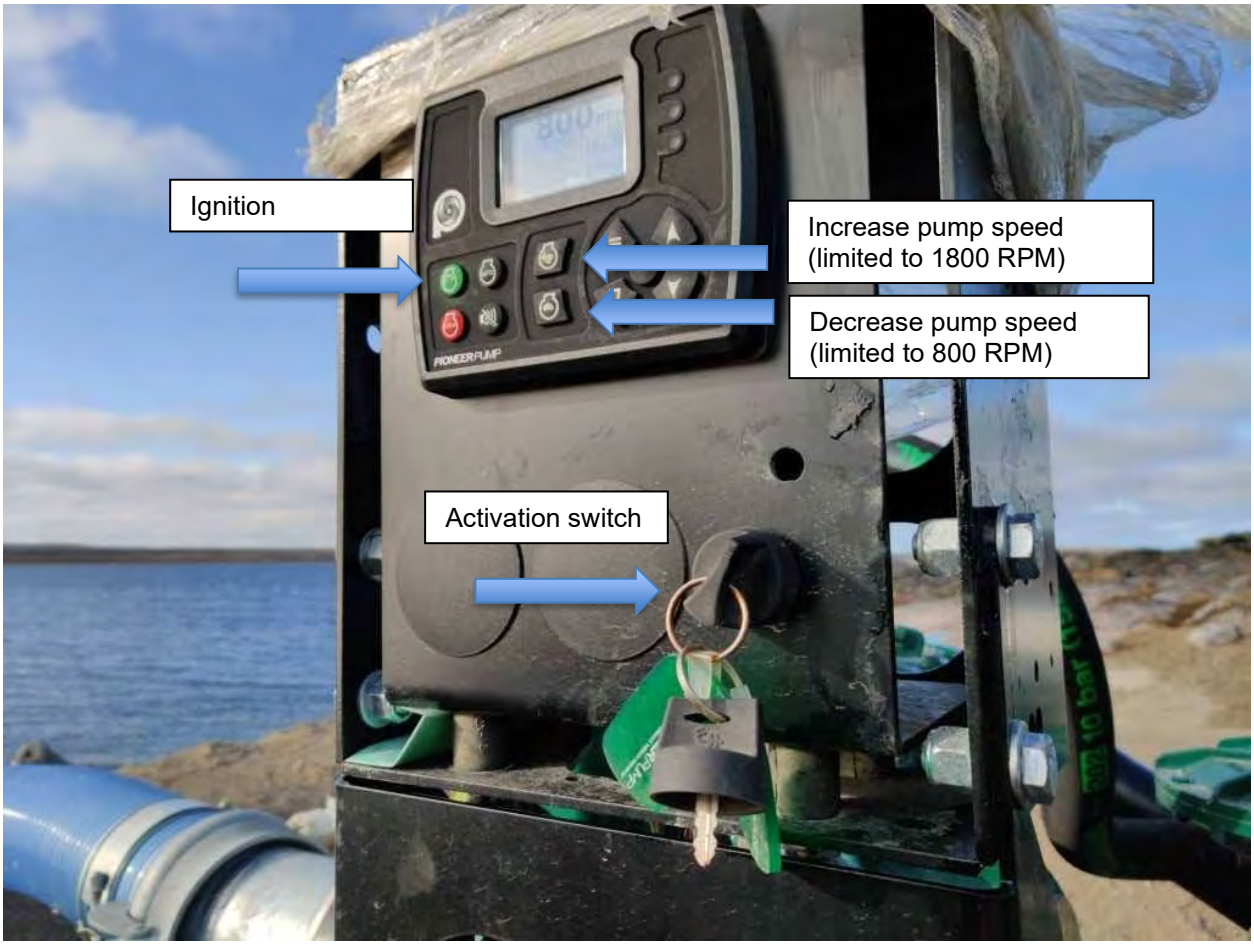


Figure 4-5: Pump Control Panel with Activation Switch in "On" position (clockwise)

4.3 FILLING PHASE

During the pipeline filling phase, the pump speed shall be gradually increased to 1800 RPM using the "Manual Throttle Increase Key" on the operation panel (see Figure 4-1 and Figure 4-5 for key location). The system will not allow the pump to exceed the design maximum of 1800 RPM. If the pump is failing to pump water, turn off the pump and check the intake and the outlet end of the pump. The screen and the suction hose should also be inspected to make sure the are not blocked. It is very important to check the suction hose for damage. Cracks or tears in the suction hose will allow air bubbles to enter the suction pump and will, over time, damage the impeller (blades) of the pump.

As the pipeline begins to fill with water, a walk-through along the pipeline should be conducted to ensure no leaks are observed, and all drain and air-release valves are operating normally. The drain valves should be closed as the operator moves closer to the reservoir. Close each valve promoting the movement of greater flows through the main pipeline until all the valves are all closed. This will allow the pipeline to flush out any debris/sediments trapped in the pipeline. Some leakage may be observed at air-release valves during the pipe filling phase. At the time of the first system commissioning, the time to fill the pipeline was approximately 30 minutes. If water is taking an excessively long time to reach the reservoir, this may signal

the presence of a blockage or leak along the pipeline. Inspect the pipeline and use the drain valves to isolate/identify the problem section. Review air-release valves for signs of leakage. It is expected for some water to discharge through the air vents during the filling phase as air bubbles escape the system initially. However, it is expected that water discharge should stop after approximately 20 minutes as the pipeline gets filled. Figure 4-6a below shows a typical drain valve box, while Figure 4-6b shows a typical air release valve box. The concrete covers can be lifted off to inspect the valves for issues.

Figure 4-6a: Typical drain valve box

Figure 4-6b: Typical air release valve box

4.4 FLUSHING PHASE

The purpose of the flushing phase of the pipeline is to clear the pipeline of debris, sediment, or potential ice in the line before the water can be directed into the reservoir. Flushing should be done for approximately 1 hour after the pipeline is filled. The water pumped during the initial flushing phase should be directed away from the reservoir.

Before flushing, disconnect the final length of HDPE pipe leading to the reservoir. Connect a flexible hose using a Camlock adapter and direct the hose towards the low-lying area to the south. Ensure that the hose extends well past the toe of the gravel pipe pad to prevent erosion as shown in Figure 4-7. Flushing of the pipeline for at least 1 full hour is required to ensure no debris remains in the pipe.

Figure 4-7: Flushing of Pipe System

4.5 OPERATION PHASE

4.5.1 Pump Speed

As per manufacturer the design of the system, the pump is limited to an operating range between 800 and 1800 RPM. At 1800 RPM, the pump is operating at a speed which produces the best balance of flow and fuel consumption. The pump will not exceed 1800 RPM, if flows are not sufficient at the maximum output of 1800 RPM, the system should be reviewed and the pump supplier should be contacted.

4.5.2 Flow Rate Monitoring

The pump has come pre-installed with a Seametrics iMAG 4700 Series Flanged Magmeter. The meter records cumulative flow for a given pumping session, and real-time flow rate in either gallons or liters per minute. The units of measurement can be changed using the arrow controls located below the LCD screen on the unit as shown in Figure 4-8 below.

Figure 4-8: Flow Meter Display

Detailed instructions of the flow meter menu and operation can be found in Seamterics' operations manual included as Appendix D. An excerpt of the key functions is provided below for convenience:

Changing Flow Meter Settings

Home Screen and General Navigation

The HOME Screen displays flow volume, direction of the flow total and flow RATE along with status conditions such as Empty Pipe. Two buttons below the LCD display are used to access menu screens for viewing and changing meter setup parameters.

These two buttons are light sensors which can detect when a finger is covering them and activate upon release. Only three button touch actions are needed to control navigation through the menus, settings changes and back to the home screen.

HORIZONTAL SCROLLING:
Tap right button to scroll horizontally through menu tabs or move horizontally within a tab dialog when applicable.

SELECT:
Tap left button to change a highlighted item within a tab dialog.

ENTER/EXIT:
Hold left button while tapping right button once to enter or exit a tab dialog or to navigate between the HOME and other menu screens.

Changing Total Direction/Resetting Totalizers

On the Main screen, tap ▲ to select the direction of the total display. To reset BATCH FWD or BATCH REV, select with ▲ and then tap ▶ four times.

Entering Menu System

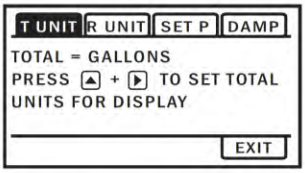
To enter the Menu System perform the hold and tap sequence. The Passcode entry screen will display. The default passcode is 000000. If a different passcode has previously been set, use the ▲ and ▶ to enter that passcode. In either case, hold and tap again to move into the menu system. (*If you enter the wrong passcode, hold and tap again to return to the previous screen. See page 21 for information on how to change a passcode.)*

Making Selections

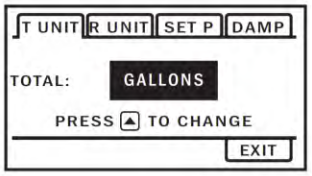
Once in the Menu System, move from tab to tab by tapping the right button. (See the next page for details on the various available tabs.)

Select the parameter. In the screen for the highlighted tab you will see the current parameter value for that tab. Tapping the right button, move to the tab for the parameter you want to change.

In this example, the first line indicates that the current unit for the TOTAL is GALLONS. The next two lines tell you what to do next.



If you would like to change the TOTAL units, just perform the hold and tap sequence to bring up a screen to change the setting.



Select a new setting. Select the new setting by scrolling through a list of selections as in the screen illustration below by tapping the left button to find a different TOTAL unit.

Accept changes. To accept any changes you have made, perform the hold and tap sequence.

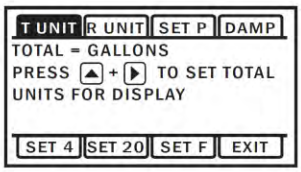
When finished making changes. When you are finished making changes, move to the EXIT tab using the right button.

To return to the HOME screen, perform the hold and tap sequence.

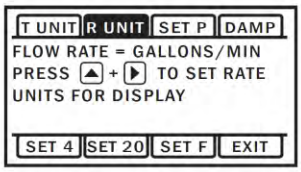
Standard Menu Options

Note: Available options will depend on specific meter configuration. Not all options are available on all meters.
Options not ordered with your meter will not appear on the meter menu.

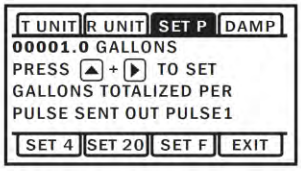
T UNIT
View or change TOTAL volume units



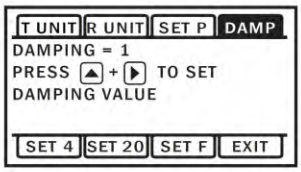
R UNIT
View or change flow RATE units



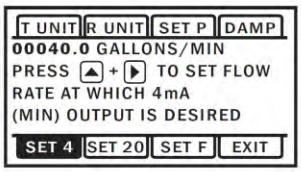
SET P
View or change pulse output scaling



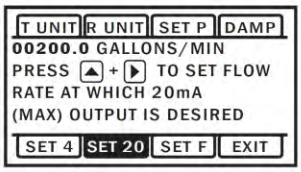
DAMP
View or change # of seconds for rolling average.
(0=1 second, 1=2 seconds, etc.)



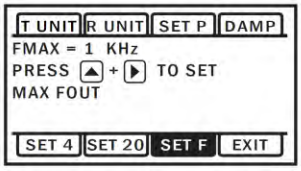
SET 4
View or change flow rate corresponding to 4mA.



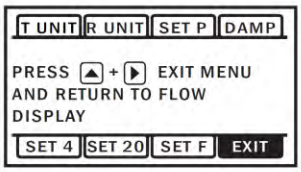
SET 20
View or change flow rate corresponding to 20mA.



SET F
View or change high frequency output scaling.



EXIT
Return to HOME SCREEN or enter SUBMENU



Special SUBMENU for Further Options

The EXIT tab in the MAIN MENU has a second function. If, instead of using the hold and tap sequence to return to the HOME screen, you tap ▲ five times, you will be redirected to a SUBMENU screen from which you can access several more options.

Navigation in this SUBMENU is the same as for the MAIN MENU. Whenever you wish, go to the EXIT tab in the SUBMENU and perform the hold and tap sequence to return to the MAIN MENU.

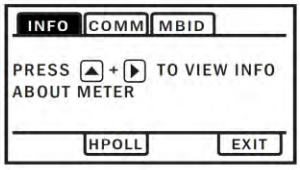
INFO: Meter model number, serial number, and firmware version.

COMM: Modbus® baud rate and parity.

MBID: Modbus® address

HPOLL: HART Address

EXIT: Return to MAIN MENU.



Sub-Menu

4.5.3 Troubleshooting

4.5.3.1 Cavitation

Cavitation occurs due to insufficient pressure at the suction end of the pump. This causes bubbles to form and collapse violently at the pump impeller, causing pump vibration and mechanical damage to the blades of the impeller. Cavitation can be seen through the clear suction hose as large bubbles forming just before the intake of the pump. An example can be seen in Figure 4-9 below.

Figure 4-9: Example of Cavitation

Source: TecQuipment (https://www.tecquipment.com/fluid-mechanics/vortices-and-cavitation)

During each startup of the pump, the intake should be inspected for signs of cavitation. A flowchart is provided below as Figure 4-10 to diagnose potential cavitation and provides several solution paths.

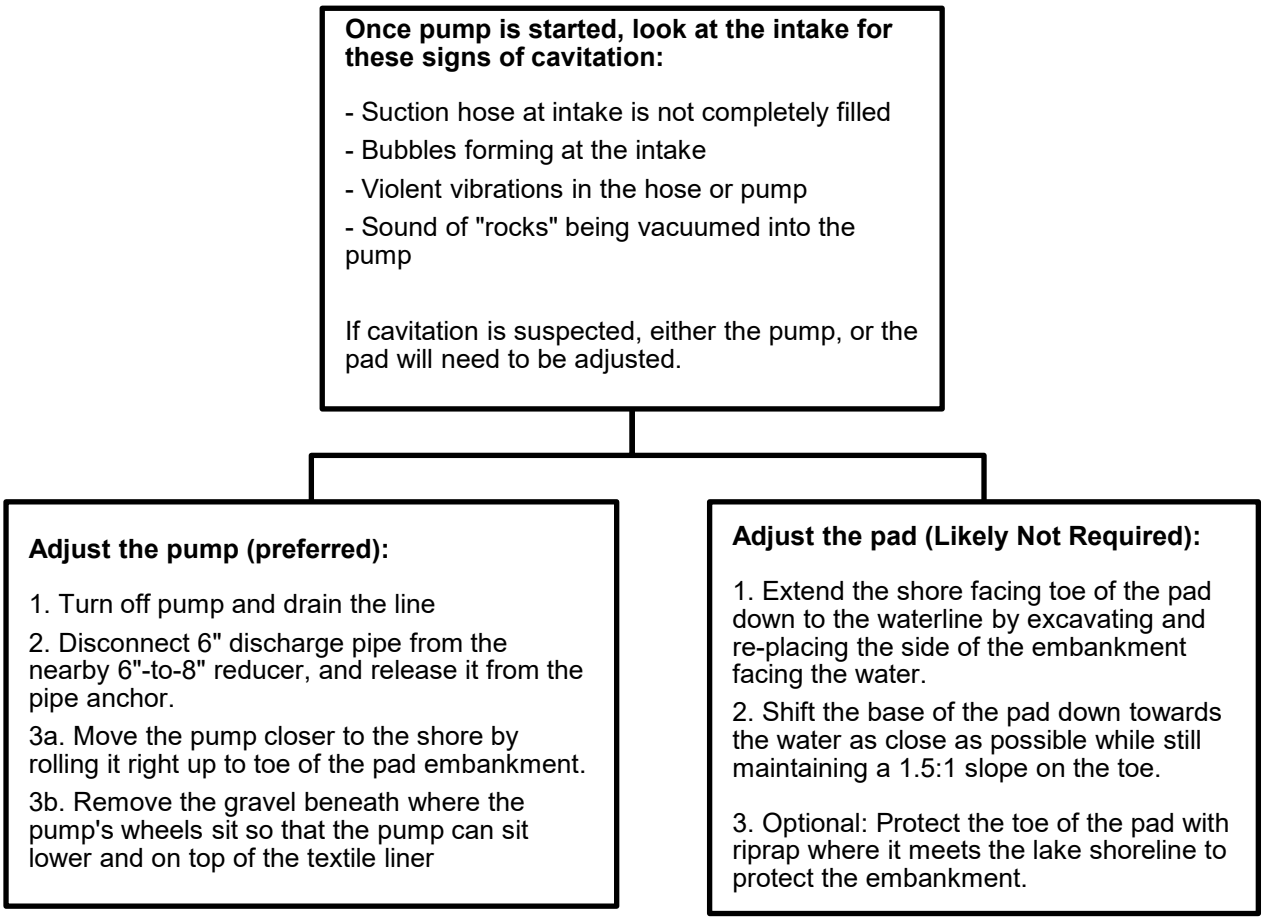


Figure 4-10: Flow Chart for Cavitation Causes

4.5.3.2 Pipe Clog

Signs of a pipe clog include reduced flow rate at the reservoir outlet, debris in the discharged water, sounds of objects hitting the inside of the pipe, and vibration or movement on one side of a pipe section but not the other side. A clog may be cleared by flushing the line using the maximum pump speed (1800 RPM), and discharging away from the reservoir.

4.5.3.3 Manufacturer Provided Troubleshooting

A more exhaustive list of potential troubleshooting solutions can be found in the Pioneer Pump's Owner's Manual attached in Appendix C. The following page is a copy of the "Troubleshooting Table" from the manual.

TROUBLESHOOTING

Symptom	Possible Causes	Symptom	Possible Causes
No Discharge	1,2,3,4,5,7,8,9,10,17,18,19,20, 37	Vibration and noise	2,4,9,10,14,15,17,26,27,28,29 30,31,32,33,34,35,36,39,40, 41,42,43,44,48
Reduced Capacity	2,3,4,5,7,8,9,10,11,17,19,20,21,383 9,40,47	Seal: excessive leakage, short life, seal housing overheating	22,23,25,33,34,35,36,41,44, 45,46
Reduces Pressure	5,7,8,11,13,18,19,38,39,40,47		
Loss of Prime	2,3,4,7,10,11,20,21,22,23	Bearings: over heating, short life, noise	26,27,28,29,30,31,32,33,34, 35,36,41,42,43,44
Power consumption excessive, driver runs hot	6,12,13,17,18,19,24,33,34,35,3637, 38,41,42,43,44	Pump overheating, seizes	1,8,9,14,33,34,35,36,41,42,43, 44
		Corrosion, erosion, pitting, oxidation or other loss of material	7,8,11,14,15,16

1. Pump not primed
2. Suction line not filled
3. Air pocket in suction line
4. Suction inlet or foot valve obstructed, insufficiently submerged, or too small
5. System head higher than pump design head
6. System head lower than pump design head
7. Insufficient NPSH
8. Parallel pump application is incorrect
9. Suction pressure to vapor pressure below minimum
10. Suction lift too high
11. Excess vapor in pumpage
12. Specific gravity of pumpage different than design
13. Viscosity of pumpage different than design
14. Operation at below rated capacity
15. Cavitation
16. Electrolysis
17. Impeller obstructed with foreign material
18. Rotation direction wrong
19. Low speed
20. Air leak into suction line
21. Air leak through mechanical seal
22. Seal fluid contaminated, hot or insufficient
23. Seal fluid system not vented
24. High speed
25. Mechanical seal insufficient
26. Bearing housing excessively cooled
27. Low oil pressure (oil lube bearings)
28. Improper or poor lubrication
29. Lubrication defective
30. Dirt in lubrication/bearings
31. Moisture in lubricant/bearing housing
32. Lubricant excess
33. Pipe strain
34. Temperature growth
35. Misalignment
36. Coupling improperly installed
37. Impeller installed backwards
38. Worn wear rings
39. Impeller damage
40. Improper balance (after repair)
41. Bent shaft
42. Excessive thrust
43. Rotational element dragging
44. Worn or incorrectly installed bearings
45. Mechanical seal not properly set, O-rings damaged or hardened
46. Shaft scored at seal
47. Volute O-ring
48. Foundation not rigid or settled

4.6 SHUTDOWN PHASE

Prior to shutting down the pump by switching off the pump, it is recommended to gradually reduce the speed of the pump to the idling 800 RPM by using the “Manual Throttle Decrease Key” on the operation panel (see Figure 4-1 and Figure 4-5 for key location).

4.6.1 Pipeline Draining

Prior to winterising the pipeline, the entire pipeline should be allowed to drain completely. To do this open all the drain valves and allow these to drain the main line.

4.6.2 Disassembly

Once the pipe and pump are fully drained, the pipeline may be disconnected from the pump intake (suction hose) and at the outlet pipe (6” elbow shown in Figure 4-11 below). Slowly release the pressure at the pipeline tie-in by partially loosening the bolts on the flange connection and allow any trapped water to drain out the last section of the pipeline. Do not fully disconnect the pipe right away. The water should be allowed to slowly discharge and drain around the toe of the pumping pad to prevent erosion.

Figure 4-11: Flange connection at pump’s tie-in to pipeline. During disassembly, the bolts should be partially loosened to allow trapped water to drain before fully disconnecting the pipe to avoid eroding the pumping pad

4.6.3 Winterising the Pipeline

Once the pipeline is drained, close all the drain valves and reinstate the concrete covers over the concrete chambers protecting the valves. Avoid dropping the concrete covers on the valves at the weight of these will likely damage the valves.

Cap each end of the pipeline.

4.6.4 Storage

The pump, suction hose, and screen should be stored indoors in a sheltered area over the winter to reduce exposure to potential corrosion and degradation of the parts due to extreme cold and freeze-thaw cycles. It is Tetra Tech's understanding that, upon its departure in 2020, the Hamlet has stored the pump, suction hose, and screen in the Hamlet garage. Always cap each end of the pump system.

In the case that the pump must be stored elsewhere in the future, the following conditions should be met by any future storage location:

1. Equipment is well off the ground so no water will accumulate around the equipment
2. Equipment is protected from blowing sand, gravel, or other debris
3. Nothing is stacked on top of the equipment
4. Equipment is sealed away from the access of insects or other pests.

APPENDIX A

RECORD DRAWINGS

WATER TRANSMISSION LINE DESIGN
CHESTERFIELD INLET, NUNAVUT

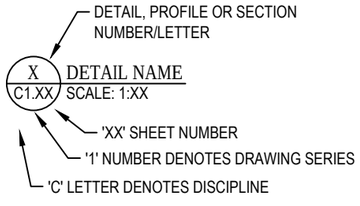
SITE LOCATION
SCALE: NTS

CLIENT		PROJECT NO.	OFFICE	DES	CKD	REV	DRAWING
Nunavut	TETRA TECH	WTRM03121-01	VANC	DNM	DNM	1	G1.00
		DATE	SHEET No.	DWN	APP	STATUS	
		November 20, 2020	of	JDM	DNM	REC	

DRAWING INDEX	
DWG No.	DESCRIPTION
G1.00	COVER SHEET
G1.01	DRAWING INDEX AND LEGEND
C1.00	KEY PLAN
C1.01	PLAN AND PROFILE
C1.02	PLAN AND PROFILE
C1.03	PLAN AND PROFILE
C1.04	PLAN AND PROFILE
C1.05	PLAN AND PROFILE
C1.06	PLAN AND PROFILE
C1.07	PLAN AND PROFILE
C1.08	PLAN AND PROFILE
C1.09	PLAN AND PROFILE
C1.10	PLAN AND PROFILE
C2.00	PUMPING PAD - PLAN
C2.01	PUMPING PAD - SECTIONS
C3.00	TYPICAL SECTION AND DETAILS
C3.01	DETAILS

LEGEND

- PROPERTY LINE
- WATERBODY
- STREAM
- EXISTING FENCE
- EXISTING PIPELINE
- EXISTING ROAD
- EXISTING TRAIL
- EXISTING CULVERT



NOTES:

1. *These drawings were prepared for the exclusive use of the Government of Nunavut (GON) and are issued pursuant to the services agreement between the client and Tetra Tech Canada, unless otherwise agreed in writing with the client or specified on these drawings. Tetra Tech Canada does not accept and disclaims any and all liability or responsibility arising from any use or reliance on these drawings by any third party or any modification or misuse of these drawings by the client. These drawings remain the intellectual property of Tetra Tech Canada.*

NUM	DATE	DWN	CKD	APR	DESCRIPTION
1	11/20/20	JDM	ML	DNM	RECORD DRAWING
0	11/12/19	JDM	ML	DNM	ISSUED FOR CONSTRUCTION

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WATER TRANSMISSION LINE DESIGN
CHESTERFIELD INLET, NUNAVUT

DRAWING INDEX AND GENERAL NOTES

PROJECT NO.	OFFICE	DES	CKD	REV	DRAWING
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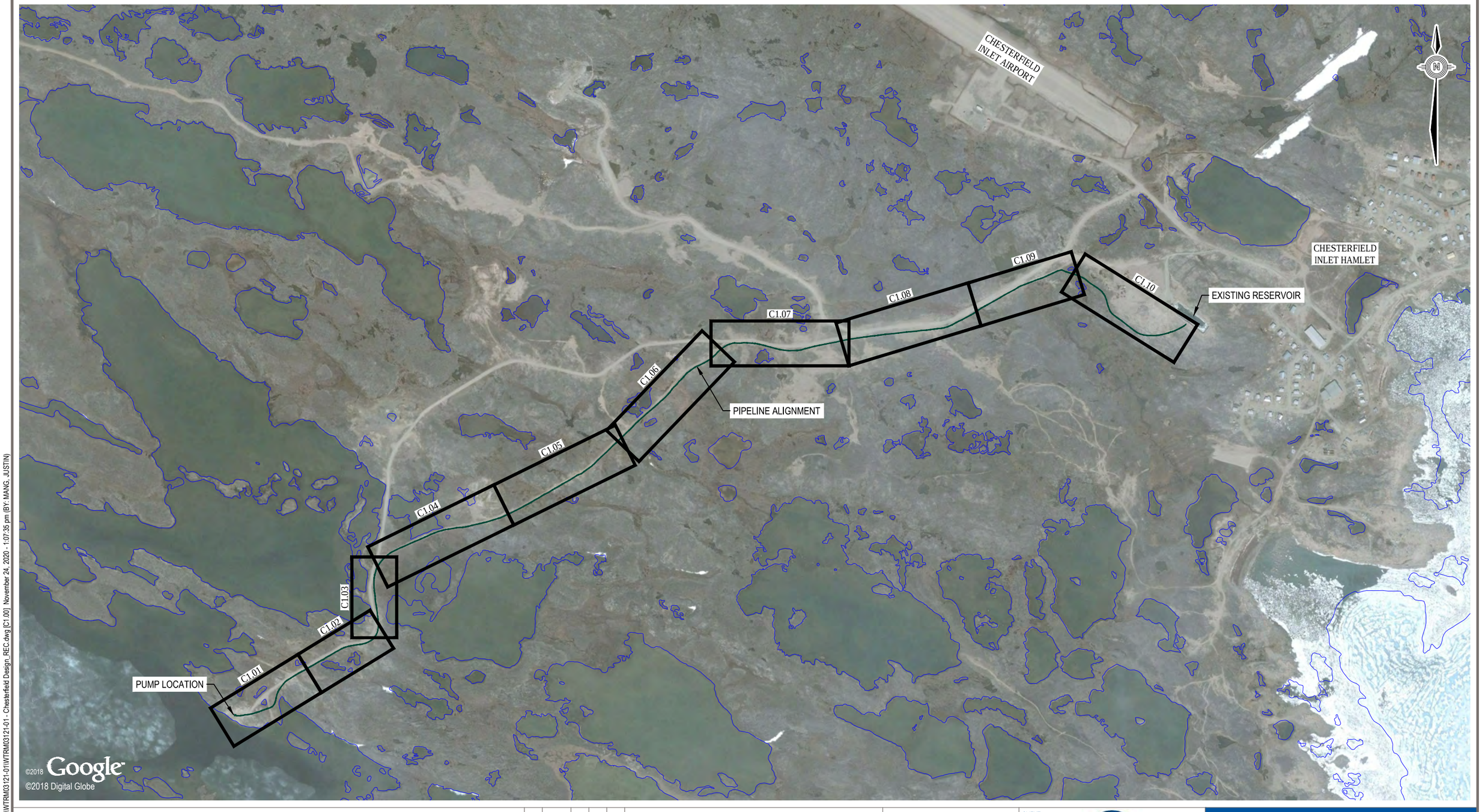
DATE	SHEET No.	DWN	APP	STATUS	
November 20, 2020	of	JDM	DNM	REC	



LEGEND

NOTES

1. Survey completed by Apex Survey Solutions Ltd. on November 22, 2018.

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NUM	DATE	DWN	CKD	APR	DESCRIPTION
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2	9/9/20	JDM	ML	DNM	FIELD DIRECTIVE 004
1	8/21/20	JDM	ML	DNM	FIELD DIRECTIVE 002
0	11/12/19	JDM	ML	DNM	ISSUED FOR CONSTRUCTION

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WATER TRANSMISSION LINE DESIGN CHESTERFIELD INLET, NUNAVUT

KEY PLAN

PROJECT NO.	OFFICE	DES	CKD	REV	DRAWING
WTRM03121-01	VANC	DNM	ML	3	C1.00
DATE	SHEET No.	DWN	APP	STATUS	
November 20, 2020	of	JDM	DNM	REC	

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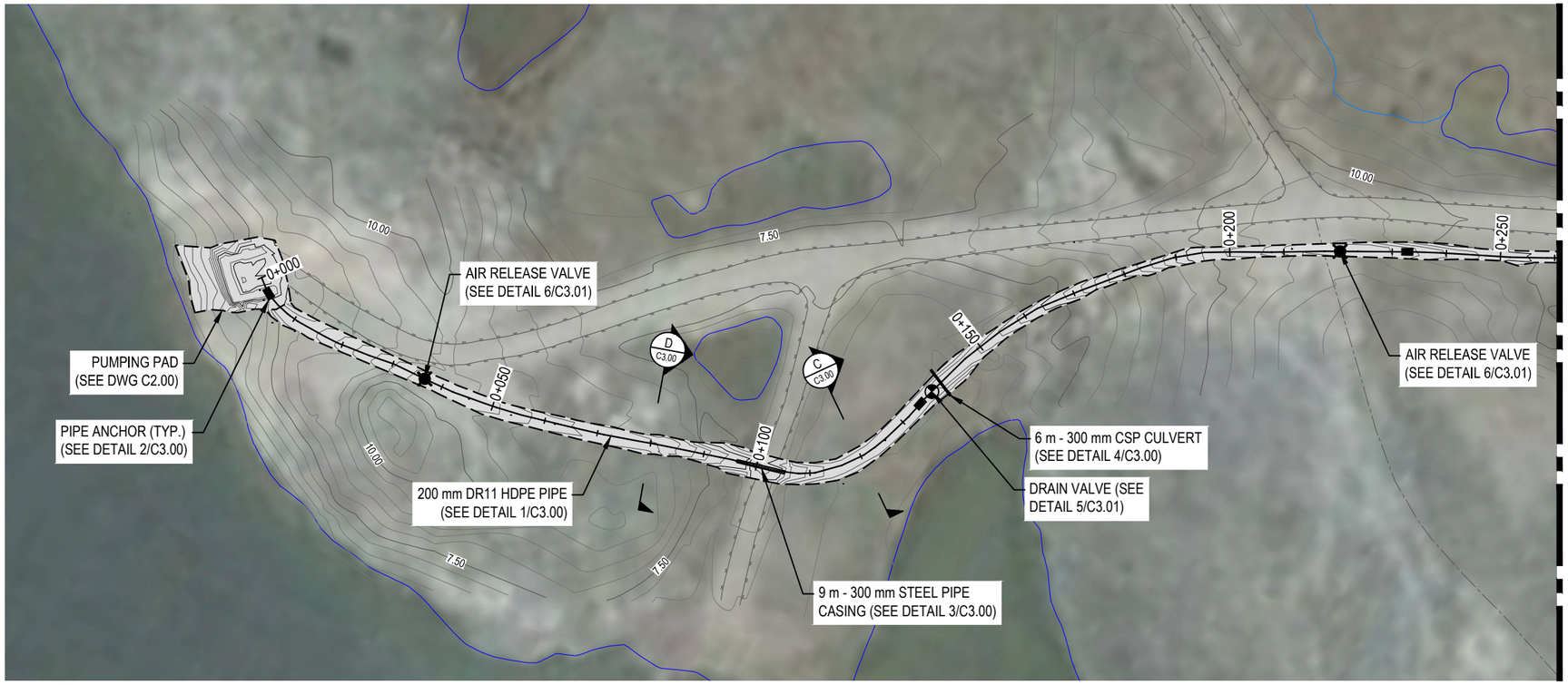

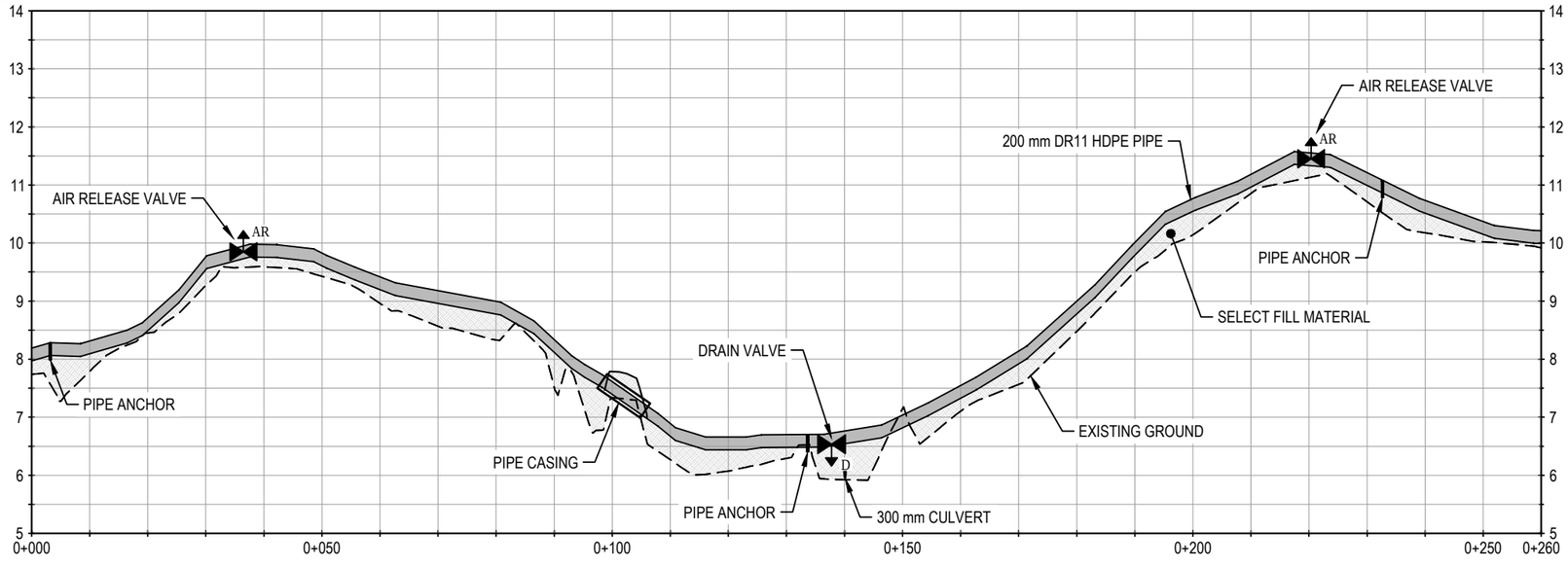

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SCALE 1:1000 (HORIZ.)
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NOTES

1. All dimensions are in meters unless noted otherwise
2. Profile view is exaggerated by 10 times vertically.

NUM	DATE	DWN	CKD	APR	DESCRIPTION
3	11/20/20	JDM	ML	DNM	RECORD DRAWING
2	8/21/20	JDM	ML	DNM	FIELD DIRECTIVE 002
1	2/12/20	JDM	ML	DNM	RFI 003
0	11/12/19	JDM	ML	DNM	ISSUED FOR CONSTRUCTION

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PLAN AND PROFILE

PROJECT NO.	OFFICE	DES	CKD	REV	DRAWING
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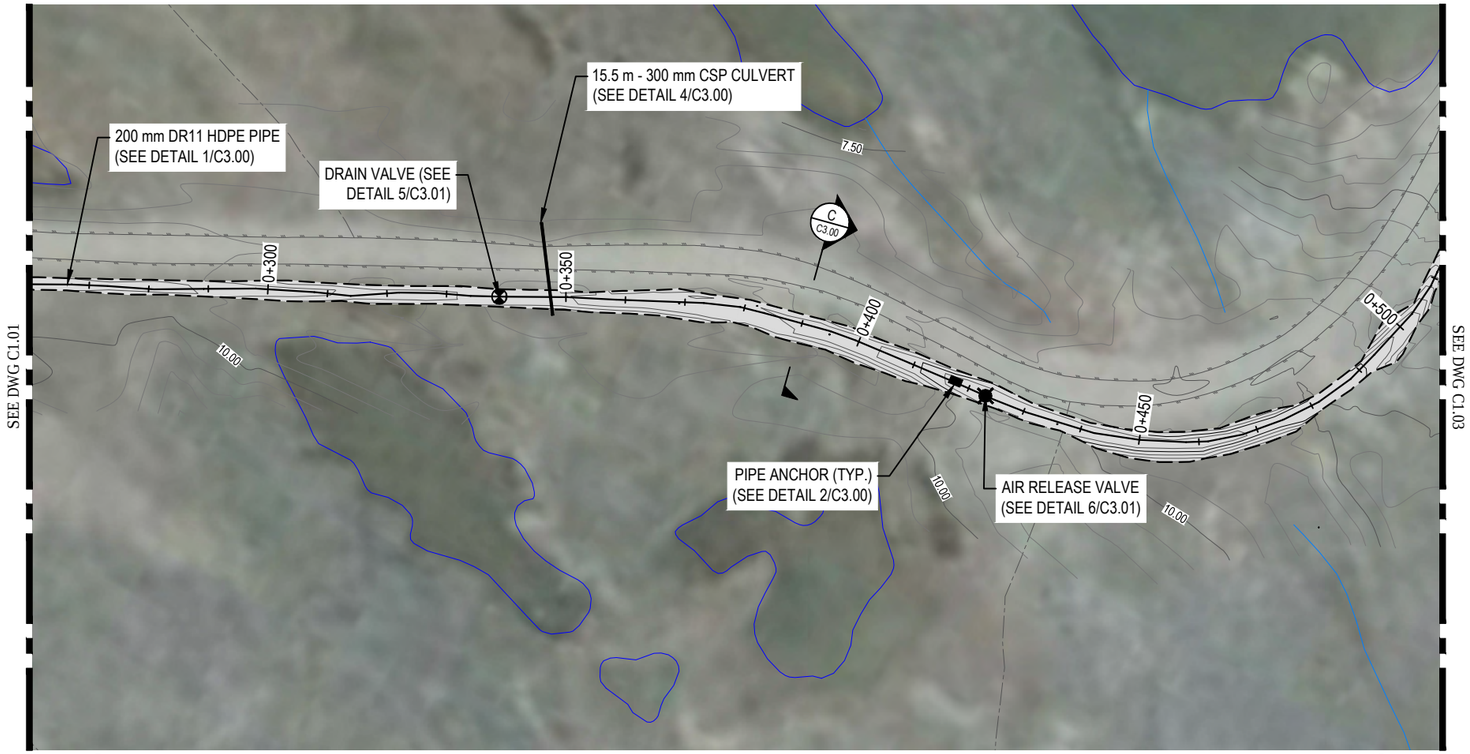

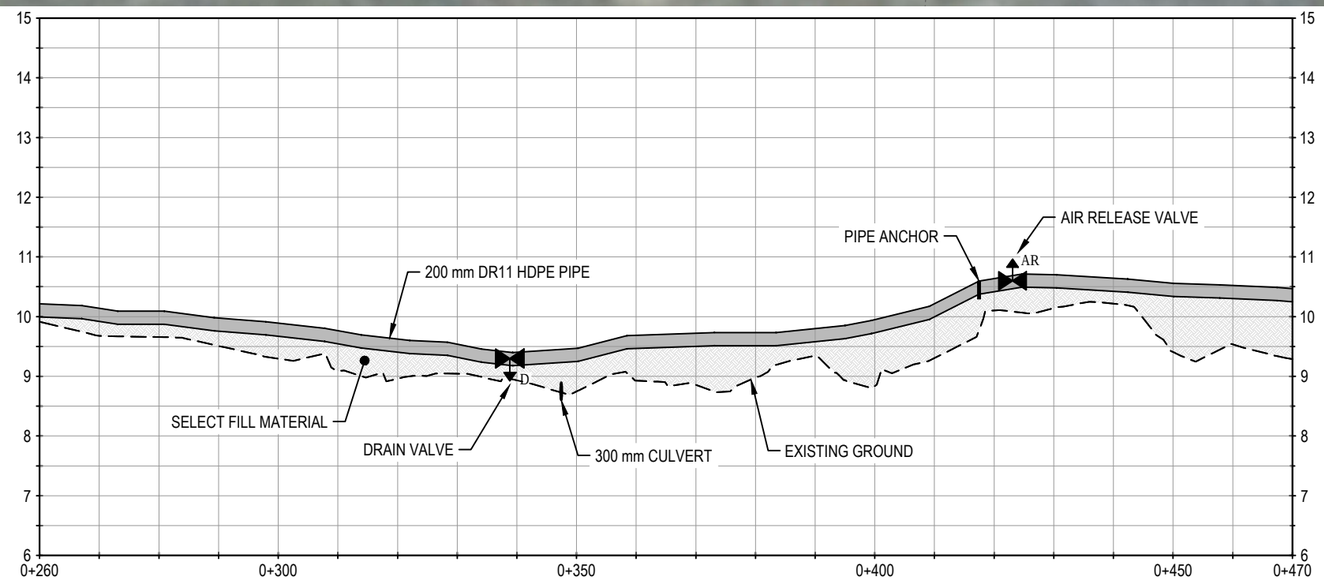

LEGEND

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NOTES

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1	8/21/20	JDM	ML	DNM	FIELD DIRECTIVE 002
0	11/12/19	JDM	ML	DNM	ISSUED FOR CONSTRUCTION

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CHESTERFIELD INLET, NUNAVUT

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PROJECT NO.	OFFICE	DES	CKD	REV	DRAWING
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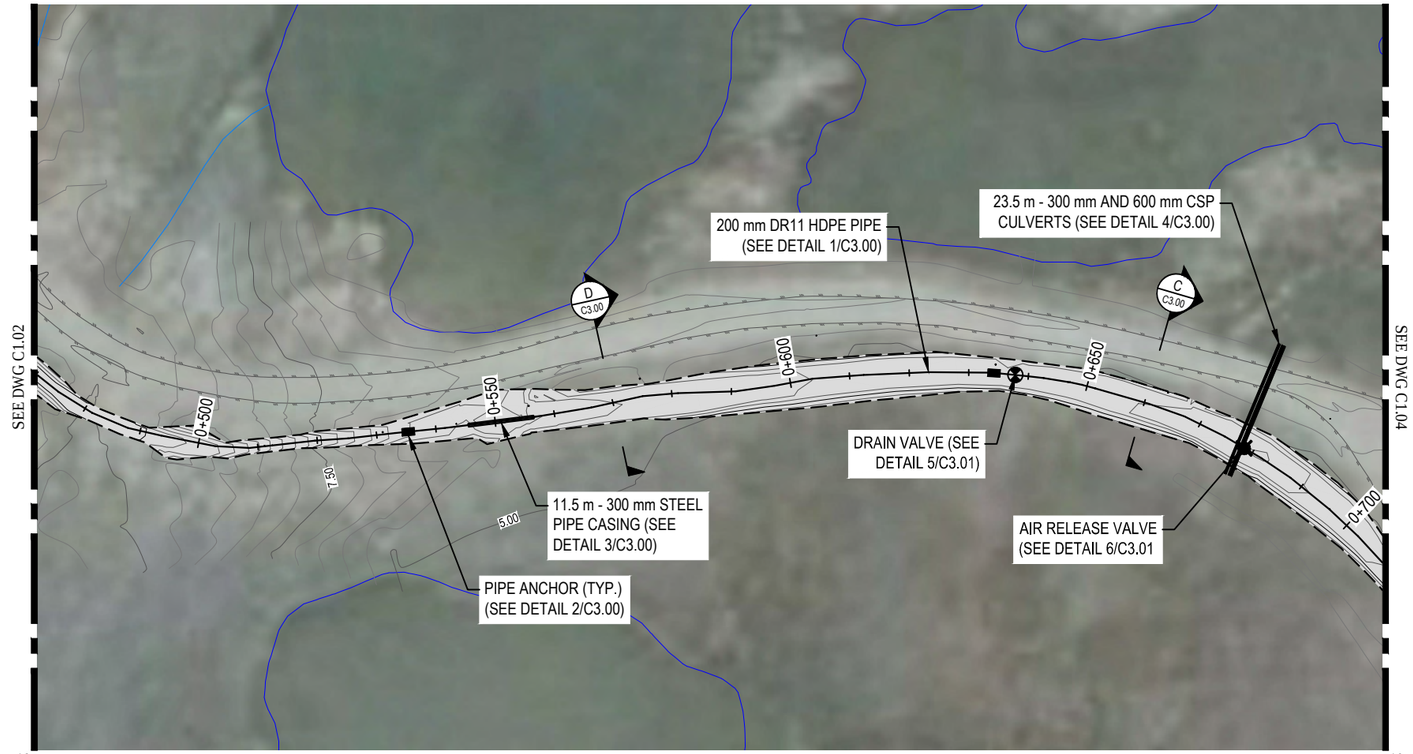

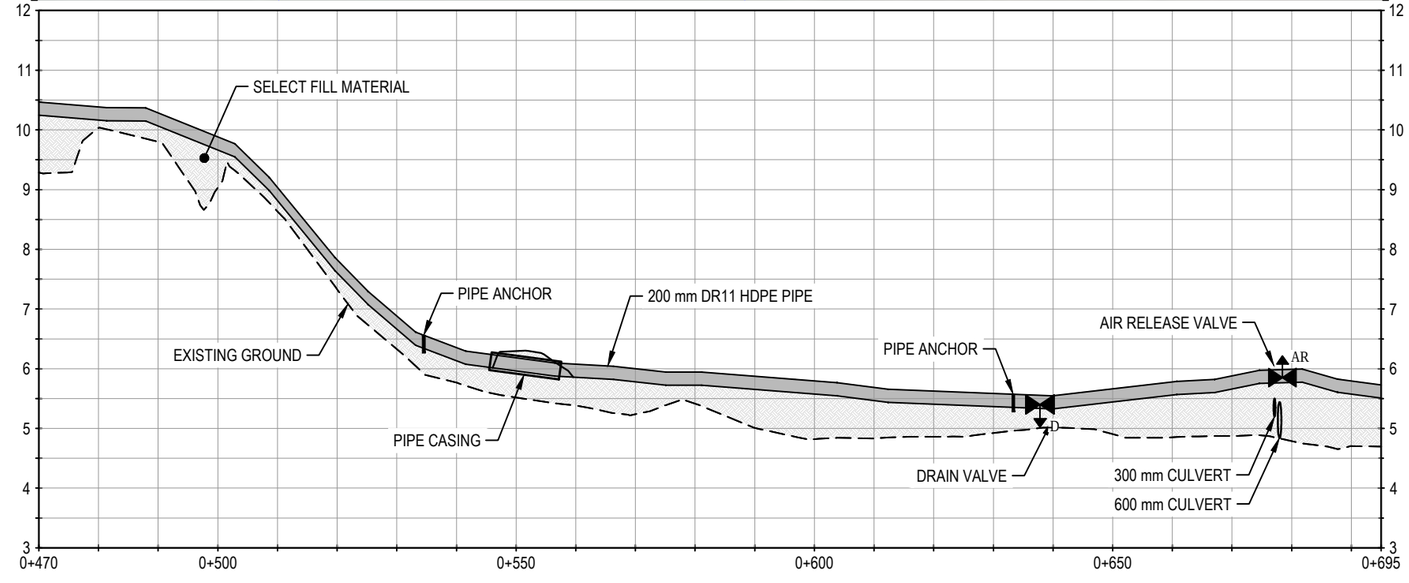

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1	8/21/20	JDM	ML	DNM	FIELD DIRECTIVE 002
0	11/12/19	JDM	ML	DNM	ISSUED FOR CONSTRUCTION

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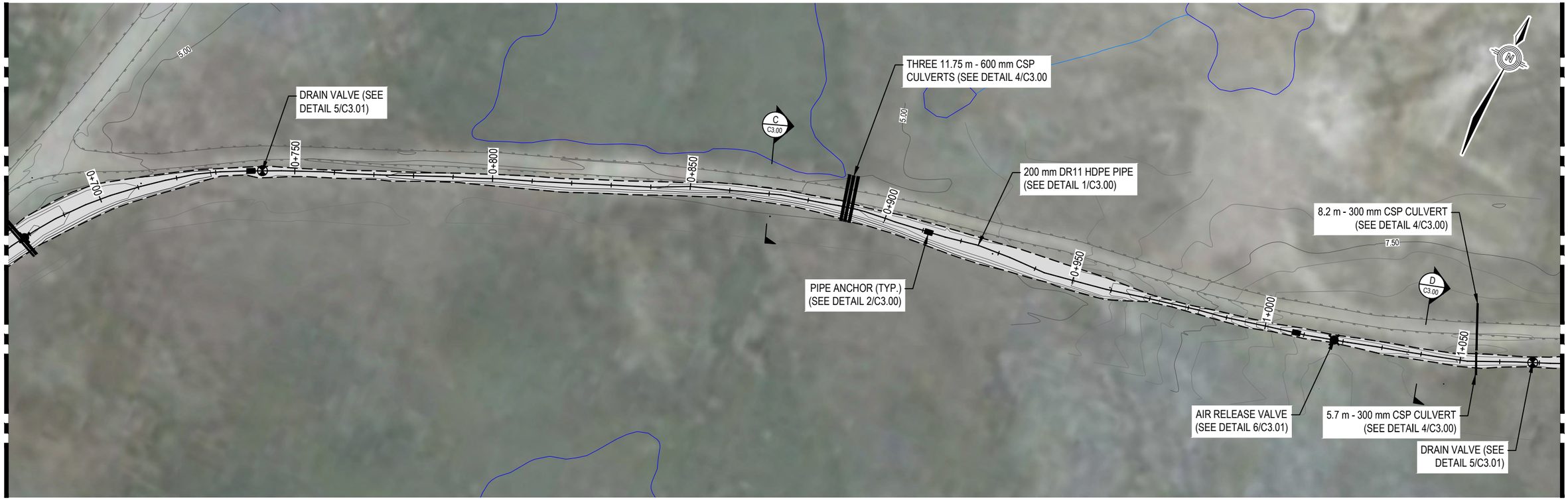

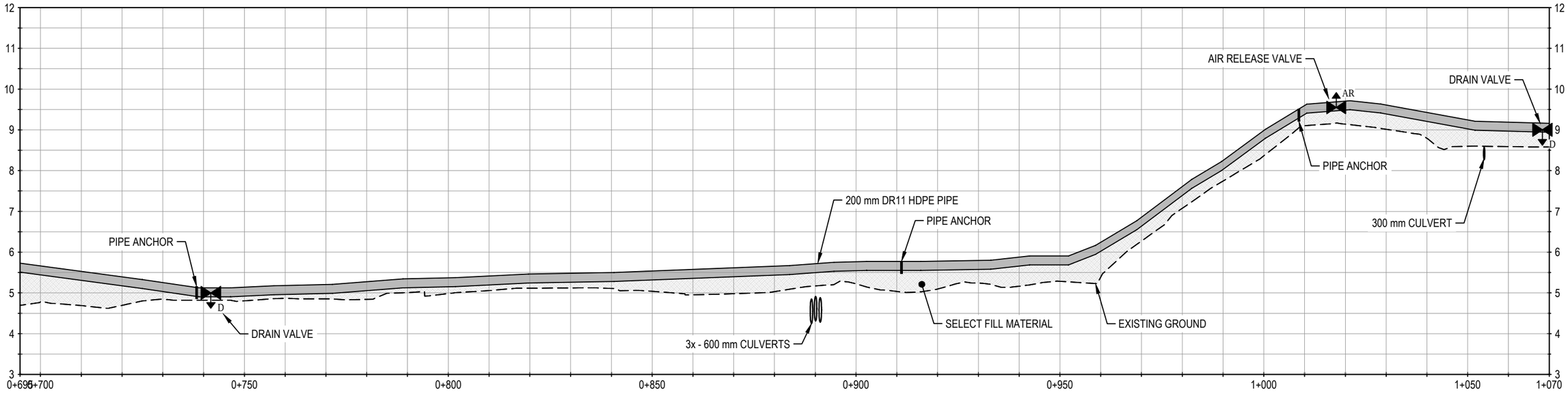

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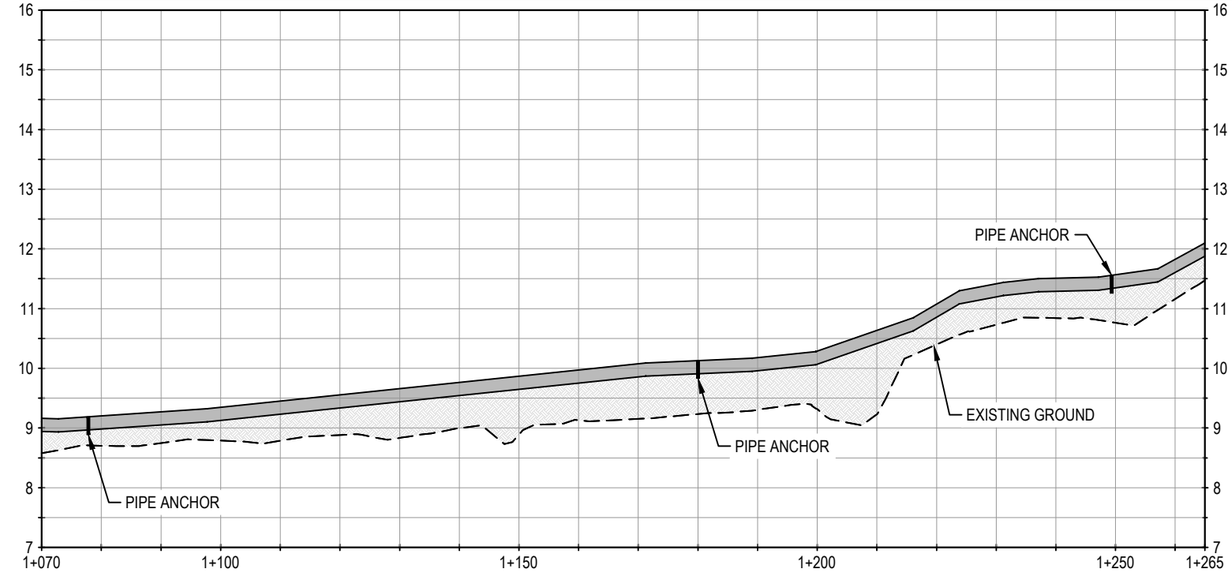

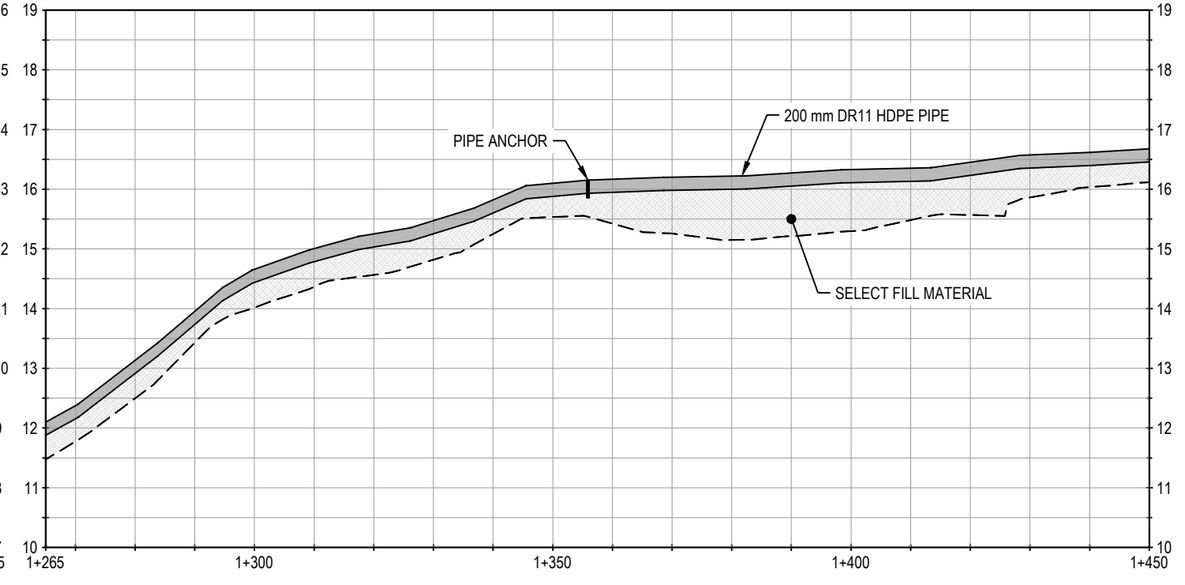

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NOTES

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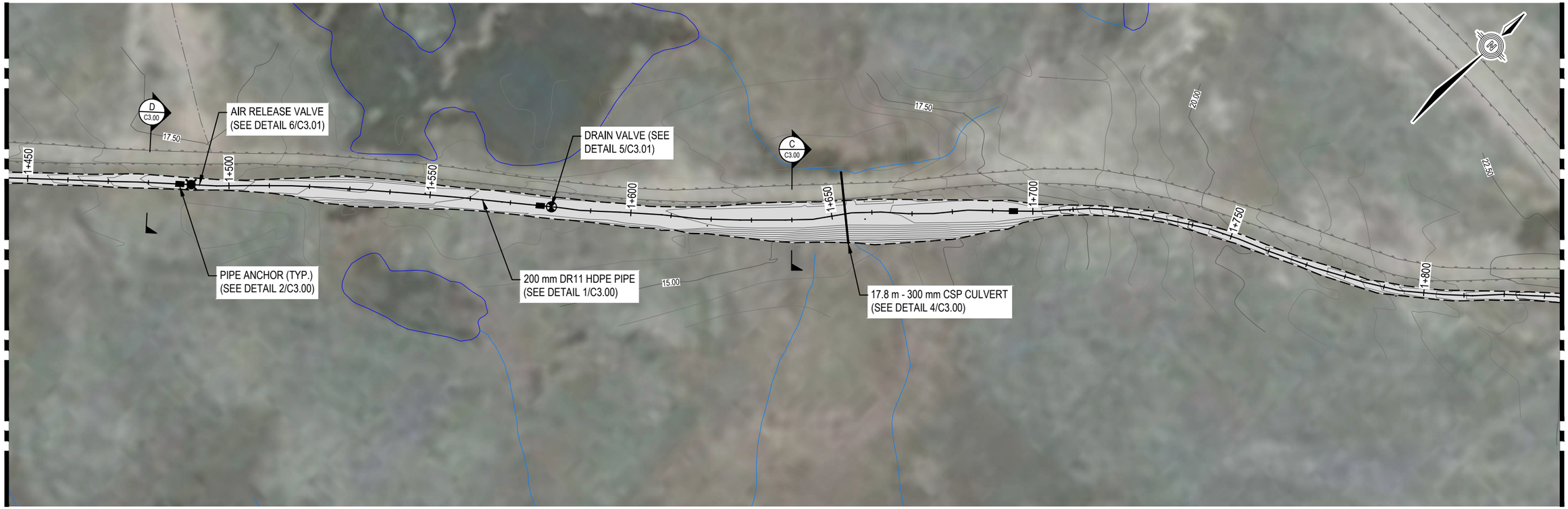

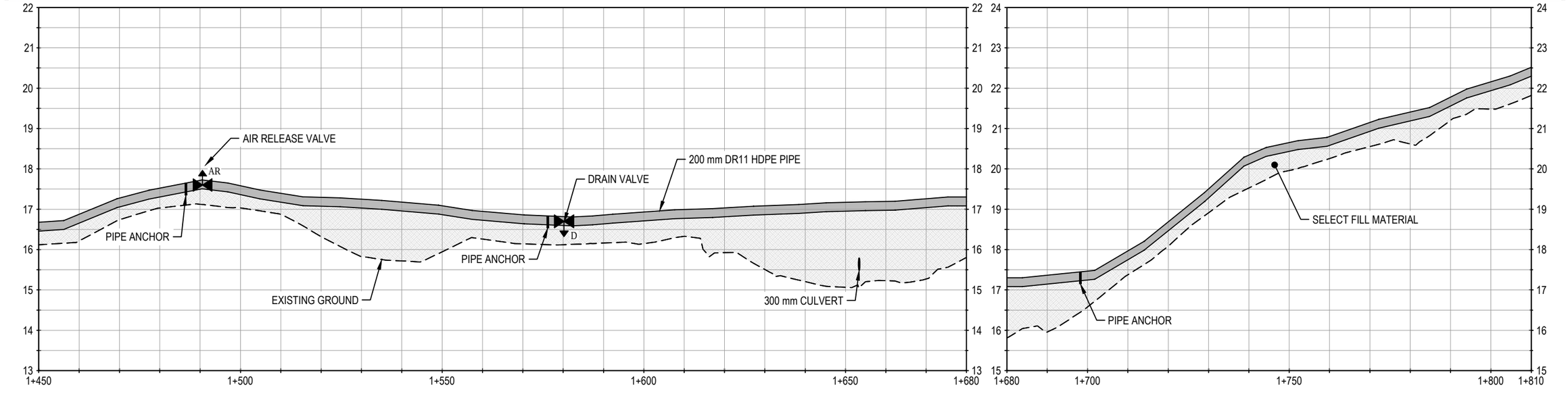

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NOTES

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1	8/21/20	JDM	ML	DNM	FIELD DIRECTIVE 002
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PROJECT NO.	OFFICE	DES	CKD	REV	DRAWING
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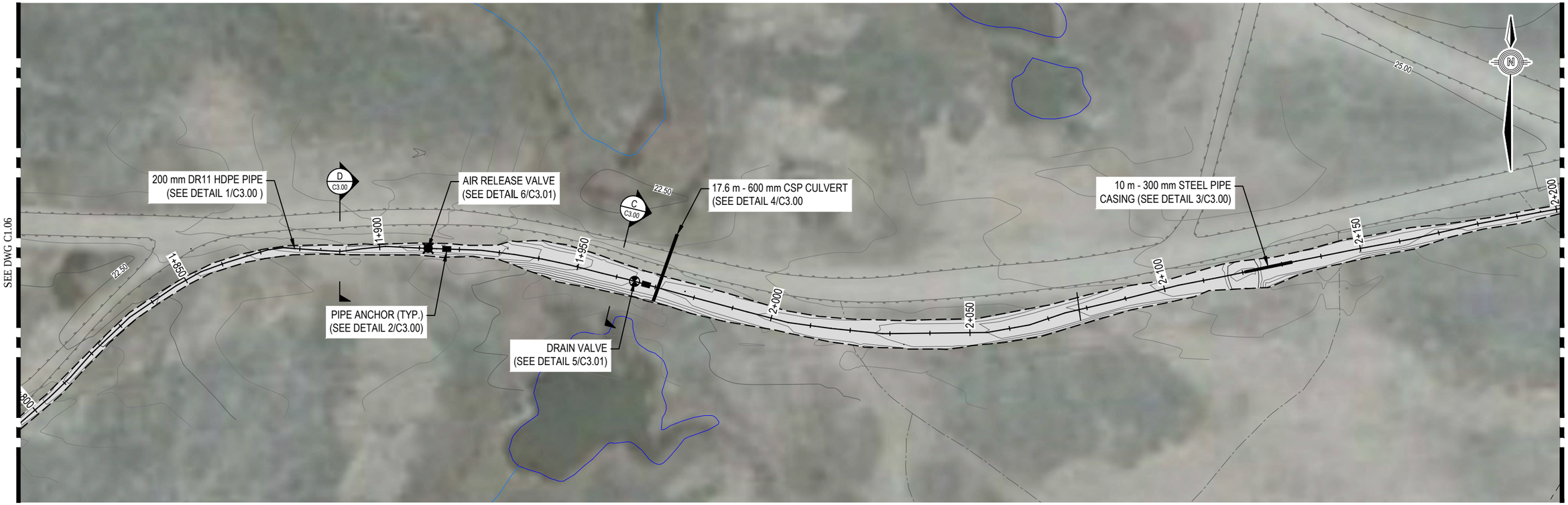

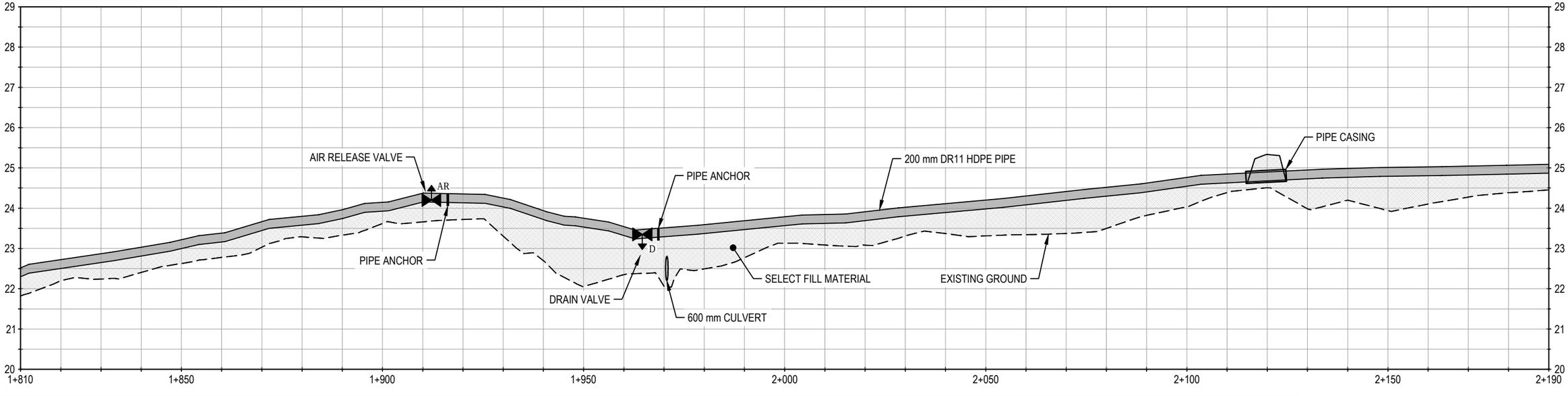

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NOTES

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0	11/12/19	JDM	DNM	DNM	ISSUED FOR CONSTRUCTION

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PROJECT NO.	OFFICE	DES	CKD	REV	DRAWING
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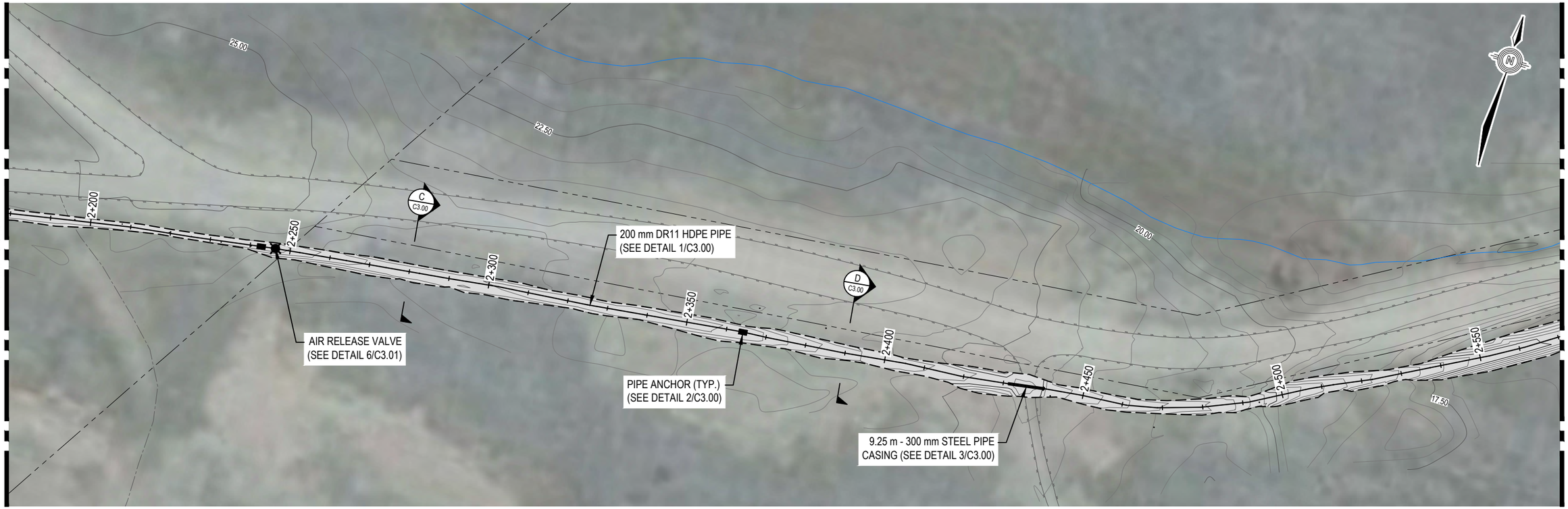

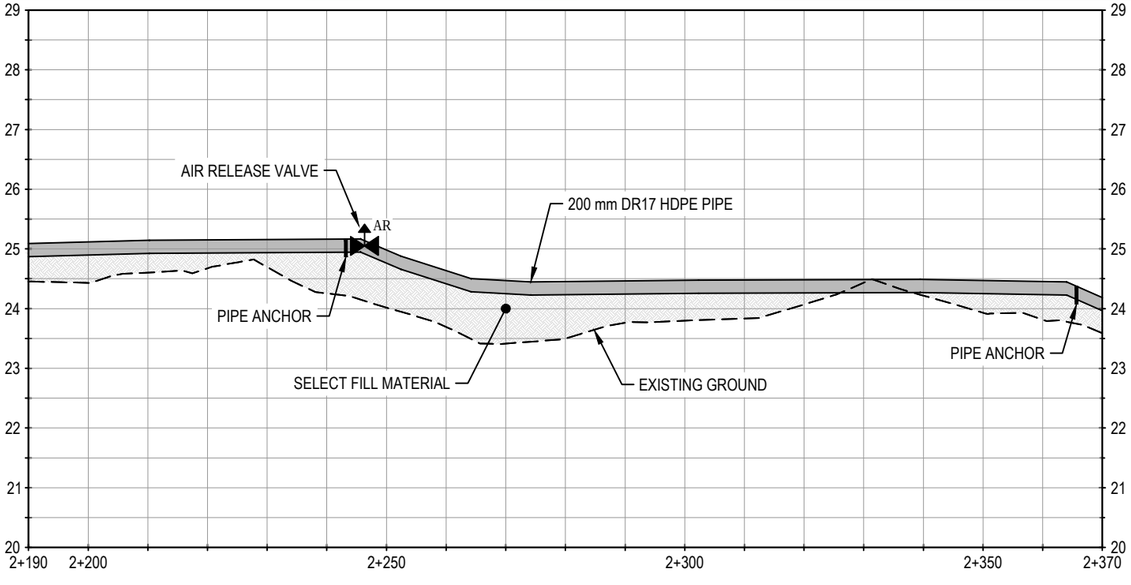

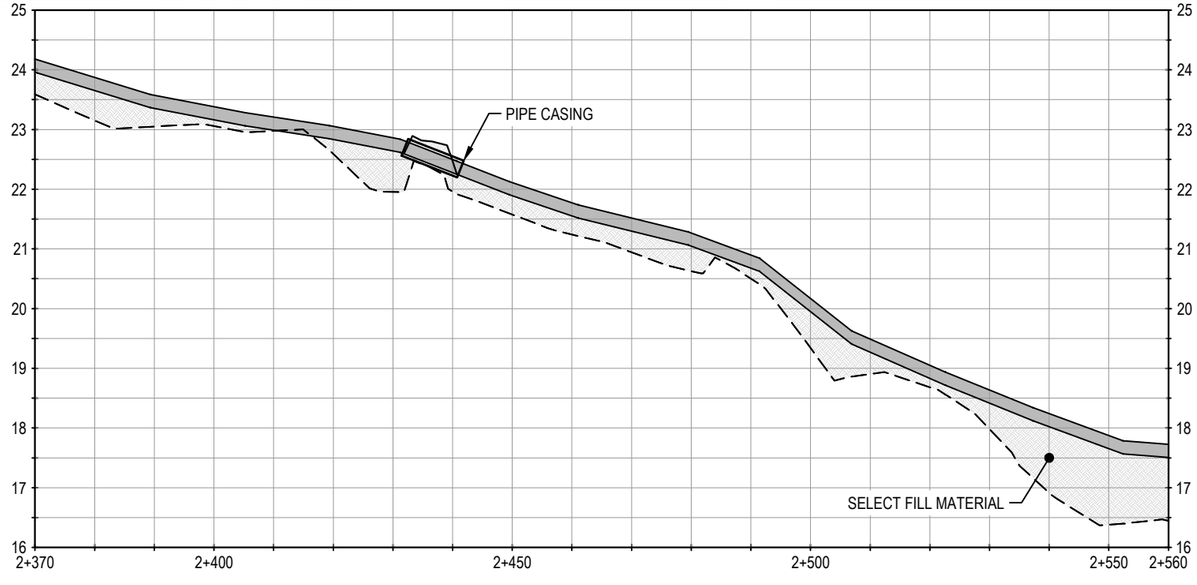

LEGEND

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SCALE 1:1000 (HORIZ.)

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NOTES

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NUM	DATE	DWN	CKD	APR	DESCRIPTION
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1	8/21/20	JDM	ML	DNM	FIELD DIRECTIVE 002
0	11/12/19	JDM	ML	DNM	ISSUED FOR CONSTRUCTION

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WATER TRANSMISSION LINE DESIGN
CHESTERFIELD INLET, NUNAVUT

PLAN AND PROFILE

PROJECT NO.	OFFICE	DES	CKD	REV	DRAWING
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DATE	SHEET No.	DWN	APP	STATUS	
November 20, 2020	of	JDM	DNM	REC	

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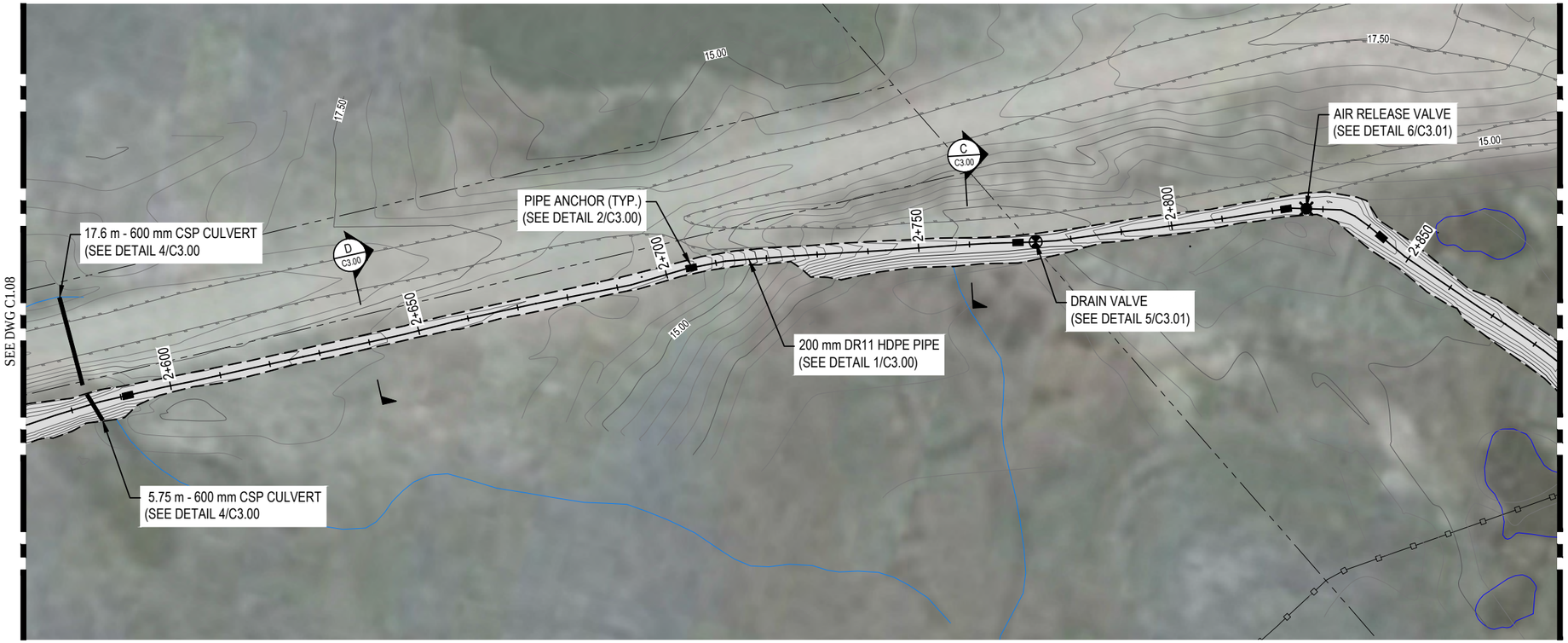

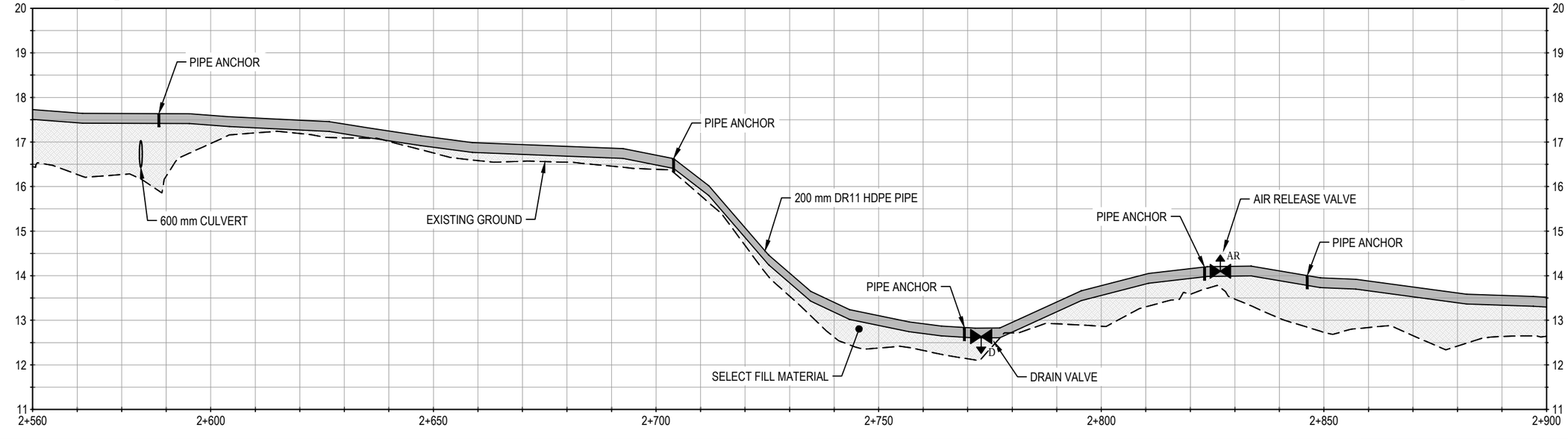

LEGEND

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SCALE 1:1000 (HORIZ.)

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NOTES

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NUM	DATE	DWN	CKD	APR	DESCRIPTION
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2	9/9/20	JDM	ML	DNM	FIELD DIRECTIVE 004
1	8/21/20	JDM	ML	DNM	FIELD DIRECTIVE 002
0	11/5/19	JDM	ML	DNM	ISSUED FOR CONSTRUCTION

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WATER TRANSMISSION LINE DESIGN CHESTERFIELD INLET, NUNAVUT

PLAN AND PROFILE

PROJECT NO.	OFFICE	DES	CKD	REV	DRAWING
WTRM03121-01	VANC	DNM	DNM	3	C1.09
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November 20, 2020	of	JDM	DNM	REC	

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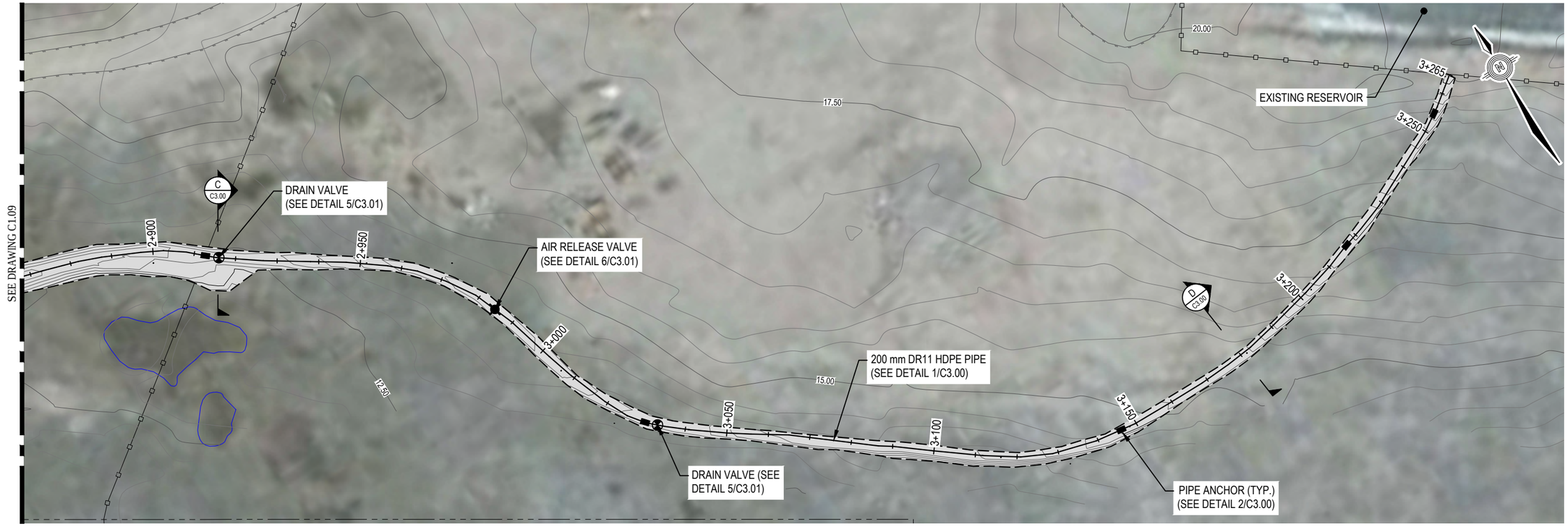

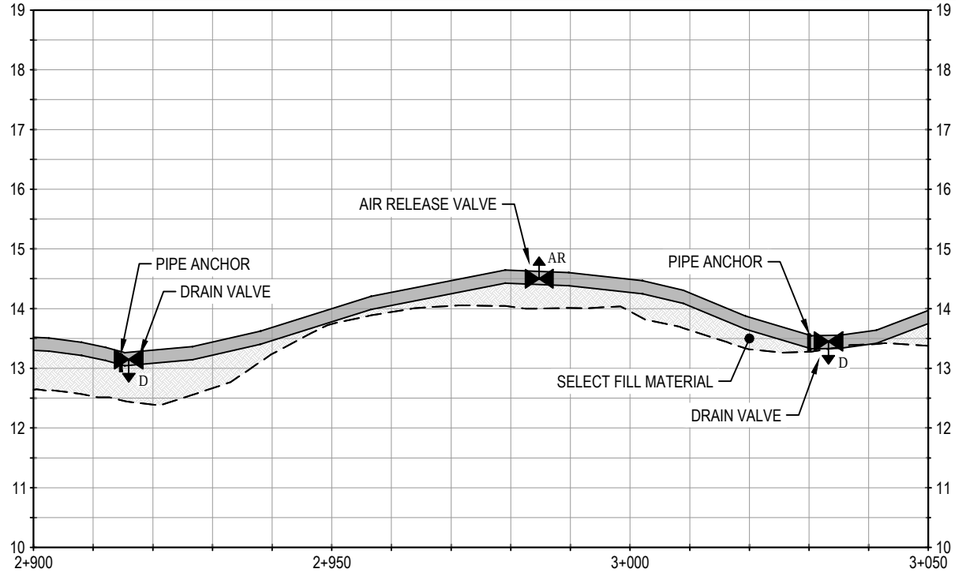

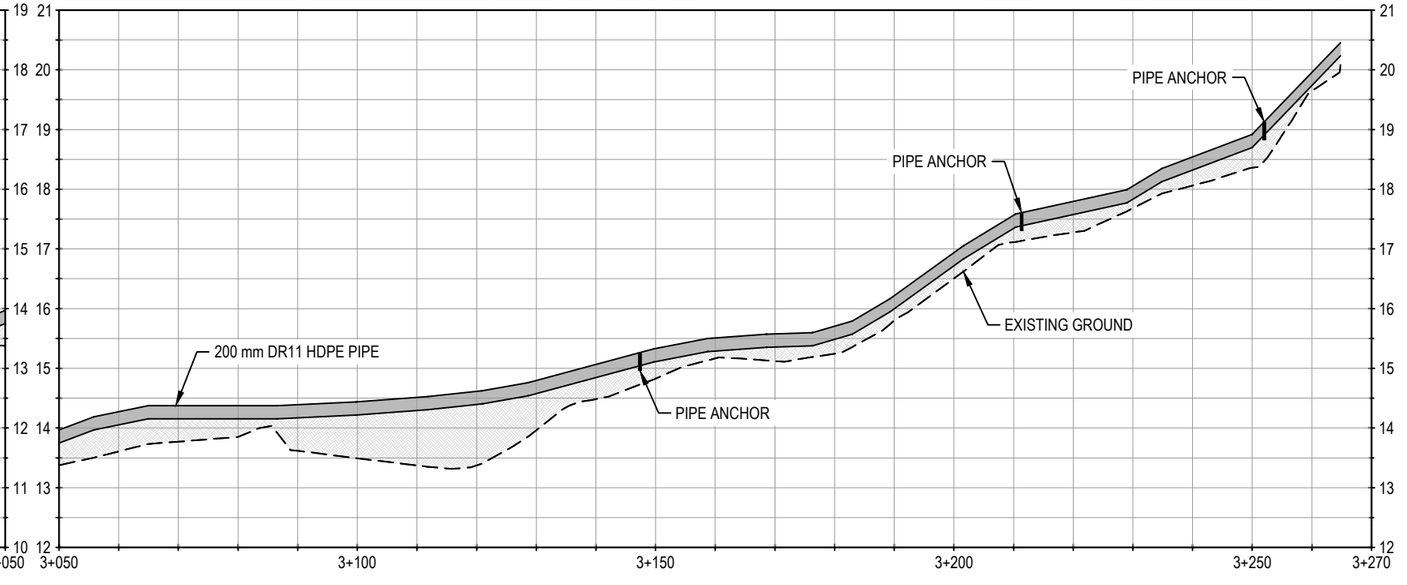

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1 0 1 2 4m

SCALE 1:1000 (HORIZ.)

10 0 10 20 40m

NOTES

1. All dimensions are in meters unless noted otherwise.
2. Profile view is exaggerated by 10 times vertically.

NUM	DATE	DWN	CKD	APR	DESCRIPTION
3	11/20/20	JDM	ML	DNM	RECORD DRAWING
2	9/9/20	JDM	ML	DNM	FIELD DIRECTIVE 004
1	8/21/20	JDM	ML	DNM	FIELD DIRECTIVE 002
0	11/12/19	JDM	ML	DNM	ISSUED FOR CONSTRUCTION

REVISIONS

REGISTERED PROFESSIONAL ENGINEER
11/20/20
D.N. MOSCHINI
LICENSEE
NT/NU

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Nunavut

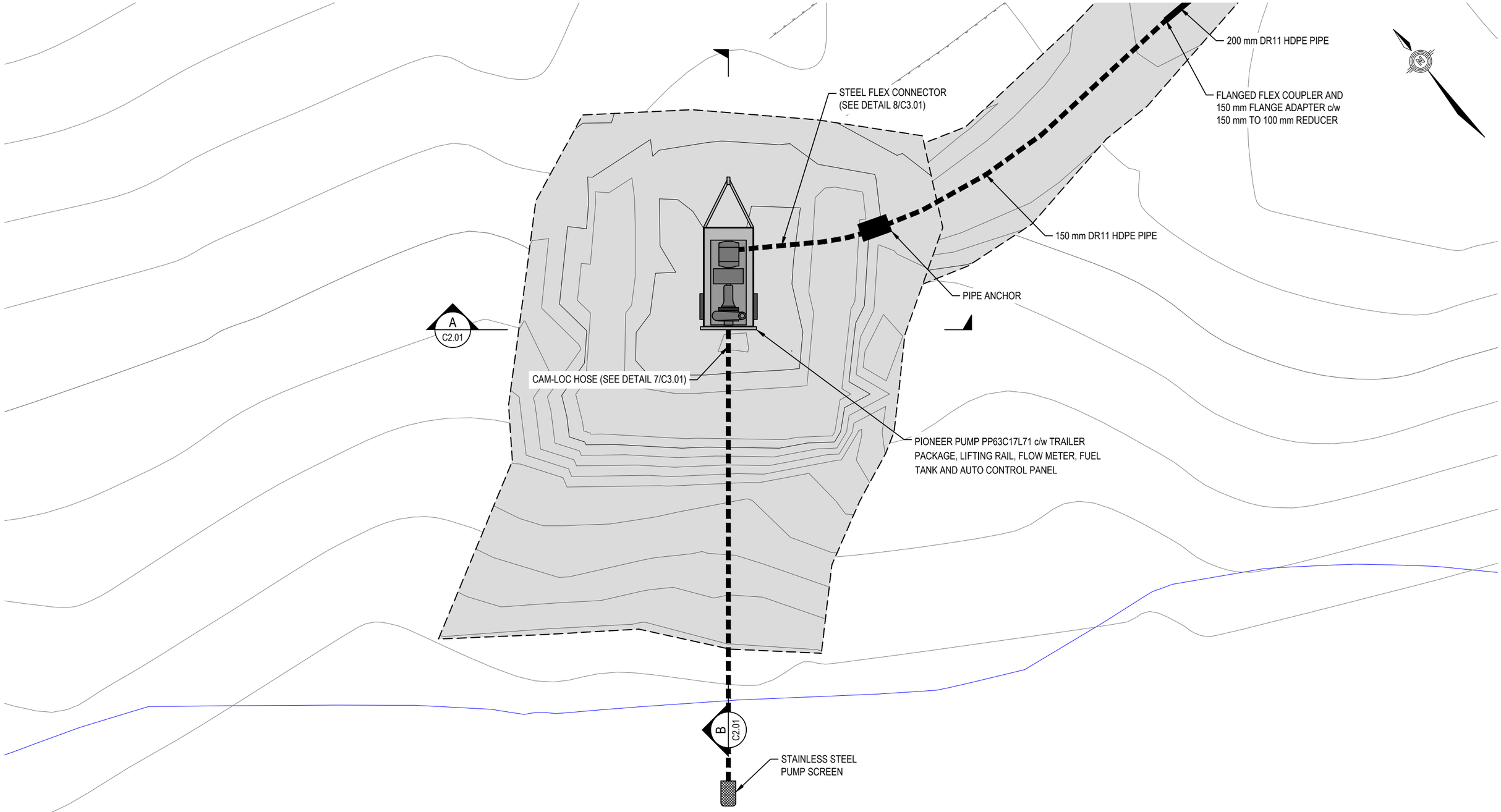
TETRA TECH

WATER TRANSMISSION LINE DESIGN CHESTERFIELD INLET, NUNAVUT

PLAN AND PROFILE

PROJECT NO.	OFFICE	DES	CKD	REV	DRAWING
WTRM03121-01	VANC	DNM	ML	3	C1.10
DATE	SHEET No.	DWN	APP	STATUS	
November 20, 2020	of	JDM	DNM	REC	

C:\Users\justin.mang\OneDrive - Tetra Tech, Inc\WTRM03121-01\WTRM03121-01 - Chesterfield Design_REC.dwg [C1.10] December 03, 2020 - 3:37:38 pm (BY: MANG, JUSTIN)



LEGEND

NOTES

SCALE 1:125

1 0 1 3 5m

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1	2/12/20	JDM	ML	DNM	RFI 003
0	11/12/19	JDM	ML	DNM	ISSUED FOR CONSTRUCTION

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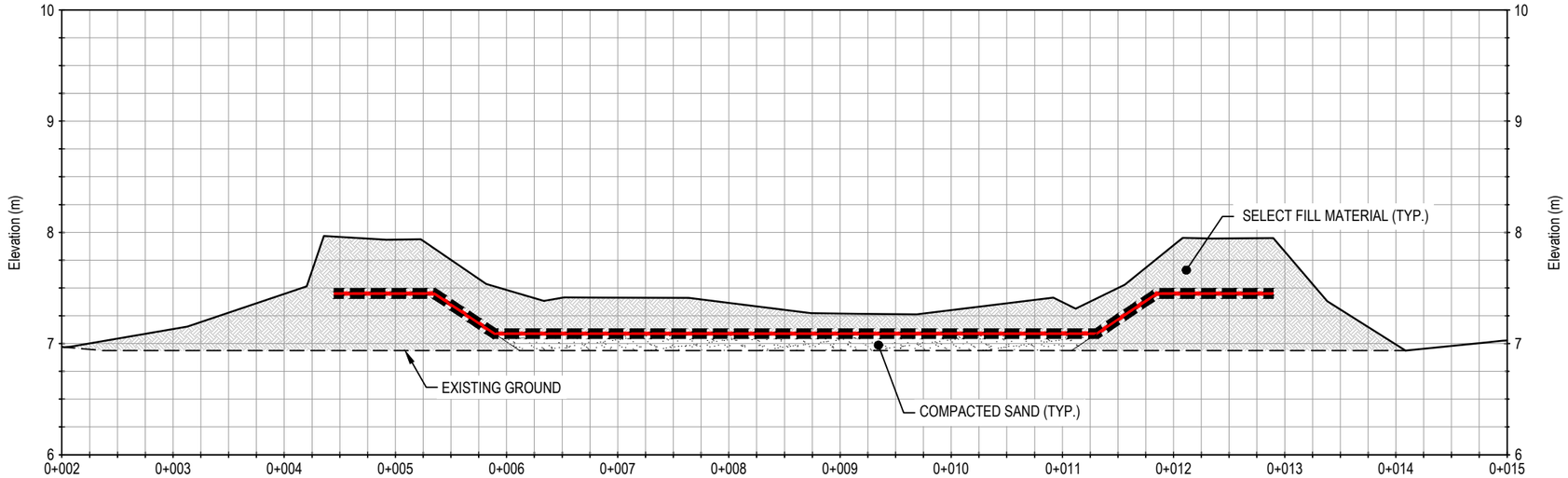
WATER TRANSMISSION LINE DESIGN
CHESTERFIELD INLET, NUNAVUT

PUMPING PAD
PLAN

PROJECT NO.	OFFICE	DES	CKD	REV	DRAWING
WTRM03121-01	VANC	DNM	DNM	2	C2.00
DATE	SHEET No.	DWN	APP	STATUS	
November 20, 2020	of	JDM	DNM	REC	



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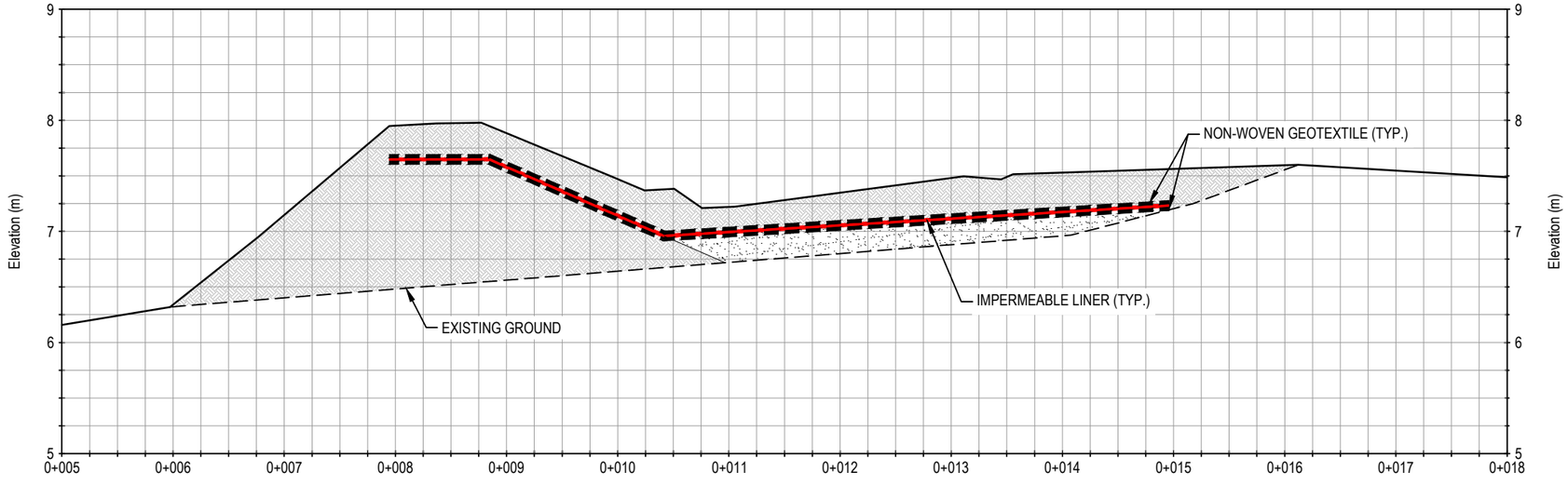

B C2.01 SECTION
SCALE: 1:50

LEGEND

NOTES

SCALE 1:50

500 0 500 1000 2000mm

NUM	DATE	DWN	CKD	APR	DESCRIPTION
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1	2/12/20	JDM	ML	DNM	RFI 003
0	11/12/19	JDM	ML	DNM	ISSUED FOR CONSTRUCTION

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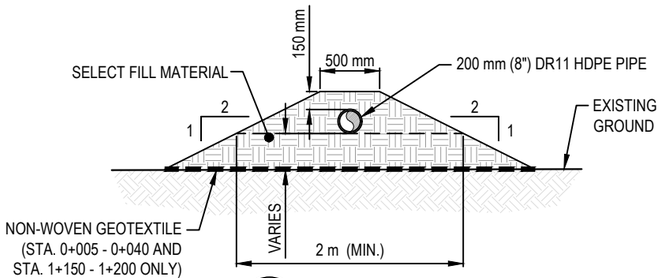
WATER TRANSMISSION LINE DESIGN
CHESTERFIELD INLET, NUNAVUT

PUMPING PAD
SECTIONS

PROJECT NO.	OFFICE	DES	CKD	REV	DRAWING
WTRM03121-01	VANC	DNM	ML	2	C2.01
DATE	SHEET No.	DWN	APP	STATUS	
November 20, 2020	of	JDM	DNM	REC	



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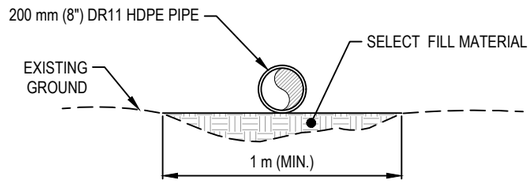

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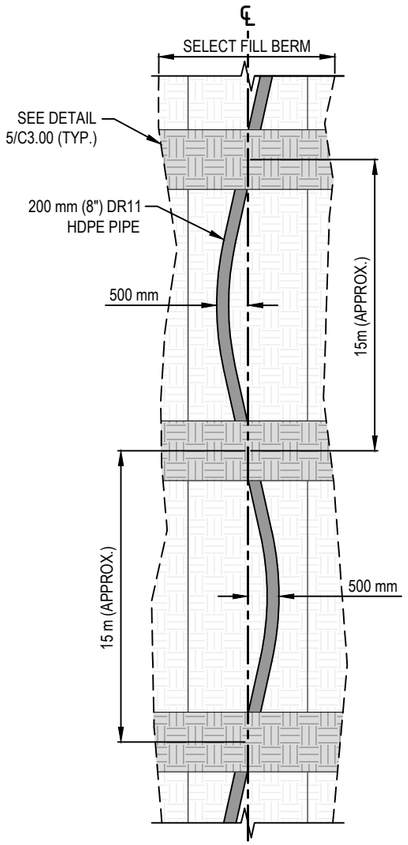

1 PIPE INSTALLATION DETAIL
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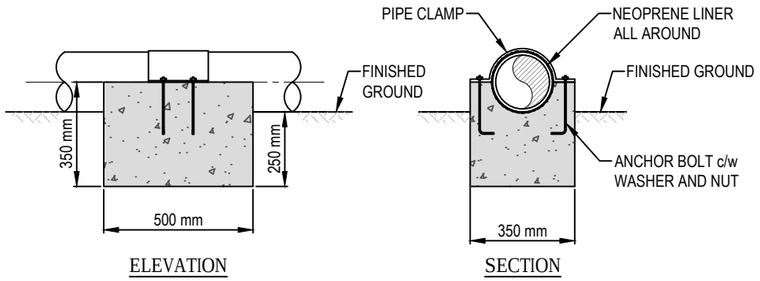
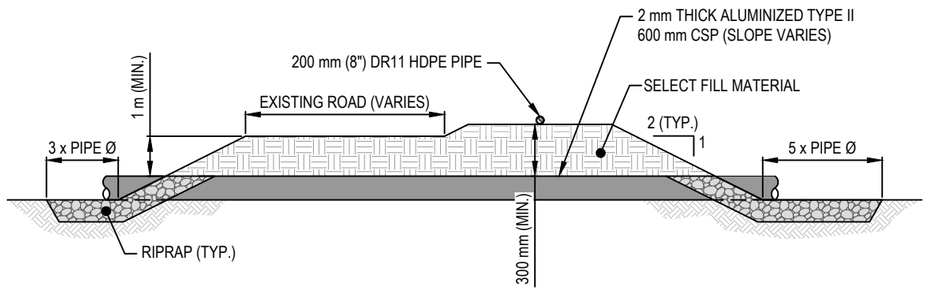


2 ANCHOR DETAIL
C3.00 SCALE: 1:20



4 CULVERT DETAIL
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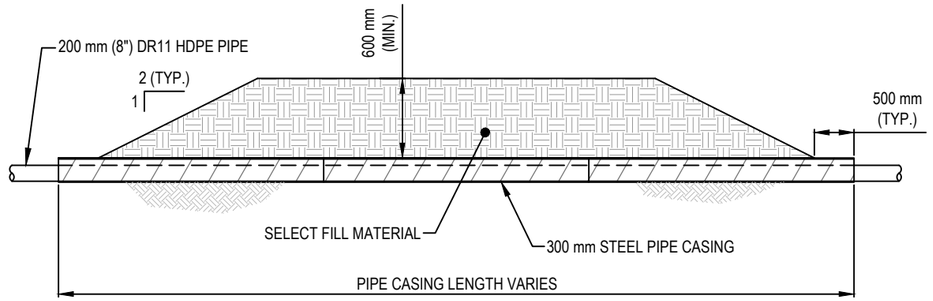

3 PIPE CASING DETAIL
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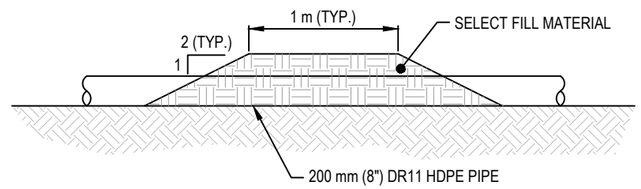

5 INTERMITTENT EARTH BERM DETAIL
C3.00 SCALE: NTS

LEGEND

NOTES

NUM	DATE	DWN	CKD	APR	DESCRIPTION
3	11/20/20	JDM	ML	DNM	RECORD DRAWING
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1	4/23/20	ML	ML	DNM	FIELD DIRECTIVE 001
0	11/12/19	JDM	ML	DNM	ISSUED FOR CONSTRUCTION

REVISIONS

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11/20/20
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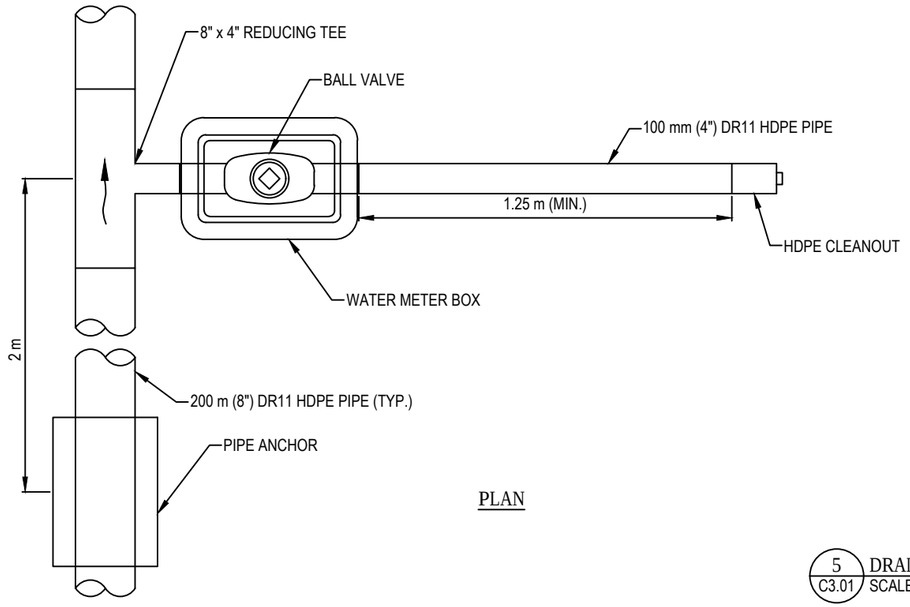
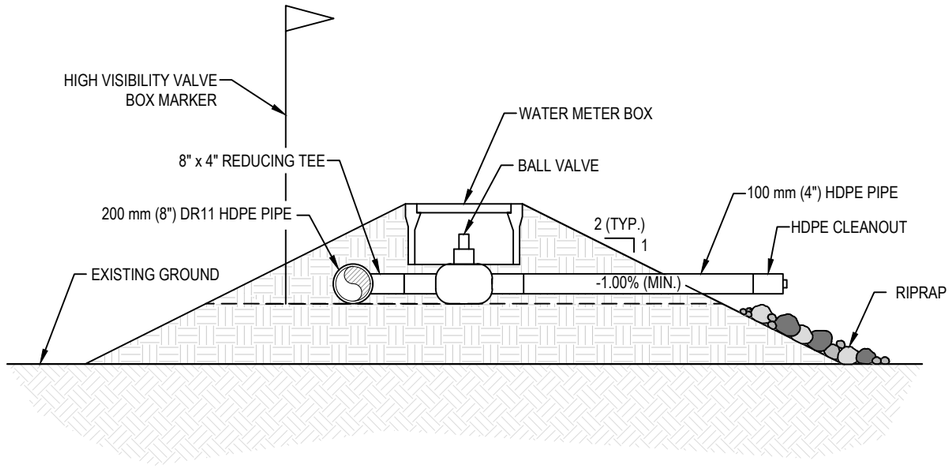
WATER TRANSMISSION LINE DESIGN
CHESTERFIELD INLET, NUNAVUT

TYPICAL SECTION
AND DETAILS

PROJECT NO.	OFFICE	DES	CKD	REV	DRAWING
WTRM03121-01	VANC	DNM	ML	3	C3.00
DATE	SHEET No.	DWN	APP	STATUS	
November 20, 2020	of	JDM	DNM	REC	



PLAN



SECTION

5 C3.01 DRAIN VALVE DETAIL
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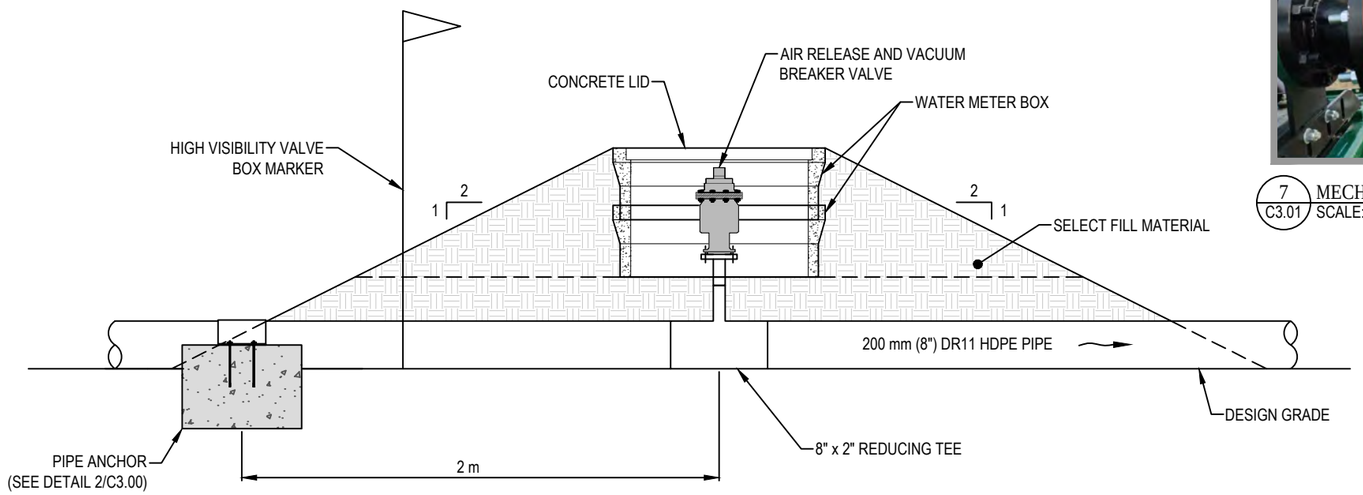
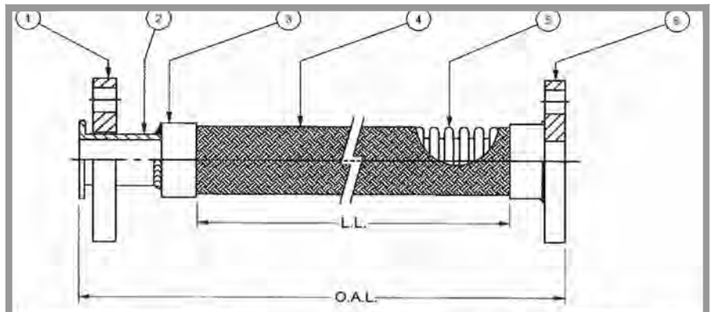


6 C3.01 AIR RELEASE VALVE DETAIL
SCALE: NTS

7 C3.01 MECHANICAL JOINT ADAPTER DETAIL
SCALE: NTS



Diameter (In.)	Length (In.)		Bend Radius (In.)		Pressure (PSIG)			
	Overall [O.A.L.]	Live [L.L.]	Dynamic	Static	Working		Burst	
6"	36"		36"	19"	70°F	165	70°F	660

ITEM	QUAN.	DESCRIPTION	MATERIAL
1	1	6" - Floating Plate Flange 150#	Carbon Steel
2	1	6" - Type 'C' Stub End	Stainless Steel T304
3	2	Braid Sleeve	Stainless Steel T304
4	1	SINGLE Braid	Stainless Steel T304
5	1	Annular Corrugated Metal Hose	Stainless Steel T321
6	1	6" - Plate Flange 150# F/F	Carbon Steel

8 C3.01 STEEL FLEX CONNECTOR DETAIL
SCALE: NTS

LEGEND

NOTES

NUM	DATE	DWN	CKD	APR	DESCRIPTION
2	11/20/20	JDM	ML	DNM	RECORD DRAWING
1	8/21/20	JDM	ML	DNM	FIELD DIRECTIVE 002
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WATER TRANSMISSION LINE DESIGN
CHESTERFIELD INLET, NUNAVUT

DETAILS

PROJECT NO.	OFFICE	DES	CKD	REV	DRAWING
WTRM03121-01	VANC	DNM	ML	2	C3.01
DATE	SHEET No.	DWN	APP	STATUS	
November 20, 2020	of	JDM	DNM	REC	

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APPENDIX B

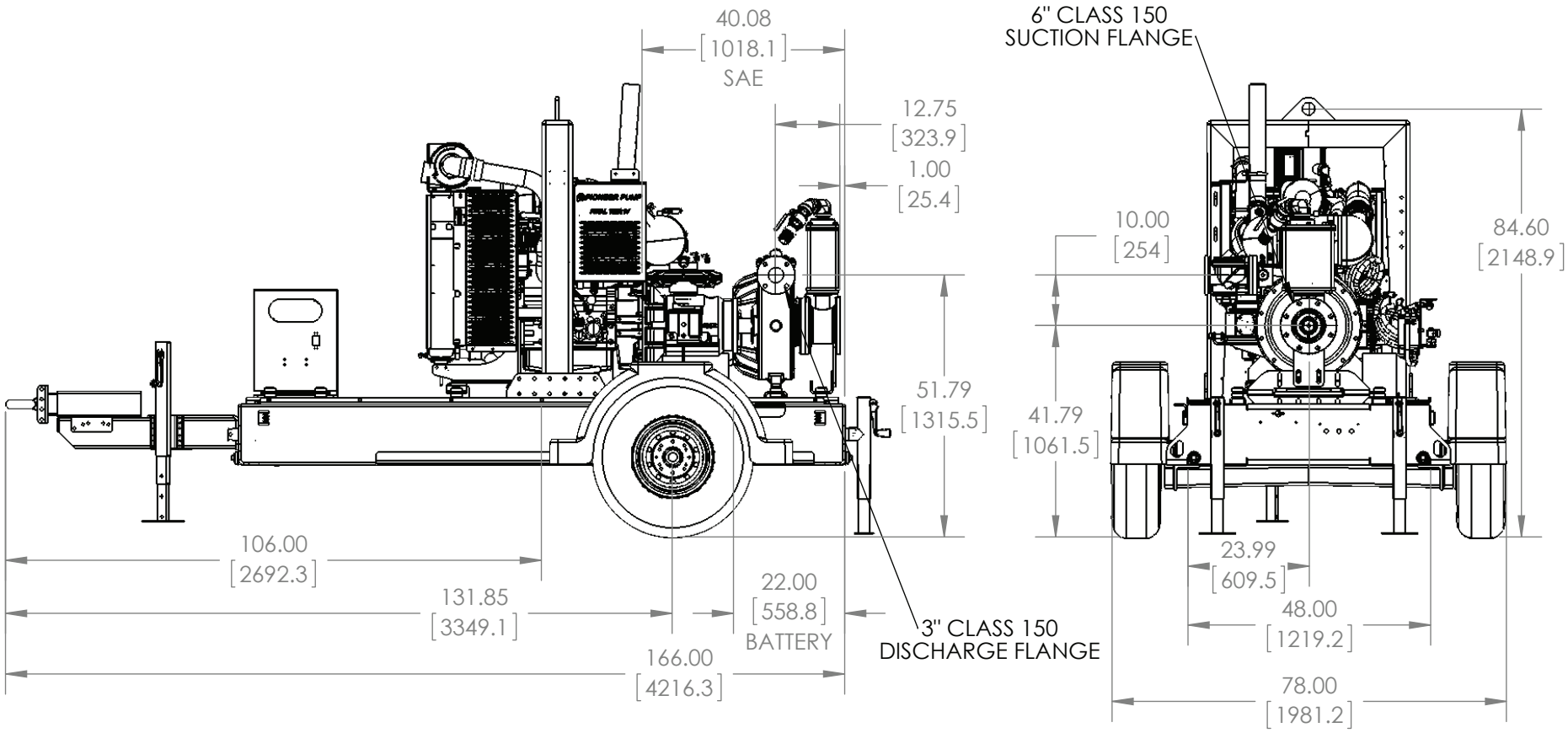
LIST OF SUPPLIERS

CHESTERFIELD INLET WATER TRANSMISSION LIN MATERIAL SUPPLIERS LIST

Supplier's Name	Supplied Material	Contact Name	Contact Number	Address	Email Address
ISCO Canada	Pipe, Fittings and Valves	Brian Mellville	403-438-0473	2901 Sturgeon Rd. Winnipeg, MB, R2Y 2L9	brian.mellville@isco-ahmcelroy.com
Canadian Industrial Pumps	Pump on Trailer incl. Flowmeter	Kjell Stroman	604-591-5055	103-6448 148th St. Surrey, BC, V35 7G7	kjell@cipumps.com
Screen Services	Suction Hose Fish Screen	Chris Rouselle	780-460-8043	1A-205 Chatelain Dr. St. Albert, AB, T8N 5A4	chrisr@screenservices.ca
Stellar Industrial	Suction Hose and Fittings	Andre Surrette	902-468-1202	94 Simmonds Dr. Dartmouth, NS, B3B 1P6	andres@stellarindustrial.ca
Shaw Concrete	Concrete Water Meter Boxes, Pipe anchors	Rylan MacDow	902-883-2201	1101 Highway #2, Lantz, NS, B2S 1M9	rmacdow@shawprecastsolutions.com
Atlantic Industrial	Culvert	Jennifer Smith	506-379-2456	CP 98, 109 Ave Dalcourt, Louiseville, QC, J5V 2L6	jsmith@ail.ca
Armtec	Nestable Culvert	Cole Dawson	204-222-7354	2976 Day St. Sunnyside, MB, RSR 0H7	cole.dawson@armtec.com

APPENDIX C

PIONEER PUMP OPERATIONS AND MAINTENANCE MANUAL



DIMENSIONS ARE IN INCHES AND [MILLIMETERES]. UNLESS OTHERWISE SPECIFIED, TOLERANCES ARE ±0.125 [3.2]

PIONEER PUMP
PERFORMANCE THROUGH INNOVATION™

TITLE:
DIM. PAGE, PP63C17-TCD3.6 DOT UP3 EB

WEIGHT:	NAME	DATE	SIZE	DWG. NO.	REV.
DRAWN BY	JLE	5/31/18	A	18994A	-.000
CHECKED BY	EW	5/31/18	SCALE: 1:32	DO NOT SCALE DRAWING	SHEET 1 OF 1

5 4 3 2 1

PIONEER PUMP
PERFORMANCE THROUGH INNOVATION™

Pioneer Prime

PP63C17L71

Typical Pump Configuration

Performance

Pioneer Prime series - vacuum assisted, end suction centrifugal pump

Bare shaft, frame mounted, fully automatic dry priming, vacuum assisted, run dry, heavy duty pump

Size	6" x 3" 150 x 76 mm
Flow, Max	960 USgpm 220 m^3/h 60 l/s
Head, Max	620 feet 190 meters
Flow at BEP	925 USgpm 210 m^3/h 60 l/s
Efficiency at BEP	72%
Solids Handling, Max	0.76" 19 mm
Operating Speed, Max	2400 rpm
Suction Connection	6" (150 mm) 150 ANSI Flanges
Delivery Connection	3" (76 mm) 150 ANSI Flanges
Bearing Lubrication	Oil STD Grease optional
Fasteners	Imperial

Applications

Oil & Gas	Construction
Industrial	Mining
Petrochemical	Rental
Agriculture	Irrigation

PosiValve™ Patent #6,783,730

High pressure, high flow, heavy duty pump

Designed to operate over a broad range of performance while delivering outstanding suction lift, the PP63C17 is the clear choice. The rugged construction and modular design provide proven reliability and flexibility in the most demanding applications.

UltraPrime™ Priming System

Priming System	Mechanically Driven Diaphragm Style Vacuum Pump
Air Removal Capability	50 CFM
Priming Chamber	Single chamber with positive sealing air separation PosiValve™ with stainless steel float ball & linkage.
Discharge Check Valve	Swing Style - ductile iron with Buna-n Disc

Other Specifications

Mechanical Seal	Single seal w/ tungsten carbide vs. silicon carbide seal faces, Viton® elastomers, 300 series stainless steel hardware and spring, designed for indefinite dry running
Pump End Bearing	Single Row Ball
Drive End Bearing	Double Row Angular Contact
Shaft	17-4 PH Stainless Steel

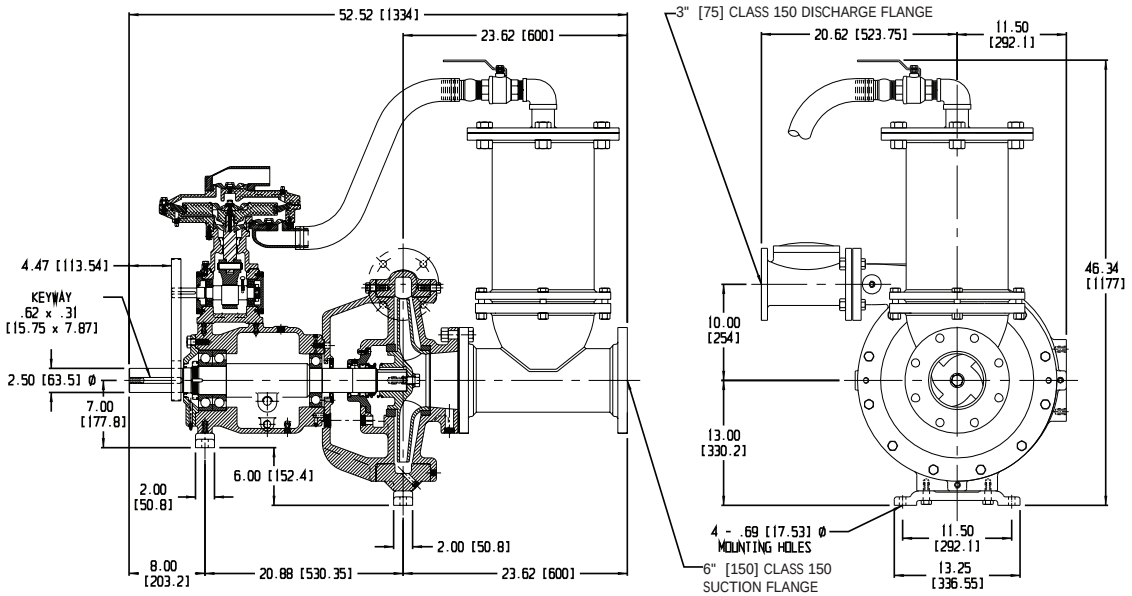
Construction Materials

	Standard Construction	CD4MCu Stainless Steel
Impeller	CA6NM SS	CD4MCu
Volute	Ductile Iron ASTM A536 65-45-12	CD4MCu
Wear Ring	ASTM A48 Class 40 Gray Iron	316 SS
Suction Cover	Ductile Iron ASTM A536 65-45-12	CD4MCu
Brac-plate	Ductile Iron ASTM A536 65-45-12	CD4MCu

Mechanical Dimensions

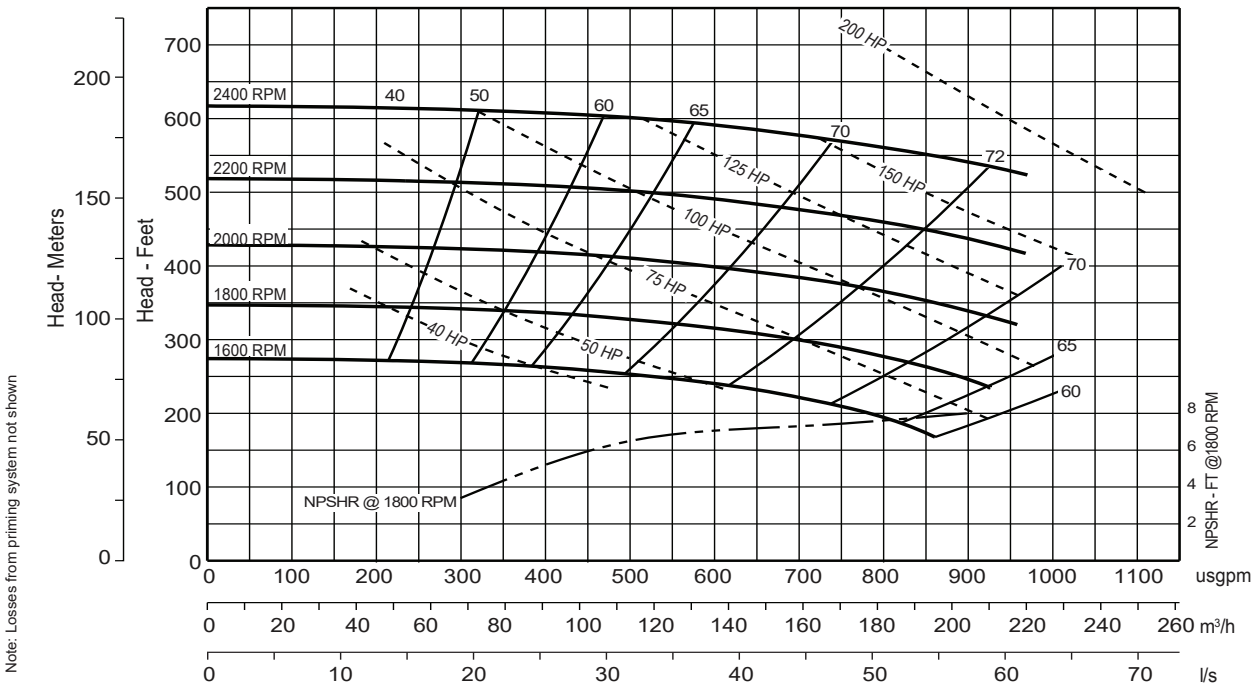
Typical Pump Configuration

PP63C17



Performance Curve

Model: PP63C17	Impeller Dia: 17”	Speed: Variable	Solids Size: 0.76”	Curve #A2032HQ



Corporate +1 (503) 266-4115 ■ EMEA +44 (0)1449 736777 ■ South Africa +27 (0) 118240085 ■ Australia +61 (3) 9988 1650

www.pioneerpump.com

Pump Data Sheet - Pioneer Pump

Company:
Name:
Date: 01/20/2020

Pump:

Model:	PP63C17	Dimensions:	Suction:	6 in
Type:	Pioneer Prime		Discharge:	3 in
Synch Speed:	Adjustable			
Dia:	17 in			
Curve:	14809HQ			
Size:	6x3			

Fluid:

Name:	Water		
SG:	1	Vapor Pressure:	0.256 psi a
Density:	62.4 lb/ft³	Atm Pressure:	14.7 psi a
Viscosity:	1.1 cP		
Temperature:	60 °F		

Pump Limits:

Temperature:	---	Sphere Size:	0.75 in
Wkg Pressure:	---		

Search Criteria:

Flow:	800 US gpm	Near Miss:	---
Head:	275 ft	Static Head:	0 ft

Motor:

DEUTZ/ TCD3.6/ 111 HP/ FT4

Pump Selection Warnings:

None

--- Duty Point ---

Flow:	800 US gpm
Head:	275 ft
Eff:	66.6%
Power:	83.1 hp
NPSHr:	5.99 ft
Speed:	1819 rpm

--- Design Curve ---

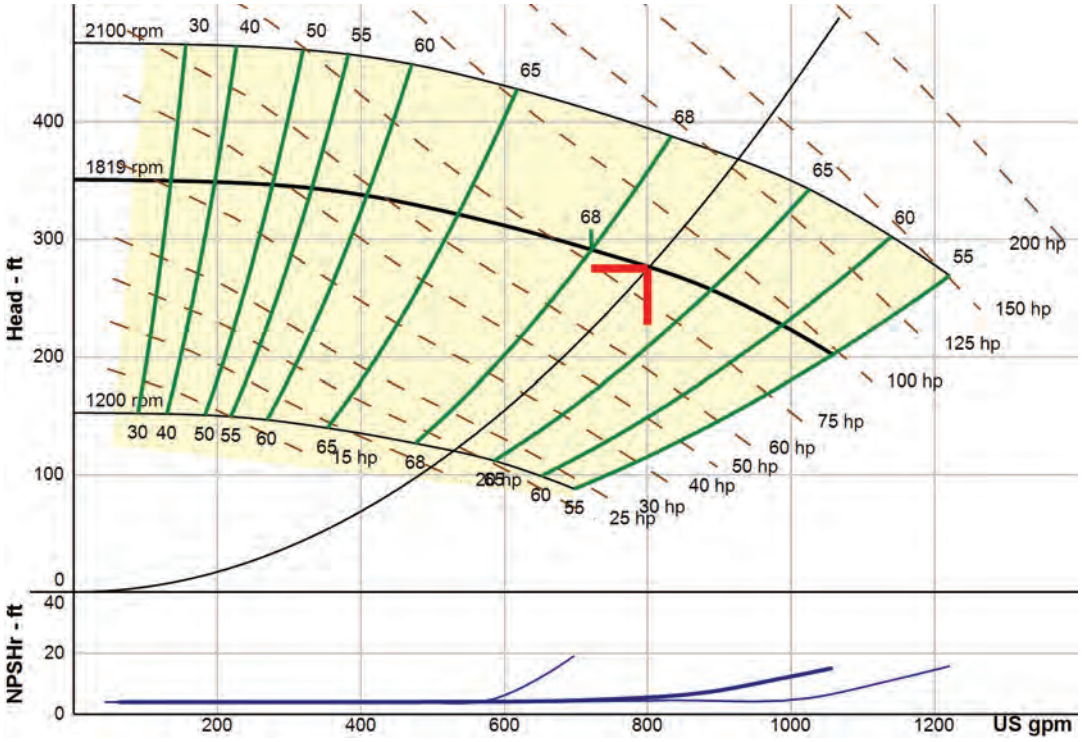
Shutoff Head:	351 ft
Shutoff dP:	152 psi
Min Flow:	--- US gpm

BEP: 68% @ 721 US gpm

NOL Power:
98.1 hp @ 1058 US gpm

--- Max Curve ---

Max Power:
151 hp @ 1221 US gpm

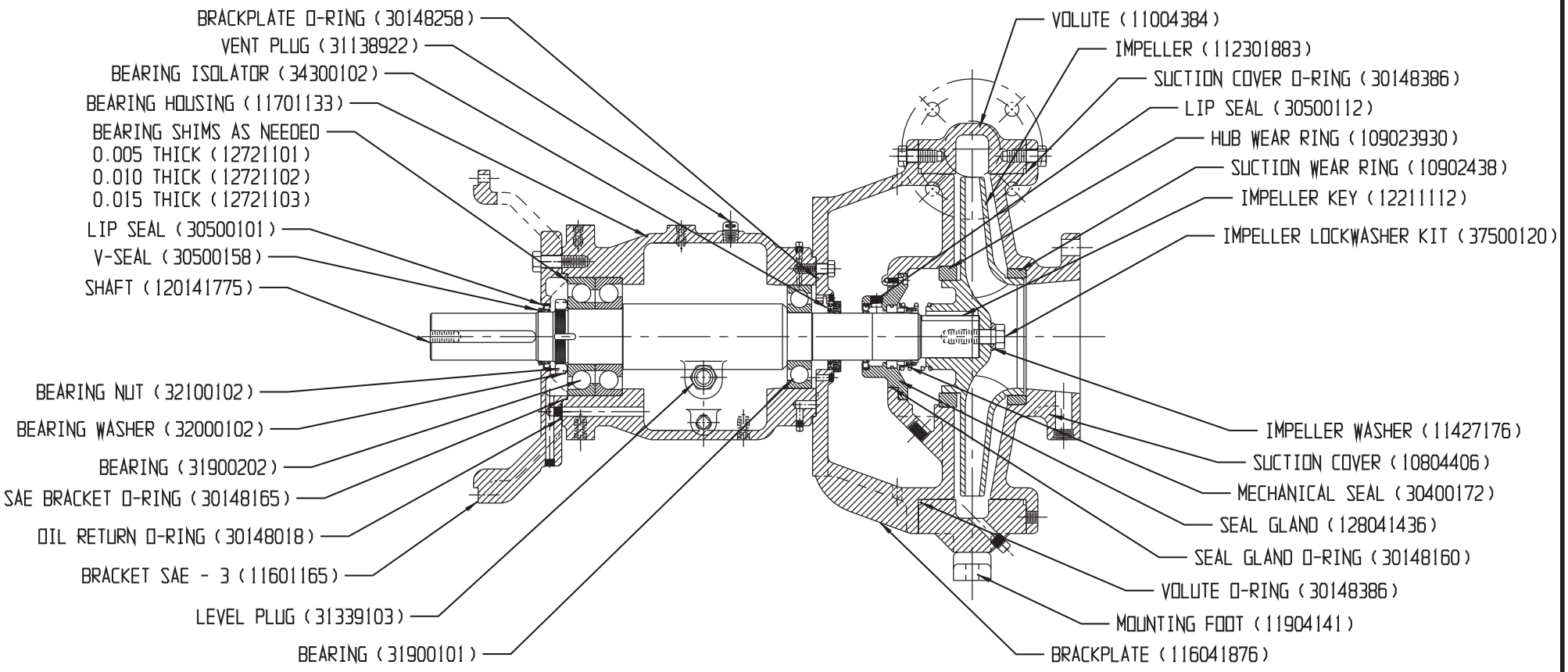


Performance Evaluation:

Flow	Speed	Head	Efficiency	Power	NPSHr
US gpm	rpm	ft	%	hp	ft
960	1819	235	61.4	92.8	10.6
800	1819	275	66.6	83.1	5.99
640	1819	304	66.7	73.1	4.45
480	1819	328	62.8	63	4.06
320	1819	344	53.9	51.5	4

NOTES:
- PIONEER PUMP PART NUMBERS IN ( ).
- CAPSCREWS NOT LISTED, USE GRADE 5 MATERIAL.
- ENGINE COUPLING (30200101) NOT SHOWN

IMPELLER LOCK WASHER KIT (37500120) INCLUDES:
- LOCK WASHER (32034101).
- LOCK WASHER (3512110231).
- IMPELLER WASHER (1142710068).
- IMPELLER SCREW (37627075C250).



PIONEERPUMP
PERFORMANCE THROUGH INNOVATION™

MODEL: SC63C17L71-E0311

REFERENCE: 63C17-0008

DWG NO. 13269A
REVISION: 000
DRAWN BY: RJG
DATE: 12/31/2013

Pioneer Prime Series
Operation & Maintenance Manual
(Open Bracket Style)

Manual #1501

Pioneer Pump, Inc.

Corporate Office

461 N.E. 3rd Avenue
Canby, OR 97013
Phone (503) 266-4115
Fax (503) 266-4116

Operation and Maintenance Manual
Table of Contents

INTRODUCTION

Thank you for purchasing a Pioneer end-suction centrifugal pump. This is a heavy duty pump intended for use with non-volatile, non-flammable liquids with specified entrained solids, except as approved by the factory.

WARNING!!!

This manual provides installation, operation and maintenance instructions for your Pioneer Pump, whether of vacuum-assisted self-priming or conventional configuration. It is intended to make your personnel aware of any procedure that requires special attention because of potential hazards to personnel or equipment. Read all instructions carefully and remember that pump installations are seldom identical. Therefore, this manual cannot possibly provide detailed instructions and precautions for each specific application. Thus, it is the owner/installer's responsibility to ensure that applications not addressed in this manual are performed only after establishing that neither operator safety nor pump integrity are compromised by the installation.

WARNING!!!

Centrifugal Pumps are designed for specific service and may or may not be suited for any other service without loss of performance or potential damage to equipment/personnel. If there is ever any doubt about suitability for a specific purpose; contact your **Pioneer Pump, Inc.** representative or the factory for assistance.

Remember: Pump performance may be affected by changes in pumpage such as, specific gravity, viscosity, temperature, operating speed and NPSHA (net positive suction head available).

INSPECTION

INSPECTION

All equipment is inspected at the factory prior to shipment. However, you should inspect all equipment upon arrival for shipping damage and item shortages from the packing slip. Report any damage or shortages to the carrier and **Pioneer Pump, Inc.**

RECORDING MODEL & SERIAL NUMBERS

Please record the model and serial number for your **Pioneer Pump** in the spaces provided below. The factory will need this information when you require parts or service.

Pump Model: _____
Pump Serial Number: _____
Engine/Motor Serial #: _____
Engine/Motor Model Mgf: _____

WARRANTY INFORMATION

LIMITED WARRANTY: Seller warrants for two years from the date of shipment Seller's manufactured products to the extent that Seller will replace those having defects in materials or workmanship when used for the purpose and in the manner which Seller recommends. If Seller's examination shall disclose to its satisfaction that the products are defective, and an adjustment is required, the amount of such adjustment shall not exceed the net sales price of the defective products and no allowance will be made for labor or expense of repairing or replacing defective products or workmanship or damage resulting from the same. Seller warrants the products which it sells of other manufacturers to the extent of the warranties of their respective makers. Where engineering design or fabrication work is supplied, buyer's acceptance of Seller's design or of delivery of work shall relieve Seller of all further obligation, other than as expressed in Seller's product warranty. **THIS IS SELLER'S SOLE WARRANTY. NO OTHER WARRANTIES, WRITTEN OR ORAL, EXPRESS OR IMPLIED, INCLUDING THE WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE AND MERCHANTABILITY, ARE MADE OR AUTHORIZED. NO AFFIRMATION OF FACT, PROMISE, DESCRIPTION OF PRODUCT OF USE OR SAMPLE OR MODEL SHALL CREATE ANY WARRANTY FROM MANUFACTURER, UNLESS SIGNED BY THE PRESIDENT OF THE MANUFACTURER**. Seller neither assumes, nor authorizes any person to assume for it, any other obligation in connection with the sale of its engineering designs or products. This warranty shall not apply to any products or parts of products which (a) have been repaired or altered outside of Seller's factory, in any manner; or (b) have been subjected to misuse, negligence or accidents; or (c) have been used in a manner contrary to Seller's instruction or recommendations. Seller shall not be responsible for design errors due to inaccurate or incomplete information supplied by Buyer or its representative.

INSTALLATION

FOUNDATION/BASE PLATE/SKID

Pioneer pumps are available in trailer mounted, skid mounted or conventional channel base mounted configurations, or bare pumps may be mounted by a third party. Typically a channel base mounted unit is intended for a permanent installation, and the following recommendations for permanent installations should be followed.

If using a concrete foundation it should be rigid enough to inhibit vibration. Pour the foundation well in advance of installation of pump equipment to allow time for drying and curing.

If the pump is to be mounted on a steel frame, or similar structure, it should be set directly over the supporting beams. These beams and the structure must be rigid enough to prevent distortion and potential misalignment due to movement within the structure or base.

The location of this structure should be as close as possible to the pumpage source. Provide adequate space for operation, maintenance and inspection of the pump and equipment.

The concrete foundation should be provided with anchor bolts for attachment to the base plate. If required, provide adequate drainage to keep pump and motor dry and clean. Also, provide either leveling nuts or leveling wedges for mounting the base plate to the foundation.

LEVELING

When mounting the base plate to the foundation use leveling nuts or wedges to provide a level, flat base plate. Use a machinist's level on the mounting pads and make adjustments as necessary as the anchor bolts are tightened. This will provide the true alignment between the pump and motor. For portable trailer or skid mounted, engine driven units, it is important that the pump / engine assembly be level so as to assure proper fuel feed and distribution of engine lubricants. Trailer mounted units can be leveled using the tongue jack and blocking under the lower wheel. Wheels should be properly chocked so as to prevent rolling of the trailer. Skid mounted units should be leveled by preparing the ground or blocking under the skid. For portable electric units accurate leveling is not particularly important except as required for proper piping alignment.

GROUT

If a base mounted pump is to be grouted, ensure that you have the mounting surface flat and level for correct alignment of pump and motor. Build a dam around the base plate perimeter that is to be watertight. Use standard grouting practice and be sure to protect (cover) the leveling wedges with caulk or plastic tape if they are to be removed later. After the grout has thoroughly hardened, remove forms. If the wedges are removed, fill holes with grout. Seal grout by covering with a quality paint or sealer.

TRAILER MOUNTED UNITS

See “OPERATION” section.

INSTALLING PUMP

Insure that all foreign material has been removed from the pump before mounting. Be sure to remove all shipping protection prior to operation.

NOTE: Many of the bare pumps are shipped with protective guards and coatings.

SUCTION PIPING

For best performance the suction piping should be at least as large as the pump flange, never smaller. Use an eccentric reducer at the suction flange with the straight side up. The use of flow-retarding fittings is to be avoided and if necessary should never be placed closer to the pump suction than four (4) times the pipe diameter. The pump should be at the highest point of the piping. Slope the piping up to the pump to prevent air pockets. Avoid changing pipe size except to reduce a larger suction pipe diameter to the pump suction flange size using the eccentric reducer mentioned above. All suction piping and fittings are to be checked for any foreign material (rocks, bolts, wire, etc.) and also any sharp burrs that could disrupt the flow.

DISCHARGE PIPING

Use a concentric taper on the discharge side to increase from pump discharge flange size to a larger discharge pipe diameter, or maintain discharge piping the same size as the discharge size of the pump. The decision of what size discharge pipe to use in an economic one, a balance between the higher cost of larger piping versus the higher energy requirements imposed by pipe friction. Otherwise, the only detrimental effects of discharge piping size choice derive from the pump running too near shut-off or too far out on its curve. The discharge size should be adequate to maintain reasonable velocities and reduce friction losses. All valving and additional fittings should be the same size as the discharge line.

SUCTION & DISCHARGE PIPE FLANGES

All piping is to be supported, braced and lined up square before connection to the pump flanges. In fixed or permanent installations a flexible fitting is recommended on both suction and discharge, to eliminate any piping strains being transmitted to the pump. Portable installations still require support of discharge and suction piping or hose near the pump so as to avoid undue forces being carried by the pump flanges. Supporting the piping or hoses with the pump flanges can result in rubbing and wear between rotating and stationary portions of the pump, possible breakage of the case or brackets or failure of seals or couplings.

NOTE: Flexible pipe couplings must be restrained so as not to transmit any strain to the pump flanges when expanding or contracting under pressure. Unrestrained expansion fittings can transmit enormous forces to the pump flanges.

SCREENING

Make provisions for the installation of a suction screen or strainer to prevent any debris from clogging the impeller. The open area of the strainer should be equal to at least four (4) times the area of the pipe. The screen should be rigid enough to prevent collapse when flow is reduced due to clogging.

SUMP DESIGN

The submergence of the suction pipe into the liquid should be at least four (4) to five (5) times the pipe diameter. If this is not possible then provide a baffle or a floating board. This is to prevent any vortex action allowing air into the pipe. For best performance a bell mouth fitting is recommended. Refer to the Hydraulic Institute Handbooks or other Hydraulic Data books for detailed sump design information.

LIFTING

Any lifting equipment is to be rated for at least five (5) times the weight of the item being lifted. Use only established methods when lifting or moving any heavy components.

ALIGNMENT OF PUMP AND MOTOR

Precise alignment is necessary to achieve correct performance of the system. Every time a component is moved this alignment will have to be checked. The alignment can be checked with a straight edge and an outside caliper, taper thickness gauge, dial indicators or, for best results, use a laser alignment tool. Use the straight edge across the outside diameters of the coupling halves to ensure that they are concentric and parallel. The outside calipers or the taper thickness gauge is to correct for any angular misalignment and to verify the correct gap between the coupling flanges. Use a laser alignment tool or dial indicators to adjust for concentric and angular displacement. With dial indicators, rotate shafts together and take readings every ninety (90) degrees. Make adjustments by placing shims under the driver, and be sure that the mounting bolts are properly tightened while taking readings and after final adjustment then install coupling guard.

If the pump is equipped with an SAE bracket and flywheel coupling for direct mounting of the pump to the engine bell housing, alignment between crankshaft and pump shaft is automatically attained due to the register fits between the bell housing and pump bracket.

ROTATION

Before the pump is started, correct rotation must be confirmed. If the rotation is not correct, then interchange any two of the leads on a three (3) phase driver. For a single-phase driver refer to the wiring diagram. Engine rotation should be confirmed with the engine supplier.

PRIMING

Pioneer pumps are available with a fully automatic vacuum priming system. If this priming device is not supplied on your pump model you will need either a flooded suction or a foot valve
and some other means of evacuating air from the pump case and suction line. With a flooded suction use a bleed valve at the top of the volute to allow trapped air to escape. If you are using a foot valve, then fill the suction line and pump case with water and use a bleed valve for trapped gas as above. If a hand primer is to be used it will be necessary to have an air tight check valve or closeable control valve on the discharge line to prevent the entry of air from the discharge side. Rotating the pump shaft will release trapped gas in the impeller.

If the pump is used with a flooded suction condition and your pump has a fully automatic vacuum priming system, you can close the isolation (failsafe) valve at the top of the priming chamber. This will isolate the vacuum pump inlet line from the pumpage and allow the vacuum pump to "coast" (extending the life of the vacuum pump and reducing the horsepower requirements on the driver).

OPERATION

PRE-START

1) Verify that rotation is correct and that the shaft rotates freely.

2) Check all piping connections for tightness.

3) Inspect all accessories and make sure they are appropriate for your installation.

4) Verify that the driver and coupling are aligned correctly and that all guards are in place.

5) Ensure that all bearings and grease seals are lubricated.

6) If vacuum assisted, check the vacuum pump oil level as well as the oil level in the backplate/bracket reservoir.

7) Oil levels should also be checked and maintained during pump operation.

8) Follow the instruction on all tags, labels and decals attached to the equipment.

STARTING

WARNING!!!

This pump is designed to handle most non-volatile, non-flammable liquids containing specified entrained solids and corrosives. Do not attempt to pump volatile, corrosive, or flammable liquids which may damage the pump or endanger personnel as a result of pump failure.

CAUTION!!!

Pump speed and operating condition points must be within the continuous performance range shown on the performance curve in the separate Part List Manual for your specific pump model.

STARTING

Any centrifugal pump must be primed before starting unless it is of a self-priming design. See preceding section on priming, and ensure suction pipe is filled with water. With discharge valve closed, start the pump and slowly open valve. Throttle the flow gradually to fully open. Avoid any abrupt changes in the discharge flow rate to prevent pressure surges in the piping. If the design pressure is not achieved shut the pump down immediately. Ensure that pump is adequately primed and restart.

Never run the pump with the discharge valve closed for extended periods of time. Never use the suction valve to throttle the flow. Check all suction and discharge piping for leaks.

If a suction strainer is installed, check the pressure drop across the strainer. If the differential in pressure exceeds five (5) PSI have the strainer cleaned.

OPERATION OF ENGINE DRIVEN UNITS

Before Starting

Check the fuel level and oil levels in the engine, check the oil level in the vacuum pump and/or grease & oil in the pump bearing housing and seal chamber (backplate/bracket reservoir).

CAUTION!!!

Make sure the pump is level. Lower jack stands and chock the wheels. Use caution when positioning the skid-mounted unit to prevent damage to the fuel tank. Consult the engine operations manual before attempting to start the unit.

WARNING!!!

Do not operate the pump without guards in place over the rotating parts. Exposed rotating parts can catch clothing, fingers or tools, causing severe injury to personnel.

WARNING!!!

Before attempting to service this pump, read this manual carefully. Operators and maintenance personnel should have a good understanding of all aspects of this pump and the pumping conditions. Failure of operating personnel to be familiar with all aspects of pump operation outlined in this manual could contribute to equipment damage, bodily injury or possible death.

WARNING!!!

Before any servicing:

1) Read this manual carefully.
2) Shut down driver and lock out incoming power to ensure that the pump will remain inoperative.
3) If the pump or components are hot, allow adequate cooling prior to servicing the unit.
4) Close the suction and discharge valves.
5) Vent the pump slowly and drain completely.

WARNING!!!

If this pump is used to handle any hazardous materials that can cause illness, either directly or indirectly, take precautions by wearing approved protective clothing and use appropriate safety equipment. Also, review section on Vacuum Pump venting.

WARNING!!!

Use lifting and moving equipment in good repair and with adequate capacity to prevent injuries to personnel or damage to equipment. Attach lifting equipment to the lifting device fitted to the pump. If chains or cable are wrapped around the pump to lift it make certain that they are positioned so as not to damage the pump and so that the load will be balanced. The bail on trailer or skid mounted units is intended for use in lifting the pump assembly only. Suction and discharge hoses and piping must be removed from the pump before lifting.

CAUTION!!!

When servicing this pump, use only components provided by **Pioneer Pump, Inc.** Any use of non-authorized parts could result in sub standard performance, damage to equipment and possible injury to personnel. Non-authorized parts will also void the warranty.

When using this manual any reference to part numbers or names will be directed to the applicable cross section drawing. These parts will also be called out in the bill of materials for full description.

Drain volute case of pumpage when unit is idle to avoid freezing and possible cracking of pump case, etc.

This manual also provides a troubleshooting section to diagnose many operational or performance problems. The equipment covered in this section is limited to the pump, priming and drive components only. Refer to the applicable vendor's manual for motors, engines and other accessory equipment. Use the troubleshooting section to help determine the cause of any problems, and only disassemble the pump components required to remedy the existing condition.

This manual provides installation, operation and maintenance instructions for your Pioneer Auto Prime Pump. The manual will also make your personnel aware of any procedure that requires special attention because of potential hazards to personnel or equipment. Read all instructions carefully and remember this manual cannot anticipate or warn of every situation that could occur. Because of this the owner is responsible that only safe procedures be used, if not addressed in this manual. If any question regarding the pump is not covered adequately please contact **Pioneer Pump, Inc.**

WARNING!!!

Select a clean suitable location for any required maintenance, and note that all work must be performed by qualified personnel.

An ongoing record of performance will assist in any troubleshooting and/or analysis of problems. A pressure gauge can be installed on the suction and discharge side of the pump to monitor any changes in differential pressure. Differential pressure is useful in monitoring and diagnosing any possible degradation in pump performance.

MAINTENANCE

PRIMING CHAMBER (Pioneer Prime only) Figures A2017A & A2169A

Disconnect and remove suction piping and air tubing from the **priming chamber/suction spool** assembly. While supporting the assembly with a sling, remove the nuts and bolts connecting the suction spool to the pump suction flange.

VACUUM PUMP (Pioneer Prime only)

The **vacuum pump** can be removed or left in place for maintenance of vacuum pump or bearing frame at the discretion of maintenance personnel

NOTE: When part names are referenced throughout these instructions they are highlighted and correspond to the part names on parts the parts illustrations, figures A638A, A2189A

VACUUM PUMP PERFORMANCE SPECIFICATIONS / FEATURES (Pioneer Prime)

This mechanically operated diaphragm vacuum pump is designed to deliver a maximum air removal rate of 50 CFM and a maximum vacuum of 25 to 26.5 inches of mercury while running at a nominal 1100 rpm. It is specifically designed for pump priming and repriming and is tolerant of small amounts of liquid passing through it. Routine maintenance is simple and can be performed on site without special tools. No auxiliary lubrication or water separation systems or filters are required.

Power consumption is minimal. At maximum air removal rate and under moderate vacuum no more than 2 h.p. is required. Once the pump is primed and the airflow to the vacuum pump is stopped power consumption is approximately ½ h.p.

VACUUM PUMP OPERATING SPEED (Pioneer Prime only)

As with most mechanical devices the replacement interval for the wear components is largely a function of speed. When operated at 1000 to 1200 rpm an average replacement interval for the **actuator seal** is approximately 4000 hours. Higher speeds will reduce this interval, and lower speeds will increase it. Operation in excess of 1400 rpm for significant periods should be avoided. If the pump being primed is to operate in excess of 2300 rpm for an extended period, then a different vacuum pump pulley ratio should be considered. While priming speed will increase or decrease directly with increasing or decreasing vacuum pump speed, actuator seal life changes very approximately as the cube of operating speed change. So, it is not advantageous to increase operating speed in order to obtain a small reduction is priming speed.

Other vacuum pump components, such as the **inlet/outlet valves, neck seal** and **actuator valve** will require replacement over a much longer interval and should simply be inspected whenever other maintenance is performed.

NOTE: The vacuum pump pulley ratio is designed to operate the vacuum pump at 1100 rpm when the driver is running at 1800 rpm.

VACUUM PUMP BELT TENSION (Pioneer Prime only)

The vacuum pump is driven by a toothed timing belt connected to a pulley on the main pump shaft. This pulley and belt system is sized for considerably higher horsepower than the vacuum pump requires, and therefore, belt tension can be kept at a minimum. The belt should be just tight enough so that it does not have any slack. Belt tension is adjusted by adding or subtracting "motor base shims" between the vacuum pump base and the mounting surface.

VACUUM PUMP VENTING (Pioneer Prime only)

WARNING!!!

If the pump is operated in an enclosed space and the pumpage may contain potentially hazardous fumes make certain that an exhaust hose is securely connected to the vacuum pump exhaust nozzle and routed outside the enclosed space. **Failure to do so may result in injury or death.**

***Before starting the vacuum pump check the following*:**

1) Oil level in the vacuum pump crankcase should be in the center of the oil level site glass. A 30wt, non-detergent motor oil should be used. Make certain that the drive pulley is secured to the shaft. Verify the tightness of the screws on the pulley bushing.

2) Make certain that the belt guard is securely in place. **WARNING!!! Do not operate the pump without all guards in place. Injury or death could result.**

3) Make certain that the suction hose between the vacuum pump and the priming chamber is tight to the suction nozzle and has no leaks. Air leaks will cause the vacuum pump to run hotter than normal, shortening the actuator seal, neck seal and valve lives.

VACUUM PUMP DISASSEMBLY FOR MAINTENANCE (Pioneer Prime only)

To replace the **exhaust valve** remove the capscrews securing the **exhaust nozzle** to the **upper housing**, and lift off the housing. The exhaust valve is now exposed. It is not necessary to remove the **valve stud** when replacing the exhaust valve - simply pull the exhaust valve off over the head of the valve stud. When installing a new exhaust valve lubricate the head of the valve stud with motor oil or liquid dish soap, then just push the exhaust valve on over the head of the valve stud. Reattach the exhaust nozzle to the upper housing. Snug the screws, but do not over tighten, or the threads in the aluminum housing may be damaged.

Replacing the **inlet valve** is the same as described above. Remove the nuts and washers securing the **inlet nozzle/valve carrier** to the studs in the **lower housing**. Remove and replace the inlet valve per the instructions for **exhaust valve** replacement. When reattaching the inlet nozzle/valve carrier check the condition of the **inlet nozzle/valve carrier gasket**, and replace as necessary.

In order to check or replace the **actuator seal, actuator valve or neck seal** remove the **housing bolts, nuts and washers**, and lift the **upper housing** off. The actuator valve is now exposed and can be removed and reinstalled exactly as the inlet and exhaust valves.
To replace the actuator seal remove the **cotter pin** and **castle nut** securing the **actuator** to the

actuator shaft (when reinstalling the castle nut, torque to 50 ft-lbs). Rotate the crankshaft so that the actuator moves to "top dead center" position. Work the actuator seal out of the groove in the **lower housing**. The actuator has two threaded holes on the top to enable attachment of a "gear puller" for removal of the actuator. Pioneer Pump, Inc. can supply a puller specifically designed for this task if a suitable puller cannot be found. The easiest way to remove the actuator seal is to clamp the actuator in a vice, and pull the actuator seal up out of the groove. If the seal is to be discarded it is easier to partially cut it with a utility knife and then pull it out of the groove. To install a new actuator seal, thoroughly lubricate the inside diameter of the actuator seal and the groove in the actuator.

Note: the actuator seal must be installed with the taper on the outside diameter parallel to that of the lower housing (the larger diameter at the top of the actuator).

Now, work one edge of the actuator seal into the groove in the actuator much the same as you would a bicycle tire when installing it on the rim. Secure the assembly in a vice, and using a blunt instrument, such as a wrench handle, work the other edge of the actuator seal into the groove. Again, liberal lubrication is necessary to perform this installation. It takes some effort, but you'll get the hang of it! See **Figure A2188A** for instructions on reinstalling the actuator onto the actuator shaft. Apply LocTite™ 262 or equivalent thread locker to the threads of the actuator screw. Tighten the castle nut to 13 foot pounds. While tightening, make certain to align one of the slots in the castle nut with the cotter pin hole through the actuator threads.

For the following procedures refer to figure A2189A

To service the **neck seal** and other components requires further disassembly. With the actuator removed, remove the nuts and washers from the studs securing the lower housing to the **pedestal**. Apply a little lubricant to the exposed portion of the actuator shaft. Now lift the lower housing off the pedestal - the neck seal should come off with the lower housing. The neck seal can now be removed from the counterbore in the bottom of the lower housing. To install a new neck seal, lubricate the inside diameter of the seal, push the seal into the counterbore of the lower housing, and remount the lower housing onto the pedestal - the neck seal, if lubricated properly, will slide over the end of the actuator shaft.

To further disassemble, remove the capscrews securing the **pedestal** to the **crankcase**, and lift the pedestal off over the actuator shaft. Take care to support the actuator shaft so that it doesn't strike the side of the crankcase and mar its surface finish. Rotate the crankshaft to bring the actuator shaft to its top dead position. Now one of the **retaining rings** at one end of the **fulcrum pin** can be removed, and the fulcrum pin can be pulled out of the **connecting rod small-end bearings** and **actuator shaft bearings**. Slide the **connecting rod** as far to one side as possible, and with a pair of plyers, remove the **oil flinger** from the **crank shaft**. Remove the **bearing cap fasteners** from both the **drive-end** and **opposite drive-end**, and remove the bearing caps. Push the crankshaft far enough out the opposite drive-end to access the **bearing locknut**. Remove the bearing locknut and **bearing washer**. Now the crankshaft can be pulled out of the drive-end of the crankcase, and the opposite drive-end **crankshaft roller bearing** should remain in the crankcase. The drive-end crankshaft roller bearing may slide off the crankshaft by hand or may have to be removed with a gear puller.

The connecting rod can now be lifted out the top of the crankcase.

Inspect the **connecting rod small-end bearings** for uneven or excessive wear. If the inside diameter of the installed connecting rod small-end bearings exceeds 0.628" they should be replaced. The old bearings will have to be pressed out using a suitable mandrel. After the new bearings are pressed in they must be finish reamed to a diameter of 0.6255 to 0.6260.

Inspect the **connecting rod large-end bearing** for excessive or uneven wear. If the inside diameter exceeds 2.007" the bearing should be replaced. Again, a suitable mandrel will be necessary in order to press out the old bearing and press in the new bearing. Be sure to install the large-end connecting rod bearing with the joint to one side or the other - not at top or bottom. This bearing requires no finishing after machining.

The **actuator shaft bearing** should be inspected, replaced and finish reamed exactly as the connecting rod small-end bearings.

If the **drive-end bearing cap lip seal** is to be replaced it should be pressed into the counterbore on the inside of the bearing cap with the lip pointing toward the crankcase. To reinstall the **crankshaft** into the **crankcase** first mount the **drive-end crankshaft roller bearing** onto the shaft. If it does not slide on by hand heat it uniformly in an oven or on a hot plate to approximately 200°F, and then quickly slide it onto the shaft and securely up against the shaft shoulder. Now set the **connecting rod** into the crankcase, and insert the crankshaft through the drive-end opening of the crankcase, through the connecting rod. Now slide the **opposite drive-end roller bearing** onto the crankshaft (it may also require heating). Install the **bearing lockwasher** with the tabs pointing away from the bearing. Make certain that the tab on the inside diameter of the washer engages the slot on the shaft. Install the **bearing locknut** with the beveled side toward the bearing. Using a suitable spanner wrench tighten the nut. Bend one of the tabs on the outside diameter of the washer down into one of the slots on the outside diameter of the bearing locknut.

Reinstall the **opposite drive-end bearing cap**. Make certain that the **bearing cap o-ring** is mounted on the “nose” of the bearing cap. Reinstall the **drive-end bearing cap**. Now, push the shaft toward the opposite drive-end as far as it will go, mount a dial indicator against the end of the **crankshaft**, then pull the shaft as far toward the drive-end as possible. The end-play should be between 0.002" and 0.010". If end-play exceeds the upper limit remove the drive-end bearing cap and install **bearing shims** as necessary to obtain the proper end-play. Be certain to install the bearing cap o-ring on the drive-end bearing cap “nose” for final installation.

Check the **actuator shaft guide bushing** for excessive or uneven wear. If it’s installed inside diameter exceeds 1.385 it should be replaced. Again, a suitable mandrel is necessary to press it out of the **pedestal** and reinstall a new bushing. It will be necessary to remove the **actuator shaft lip seal** in order to remove and reinstall the **actuator shaft guide bushing**. A new actuator shaft lip seal should be installed after the new actuator shaft guide bushing is in place. The actuator shaft lip seal is to be installed with the lip pointing downward. After installation, the inside diameter of the actuator shaft guide bushing should be wiped with grease.

The remainder of the reassembly is the opposite of the disassembly procedure. Be sure to mount the **pedestal o-ring** over the “nose” of the bottom end of the **pedestal** before reinstalling the **pedestal**.

PRIMING VALVE SERVICING (Pioneer Prime only) Figures A1459A, A1784A

The **priming valve** system, housed inside the priming chamber, is adjusted at the factory and should rarely require service. It is possible, after extended use, that wear of the holes in the **upper arm, lower arm, link** or **pins** could necessitate slight adjustment of the **stem washer** to upper arm clearance. Furthermore, it may become necessary to adjust the **valve spring** tension. The procedures for both of these adjustments are delineated in figure A1784A. The only other potential service requirement is replacement of the **stem o-ring**. To replace this o-ring, remove the elbow attached to the outlet of the priming chamber. This will expose the internal valve components. Grasping the lower end of the valve stem, remove the nut and washer located on top of the **valve washer**. Remove the valve washer and valve spring. The valve stem can now be removed through the bottom side of the **priming chamber lid**. Cut the old stem o-ring to remove it, and simply "roll" a new o-ring into place. Reassembly is the opposite of disassembly.

DISCHARGE CHECK VALVE (Pioneer Prime only)
Figures A2017A, A2170A & Fig. 17

Support the **check valve** with a sling and remove the nuts, bolts, and gasket between the check valve and pump discharge flange. If the check valve disc (3) needs to be replaced, remove the top cover (2) and insert new disc. The top cover gasket (4) should be replaced at this time.

SUCTION COVER AND WEAR RING
Figure A2048A

If the pump is equipped with an **external balance line** it must be removed prior to removing the suction cover. Disconnect the balance line from either the **suction cover** , **suction spool** or the **backplate.**

Support the **suction cover** using a suitable sling. Remove the capscrews between the suction cover and **volute**. Jackscrew holes are provided in the suction cover to aid removal from the volute. Insert two of the capscrews attaching the suction cover to the volute into the jackscrew holes, and tighten them evenly to jack the suction cover free of the volute. If the **suction wear ring** shows grooves or uneven wear it should be replaced. Minor irregularities can be dressed with a fine file and crocus cloth. Wear rings may be reworked by light machining, if proper equipment is available to correct minor irregularities. After the removal of any stock, the ring must remain within allowable clearances for maximum performance. (Consult factory for clearances for specific models).

When the pump performance drops below acceptable limits the **suction wear-ring** and **hub wear ring** (if so equipped) should be replaced. These rings can be removed by drilling two holes of the adequate size, axially, through the ring 180° apart. The ring can now be collapsed and removed.

Tap new ring into place evenly around circumference with chamfer toward suction flange. Anti-seize lubrication should be applied to the "OD" of the ring prior to installation in suction cover. Make sure wear ring is installed tight against shoulder.

ONE PIECE VOLUTE AND WEAR RING
Figure A2049A

Support the **volute** using a suitable sling and remove the capscrews between the volute and **backplate**. There are jackscrew holes in the backplate flange to aid in removal of the volute. Insert two of the volute capscrews in the jackscrew holes, and tighten them evenly to push the volute free of the backplate. If the **suction wear ring** shows grooves or uneven wear it should be replaced. Minor irregularities can be dressed with a fine file and crocus cloth. Wear rings may be reworked by light machining, if proper equipment is available to correct minor irregularities. After the removal of any stock, the ring must remain within allowable clearances for maximum performance. When the pump performance drops below acceptable limits the **volute wear ring** should be replaced. This ring can be removed by drilling two holes, of the proper size, axially, through the ring 180° apart. The ring can now be collapsed and removed.

Tap new ring into place evenly around circumference with chamfer toward suction flange. Anti-seize lubrication should be applied to the outside diameter of the ring prior to installation in volute, make sure wear ring is installed tight against shoulder.

NOTE: If this pump is equipped with Pioneer's run-dry feature for mechanical seal protection, then, prior to any further disassembly of this pump, the external **oil reservoir** and **auxiliary gland** should be drained. First drain the reservoir via the plug in the bottom. Then disconnect the oil line from the reservoir, and lower this disconnected end into a suitable container.

IMPELLER REMOVAL
Figure A2050A

Remove the **impeller lockscrew** and **washer** at the center of the **impeller**. Utilizing a properly sized gear puller, evenly pry between the back shroud of the impeller and the **backplate**. Take care not to lose or damage any **impeller shims** that may be inside the impeller bore, and do not lose the **impeller key**. As the impeller is being removed from the **shaft** ensure that the **seal spring**, if present, is not lost or damaged. Inspect the impeller and replace or repair if warranted.

SEAL REMOVAL (Rotating Element)
Figure A2051A

Once the **impeller** is removed, the **rotating assembly** of the seal (bellows, spring and retainer) can slide off of the **shaft** as a unit. Apply a light coat of oil to the shaft to help free the rotating assembly. Take care to protect this assembly from any foreign matter or damage. **For hot oil pumps**: Note the position of the tail of the seal on the shaft so that seal can be reinstalled to the exact same location on the shaft. Loosen the set screws securing the metal bellows seal to the shaft and pull the seal off the shaft by grasping the seal at the "face end" and compressing the bellows. Do not pull the seal off from the set screw end as this may stretch and permanently deform the bellows.

BRACKPLATE REMOVAL Figure A2052A / Figure A2053A

The "**brackplate"** can now be removed by removing the capscrews between the **brackplate** and the **bearing housing**. A sling or other support should be attached to the brackplate prior to its removal. Slide the brackplate straight off of the **shaft** to prevent any damage to the **stationary seal seat** or the surface of the shaft. Care should also be taken to avoid damaging the **brackplate lipseal(s)** or the **run-dry gland lipseal.** The stationary seal seat can now be pressed out of the brackplate bore, taking care not to break the seat. The entire **seal assembly** can now be inspected for any damage that will require replacement or reconditioning.

BEARING HOUSING Figure A2054A

If the frame **bearings** require servicing it will be necessary to remove the **bearing housing** from the driver and the pump end from the bearing housing. Remove the coupling guard as necessary. With the bearing housing supported with a hoist and sling remove bolts holding the housing to the baseplate. Now the bearing housing can be moved away from the driver for further servicing.

Loosen the setscrews holding the **timing belt pulley** (Pioneer Prime only) to the bearing housing **shaft**. Remove the ¼-20UNC socket head screw from the **wedge key** in the pulley. Insert a 5/16-18UNC capscrew into the threads of the wedge key, and tighten until the key is loose. Reinstall the ¼-20UNC socket head screw until the threads just engage the non-visible half of the wedge key, and grasping the head of the screw, pull the key out. Slide the pulley off the end of the shaft.

On the drive-end of the bearing housing remove the capscrews holding the **bearing housing cover** or the **SAE bracket** to the housing. Gently slide the housing cover or the SAE bracket off of the shaft to protect the lip seal(s) if it is to be reused.

Now the shaft assembly, including the **shaft, bearings and the bearing locknut and washer** can be removed through the drive-end of the bearing housing. This operation may require placing a block of wood against the impeller-end of the shaft and tapping with a "dead blow" hammer or using a mechanical or hydraulic press against the impeller end of the shaft. If the bearings are to be re-used, the shaft should be pressed out rather than tapped out with a hammer. With the shaft and bearing assembly out of the housing the bearings can be inspected and replaced as necessary.

CAUTION!!!

Any work on the **shaft** and bearing assembly should be done in a properly equipped shop by experienced personnel. We recommend that the **bearings** be replaced any time they are removed from the **bearing housing**. Clean the bearing housing and the shaft and other components except the bearings, with cleaning solvent and a string / lint free cloth. Inspect all parts and blow components dry with compressed air. If the **bearings** are to be replaced, the old bearings can be removed using a suitable gear puller. It is recommended that brackplate and **bearing cap lip seals** also be replaced at this time. These lip seals can be driven out of their bores with a drift, punch or screw driver. Before removing the lip seals note the orientation of the lips, and be certain to install the new seals with the same orientation. When driving or pressing in the lip seals use a flat block or plate which applies pressure around the entire circumference of the seal – **do not drive the seal in with a drift or punch.**

WARNING!!!

When using cleaning solvent be sure to have adequate ventilation, as most solvents are toxic and flammable. Follow all precautions pertaining to the solvent and keep area free from excessive heat, sparks and flame.

Rotate the bearings by hand and check for any roughness or wear. If any roughness, wear or discolored areas are present, replace the bearings. Also, check the fit between the bearings and shaft for a tight press fit and between the bearings and the housing for a snug slip fit. If the fits are not correct then replace the bearings, shaft or the bearing housing as indicated by wear. If bearings are to be replaced use a bearing puller to remove then from the shaft.

BEARING HOUSING REASSEMBLY Figure A2054A / A2055A

After all components have been inspected, repaired, and or replaced ensure all parts are clean and ready for assembly as indicated above. Use extreme caution, during assembly, to protect all parts from dirt and damage. The bearings should be installed using the bearing manufacturer's recommended installation procedure.

CAUTION!!!

If heat is used to install the **bearing** use an induction heater, electric oven or hot plate. Do not use a direct flame. Heat the bearings to a uniform temperature of 220E F (105EC) maximum, and slide each bearing onto the **shaft** until firmly seated against the shaft shoulder. Once the bearing is removed from the heat it must be placed over the shaft and seated against the shoulder very quickly or it will seize to the shaft in the wrong position. After the bearings have cooled; ensure that they are still seated against the shaft shoulder. If they are not seated use a sleeve, of the correct size, and a press to seat bearing. This sleeve and press can be used if heating the bearing is not practical, but only press against the inner race of the bearing.

CAUTION!!!

With the **Drive-End bearing** firmly seated against the shaft shoulder install the **bearing lockwasher** and the **bearing locknut**. Refer to **figure A2055A** for the correct orientation. Ensure the washer tab on the inside diameter is engaged in the slot in the shaft and the tab pointed toward the bearing. After the bearing nut has been tightened, bend one of the tabs on the outside diameter of the washer to engage one of the slots in the nut.

Some pumps are equipped with double angular contact bearings at the drive end. It is imperative that these bearings be installed in the correct orientation relative to one another. When installing the first of the two angular contact bearings onto the shaft make certain that the side of the inner race with the largest diameter is located against the shaft shoulder. The next bearing must be installed with smaller diameter side of the inner race against the first bearing. **Refer to illustration A2056A.**

Check that the **bearing housing** is clean and that the bearing bores are free of any burrs or nicks. Ensure that the **bearing housing spacer** (not used with double drive-end bearings) is installed in the drive-end bore of the housing. Wait for bearing to cool, then, from the drive-end of the bearing housing, slide the shaft/bearing assembly into the drive-end of the housing. Press the drive end of the **shaft** until the **drive-end bearing** contacts the housing or bearing spacer shoulder.

Apply a light coat of oil or grease to the **bearing cap lipseal(s)** that is installed in the or **SAE bracket lip seal(s)**. Slide the bearing cap or SAE bracket over the drive end of the shaft taking care to protect the lip seal. Secure the bearing cap to the bearing housing using the capscrews. For oil lubricated bearing frames make sure that the **bearing cap o-ring** is installed on the bearing cap register. Moving the shaft in both axial directions should produce a total endplay between 0.002"and 0.010". Use **bearing shims** to limit endplay to this range.

BEARING HOUSING TO DRIVER REASSEMBLY Figures A2054A, A2183A, A2187A

For Pioneer Prime pumps slide the **timing belt sprocket** onto the pump shaft and all the way up against the shaft shoulder. Assemble the two halves of the **wedge key** so that there is approximately ¼" gap between the two halves with the ¼-20UNC socket head screw installed. Place the assemble wedge key into the shaft keyway, and slide it into the pulley keyway so that the key is approximately flush with the outer face of the pulley. Tighten the ¼-20UNC socket head screw until the key is firmly locked into the keyway. Tighten the sprocket set screws to the pump shaft. See the section on **vacuum pump maintenance** for servicing and installation details. Install the **shaft key** and **flexible coupling hub** onto the pump shaft, but do not secure. Position the bearing housing assembly into its running location and align to the driver as per the alignment section in this manual.

After the **bearing housing** assembly and driver have been aligned, secure the bearing housing assembly to the baseplate, then recheck alignment. Check that the coupling hub is secured to the **shaft** and install the coupling guard.

NOTE: For SAE bracket equipped bearing frames, coupling alignment is attained by simply bolting the bearing frame SAE bracket to the engine bellhousing.

FLYWHEEL COUPLING INSTALLATION / SAE BRACKET EQUIPPED PUMPS
Figure A2184A

Pioneer pumps purchased with SAE brackets and Flywheel couplings are shipped with the coupling mounted to the shaft in the correct axial location for engines with bell housings and flywheels manufactured to SAE standard dimensions.

CAUTION!!!

If the pump is to be mounted to the engine by other than Pioneer Pump, Inc. factory personnel, the assembler must take full responsibility to verify that the pump shaft does not bear against or make any contact with the engine crankshaft or flywheel and that the flywheel coupling is mounted in such a position so as not to transmit any axial thrust to the flywheel. Failure to verify this could result in severe engine damage.

Bolt the aluminum drive ring of the flywheel coupling to the flywheel register, and torque the fasteners (grade 8) to 372 in-lbs. Place the notched key (provided by Pioneer) into the taperlock bushing, and position the rubber element and taperlock bushing on the shaft as shown on illustration A2184A (refer to the preceding caution). Torque the taperlock bushing screws to 430 in-lbs.

BRACKPLATE TO BEARING HOUSING REASSEMBLY

Apply a coat of oil or grease to the **brackplate lip seal(s)** and to the **run-dry gland lip seal** (if present). Slide the **brackplate** over the pump-end of the **shaft**, protecting the lip seals. Check that the **brackplate drain port** is located in the bottom position. Secure the brackplate to the **bearing housing** using capscrews provided.

If pump is grease lubricated both bearings should be initially packed with grease before reinstalling the bearing cap and brackplate. For oil lubricated bearing housings note that there is a grease fitting on the face of the brackplate. This fitting is there to allow grease to be injected between the two brackplate lipseals so as to provide lubrication for the outermost of the two lip-seals. A hand operated grease gun should be used, after reassembly of the brackplate to the bearing housing, to inject two or three "pumps" of grease between these seals. **For Hot Oil pumps** this should be a high temperature grease.

SEAL REASSEMBLY

Figure A2051A

Always handle all seal parts with extreme care to prevent damage. Be especially cautious not to contaminate the precision finished mating faces as even fingerprints can shorten seal life. If required, clean the faces with a non-oil based solvent and a clean, lint-free cloth. Use a concentric pattern while wiping to prevent scratching the faces.

Carefully inspect all seal parts for any damage or wear. Any scoring or grooves in the mating faces could cause the seal to leak, so it should be refurbished and mating faces relapped or replaced with a new complete **seal assembly**.

Clean the **shaft** and remove any nicks, cuts or burrs. Lubricate the outside diameter of the **seat o-ring** with 30 wt. to 80 wt. motor oil or hydraulic hose assembly lube and apply a drop of light lubricating oil to the seal faces.

Slide the **stationary seat** over the shaft and carefully press into the bore of the **brackplate.** Ensure that it is squarely seated into the brackplate. Lubricate the shaft surface and the inside diameter of the rubber bellows. Now slide the **rotating element** over the **shaft** up to the stationary seat. With the polished face (primary ring) of the rotating element toward the polished face of the seat. Slide the spring over the outside of the seal assembly up to the retainer flange.

For Hot Oil pumps refer to figure A2019A. Measure from the installed stationary seat face a distance of 1.562", and mark the shaft. Lubricate the **rotating element o-ring**, and install the metal bellows seal onto the shaft, and compress the bellows until the back-end of the seal assembly is even with the mark made at 1.562". Tighten the seal set screws.

IMPELLER REASSEMBLY

Figure A2050A

Inspect the **impeller** for any cracks or badly worn areas. Replace if necessary. Install the **impeller key** and slide impeller over the **shaft**. Ensure that the **seal spring** is in place over the outside diameter of the impeller hub (this does not apply for hot oil pumps with metal bellows seals). Install the **impeller washer** and **impeller lockscrew** (use #262 red loctite™ on threads

of the impeller lockscrew when reinstalling in the shaft) and tighten (See torque specs, page 17).

For impellers that are equipped with "backvanes" rather than a hub wear-ring, use the following procedure:

With the impeller firmly against the shaft end, measure the gap between the back vanes of the impeller and the face of the **brackplate**. Remove the impeller and place **impeller shims** (0.005, 0.010 and 0.015 thick) in the bore of the impeller until the gap is the same as it was when originally removed. Each time the impeller is installed on the shaft make sure the seal spring is in place over the outside diameter of the impeller hub (not applicable for hot oil pumps). Once the desired gap between the back vanes and backplate is attained, install the **impeller washer** and **impeller lockscrew** (use #262 red loctite™ on threads of the impeller lockscrew when reinstalling on the shaft) and tighten (See torque specs, page 17).

VOLUTE REASSEMBLY

Figure A2049A

For a one-piece **volute** and suction cover, inspect the **suction wear-ring** and review the wear ring section in this manual if replacement is required. Slide a new **o-ring** over the register of the **brackplate**. Make sure the o-ring is up against the face of the brackplate flange. Lubricate the o-ring with grease. Position the volute, with the discharge nozzle in the same orientation as the piping, and secure with capscrews.

For separate volute and **suction cover**, check on the wear ring section in this manual for replacement, if required. Place a new **o-ring** over the register of the suction cover, lubricate with grease and seat it against the cover face. Secure to **volute** with appropriate capscrews.

DISCHARGE CHECK VALVE REASSEMBLY

Figures A2170A and 17

Refer to the **discharge check valve** parts illustration if any repairs are to be made. Install the **gasket** and secure to the discharge nozzle with bolts and nuts. Ensure that the check valve is installed for the correct flow direction.

PRIMING CHAMBER REASSEMBLY

Figure A2169A

Refer to the **Priming Chamber / Valve** section if any repairs or adjustments are required. Install the gasket and use nuts and bolts to attach the priming chamber, with spool, to the suction flange of the pump.

LUBRICATION – BEARING FRAME

The lubrication of the ball bearings will depend on speed, load, ambient temperature, contamination, moisture, intermittent or continuous service and other factors. These regreasing recommendations are general in nature and are to be used with good judgment and consideration of the pump service. The following is a suggested lubrication interval chart:

Pioneer Frame Size	2200 RPM	1800 RPM	1200 RPM
8.5 AK Frame	5,000 hrs.	7,500 hrs.	10,000 hrs.
12.5 AK Frame	2,500	3,500	5,000

To lubricate the ball bearings, remove the plastic covers from the zerk fittings. Ensure that the zerk fitting and the end of the grease gun are clean. Use only a hand-operated grease gun with ball bearing grease as shown below, or equal:

Texaco Starplex Moly 2
Mobile MobiLux No. EP2
Shell Alvania EP2
Chevron SRI

For Hot Oil pumps the bearing frame will be oil lubricated. An oil level gauge is attached to the bearing frame and marked at the factory for proper oil level. ISO viscosity grade 32 turbine oil is installed at the factory. This oil is suitable for a wide range of temperatures. However, during operation temperature measurements should be taken on the bearing frame at the oil sump location. If the indicated temperature is greater than 160°F then the oil should be changed to an ISO viscosity grade 68 turbine oil at the next maintenance interval. Oil should be changed approximately every three months of continuous operation.

LUBRICATION – SEAL OIL RESERVOIR

See Figure A2049A / A2056A

This pump is provided with a seal oil reservoir that permits this unit to run dry. The reservoir supplies lubrication and cooling to the outboard side of the mechanical seal without any liquid in the pump. Monitor the oil level sight gauge and add oil as indicated. During normal operation it is suggested to change this oil every three (3) months. If the sight gauge shows indications of contamination or discoloration, change oil more frequently. The external oil reservoir is filled via a plug on the top of the tank. There is a petcock located on the opposite side of the run-dry gland from the oil inlet line. During initial filling, this petcock should be opened to allow the air to vent from the gland.

Use turbine oil with an ISO rating of 32 or lower. If you have unusual pumping conditions consult **Pioneer Pump, Inc**.
Oil used in the reservoir should be ISO VG 32 Turbine Oil or Automatic transmission oil, equivalent to one of the following manufacturer's products: (for hot cooking oil applications see paragraph below)

Chevron Turbine oil GST 32
Mobile DTE 797
Shell Turbo T oil 32

For Hot Cooking Oil pumps the seal oil reservoir must be filled with with a USDA H-1, non-toxic fluid capable of operating at pumping temperature without boiling off or burning**.** **Pioneer Pump, Inc. has approved only Paratherm NF® for cooking oil applications.** Substitutions are entirely at the discretion of the end-user, and it is the end-user's responsibility to determine compatibility with the application as pertains to Federal and State regulations. It is not required that the seal oil reservoir be filled in order to use the pump as long as the pump is not allowed to run dry at any time. However, the fluid in the seal oil reservoir extends mechanical seal life by keeping atmosphere away from the seal faces and thus greatly reducing carbon build-up at the faces and inside diameter of the seal bellows. The seal oil reservoir also provides greatly improved seal lubrication during caustic boil out of the pump and fryer system. It is strongly recommended, for the above mentioned reasons, that the seal oil reservoir be kept filled.

MAINTENANCE

TORQUE VALUES

SIZE UNC	MATERIAL		
	304 SS	GRADE 5 BOLTS	GRADE 8 BOLTS
¼	3.0 lb-ft	9 lb-ft	13 lb-ft
5/16	7.0 lb-ft	19 lb-ft	27 lb-ft
3/8	13 lb-ft	34 lb-ft	48 lb-ft
7/16	20 lb-ft	54 lb-ft	77 lb-ft
1/2	31 lb-ft	83 lb-ft	117 lb-ft
9/16	45 lb-ft	120 lb-ft	170 lb-ft
5/8	63 lb-ft	165 lb-ft	234 lb-ft
3/4	112 lb-ft	293 lb-ft	415 lb-ft
7/8	180 lb-ft	474 lb-ft	670 lb-ft
1	270 lb-ft	710 lb-ft	1000 lb-ft
1 1/4	540 lb-ft	1421 lb-ft	2000 lb-ft

The above values are general in nature. If a grade 2 or 5 capscrew is threaded into stainless steel, use the lower value i.e. 304 stainless.

PARTS ORDER

When ordering parts from **Pioneer Pump, Inc.** please provide the following information:

1) Pump serial number
2) Pump model
3) Cross section drawing number
4) Part number from cross section drawing
5) Description of part
6) Quantity required
7) Package VIN (Vehicle Identification Number)

SPARE PARTS

Spare parts should be kept on hand to reduce downtime. Service of a particular pump determines the quantity and range of spares. At a minimum the following parts should be stocked.

Suction wear ring
All O-rings
Set of bearings
Mechanical seal
Set of grease seals

If you have unusual pumping conditions, consult **Pioneer Pump, Inc.** for additional recommended spare parts.

TROUBLESHOOTING

Symptom	Possible Causes	Symptom	Possible Causes
No Discharge	1,2,3,4,5,7,8,9,10,17,18,19,20, 37	Vibration and noise	2,4,9,10,14,15,17,26,27,28,29 30,31,32,33,34,35,36,39,40, 41,42,43,44,48
Reduced Capacity	2,3,4,5,7,8,9,10,11,17,19,20,21,383 9,40,47	Seal: excessive leakage, short life, seal housing overheating	22,23,25,33,34,35,36,41,44, 45,46
Reduces Pressure	5,7,8,11,13,18,19,38,39,40,47		
Loss of Prime	2,3,4,7,10,11,20,21,22,23	Bearings: over heating, short life, noise	26,27,28,29,30,31,32,33,34, 35,36,41,42,43,44
Power consumption excessive, driver runs hot	6,12,13,17,18,19,24,33,34,35,3637, 38,41,42,43,44	Pump overheating, seizes	1,8,9,14,33,34,35,36,41,42,43, 44
		Corrosion, erosion, pitting, oxidation or other loss of material	7,8,11,14,15,16

1. Pump not primed
2. Suction line not filled
3. Air pocket in suction line
4. Suction inlet or foot valve obstructed, insufficiently submerged, or too small
5. System head higher than pump design head
6. System head lower than pump design head
7. Insufficient NPSH
8. Parallel pump application is incorrect
9. Suction pressure to vapor pressure below minimum
10. Suction lift too high
11. Excess vapor in pumpage
12. Specific gravity of pumpage different than design
13. Viscosity of pumpage different than design
14. Operation at below rated capacity
15. Cavitation
16. Electrolysis
17. Impeller obstructed with foreign material
18. Rotation direction wrong
19. Low speed
20. Air leak into suction line
21. Air leak through mechanical seal
22. Seal fluid contaminated, hot or insufficient
23. Seal fluid system not vented
24. High speed
25. Mechanical seal insufficient
26. Bearing housing excessively cooled
27. Low oil pressure (oil lube bearings)
28. Improper or poor lubrication
29. Lubrication defective
30. Dirt in lubrication/bearings
31. Moisture in lubricant/bearing housing
32. Lubricant excess
33. Pipe strain
34. Temperature growth
35. Misalignment
36. Coupling improperly installed
37. Impeller installed backwards
38. Worn wear rings
39. Impeller damage
40. Improper balance (after repair)
41. Bent shaft
42. Excessive thrust
43. Rotational element dragging
44. Worn or incorrectly installed bearings
45. Mechanical seal not properly set, O-rings damaged or hardened
46. Shaft scored at seal
47. Volute O-ring
48. Foundation not rigid or settled

STORAGE

STORAGE

This is adequately prepared for outside storage prior to shipment, but use the following list of additional suggestions for extended storage.

1) Store the unit off the ground so no water will accumulate around the equipment.

2) Protect unit from blowing sand and dirt.

3) Stack no other items on top of pump/equipment.

4) Protect unit from the entry of any animals.

5) Periodically rotate shaft to lubricate bearings and protect bearings from brinelling.

6) Protect unit with approved drying agents.

7) Ensure all bare metal areas are coated with a rust preventive.

8) Inspect unit every four (4) weeks and replace drying agents (Silica Gel) as required or a minimum of ever six (6) months.

9) Keep and inspection record showing dates of inspection with any maintenance preformed and condition of drying agents.

10) Before installation ensure that all rust protection has been removed. Also, remove any foreign material that may have accumulated during storage.

11) Before installation remove all drying agents (Silica Gel).

Conditions and terms of sale

CONTROLLING PROVISIONS: These terms and conditions shall control with respect to any purchase order or sale of Seller's products. No waiver, alteration or modification of these terms and conditions whether on Buyer's purchase order or otherwise shall be valid unless the waiver, alteration or modification is specifically accepted in writing and signed by an authorized representative of Seller.

DELIVERY: Seller will make every effort to complete delivery of products as indicated on Seller's acceptance of an order, but Seller assumes no responsibility or liability, and will accept no backcharge, for loss or damage due to delay or inability to deliver caused by acts of God, war, labor difficulties, accident, delays of carriers, by contractors or suppliers inability to obtain materials, shortages of fuel and energy, or any other causes of any kind whatever beyond the control of Seller. Seller may terminate any contract of sale of its products without liability of any nature, by written notice to Buyer, in the event that the delay in delivery or performance resulting from any of the aforesaid causes shall continue for a period of sixty (60) days. Under no circumstances shall Seller be liable for any special or consequential damages or for loss, damage, or expense (whether or not based on negligence) directly or indirectly arising from delays or failure to give notice of delay.

SELLER'S LIABILITY: Seller will not be liable for any loss, damage, cost of repairs, incidental or consequential damages of any kind, whether based upon warranty (except for the obligation accepted by Seller under "Warranty" above), contract or negligence arising in connection with the design, manufacture, sale, use or repair of the products or of the engineering designs supplied to Buyer.

RETURNS: Seller cannot accept return of any products unless its written permission has been first obtained, in which case same will be credited subject to the following: (a) All material returned must, on its arrival at Seller's plant, be found to be in first-class condition; if not, cost of putting in saleable condition will be deducted from credit memoranda. (b) A handling charge deduction of twenty percent (20%) will be made for all credit memoranda issued for material returned. (c) Transportation charges, if not prepaid, will be deducted from credit memoranda.

CANCELLATION OR ALTERATION: Cancellation or alteration of an order by Buyer may not be made without advance written consent of Seller and shall be subject to a cancellation charge. The cancellation charge will be a minimum of fifteen percent (15%) or actual cost incurred by Seller at the time of cancellation or alteration, whichever is greater.

SHIPMENTS: All products sent out will be carefully examined, counted and packed. The cost of any special packing or special handling caused by Buyer's requirements or requests shall be added to the amount of the order. No claim for shortages will be allowed
unless made in writing within ten (10) days of receipt of a shipment. Claims for products damaged or lost in transit should be made on the carrier, as Seller's responsibility ceases, and title passes, on delivery to the carrier.

SPECIAL PRODUCTS: Orders covering special or non-standard products are not subject to cancellation except on such terms as Seller may specify on application.

QUOATIONS: All quotations are subject to approval, acceptance and correction at the home office. Any errors in quotations resulting in orders will be corrected and re-submitted to the customer for their acceptance or refusal. All quotations are valid for 45 days from the date on the quotation.

PRICES AND DESIGNS: Prices and designs are subject to change without notice. All prices are **F.O.B. Point of Shipment**, unless otherwise stated.

TAXES: The amount of any sales, excise or other taxes, if any, applicable to the products covered by this order, shall be added to the purchase price and shall be paid by Buyer unless Buyer provides Seller with an exemption certificate acceptable to the taxing authorities.

TERMS OF SALE: For value received, Buyer agrees to honor all terms of the sale, as outlined on the reverse hereof, including, but not limited to the following:

- 3% 10, net 30 days unless otherwise specified in writing.
- Buyer agrees and understands that payments will be considered past due if payment is not received within thirty (30) days of the invoice date.
- Buyer agrees that all past due payments shall bear interest at the rate of 1.5% per month (18% per annum) until paid in full.
- Buyer agrees that it is the intention of Buyer and Seller to conform strictly to all usury laws now in force and effect in the state of purchase.
- Buyer further agrees not to suffer or permit any charge, lien, security interest, adverse claim or encumbrance of any and every nature whatsoever against the equipment until the indebtedness secured thereby is satisfied in full.
- Minimum invoice amount will be no less than $25.00 plus transportation.

USE OF EQUIPMENT: Buyer agrees to maintain and use the equipment solely in the conduct of its own business, in a careful and proper manner, and in conformity with all applicable permits, licenses, statues, ordinances, regulations and laws.

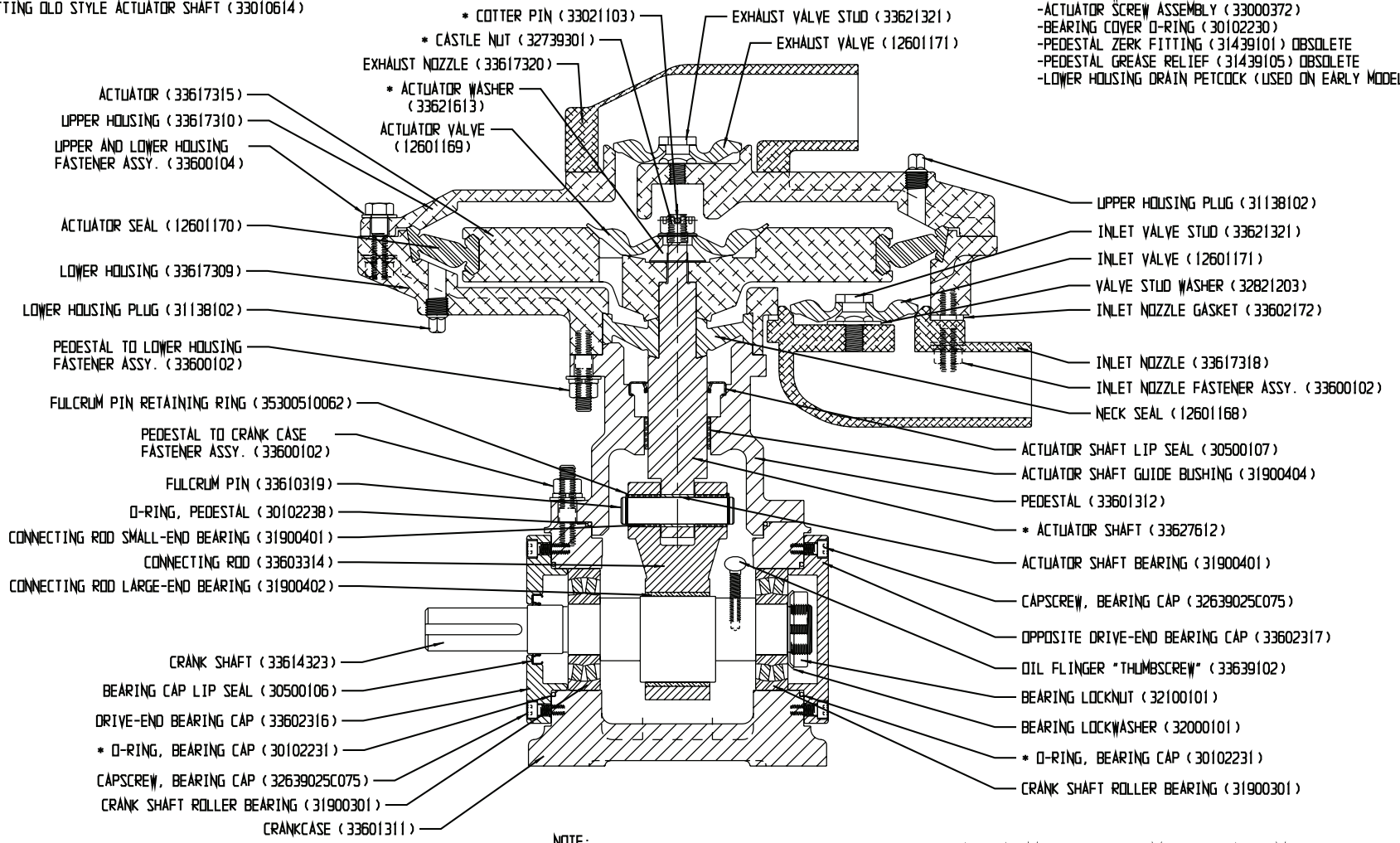
INSURANCE: Buyer shall have and maintain at all times with respect to all equipment insuring against risk of fire, theft and other risks as Seller may require, until the indebtedness secured thereby is satisfied in full.

NOT SHOWN ON CURRENT MODEL:
-CRANKCASE VENT ASSEMBLY (33611103)
-OIL LEVEL SIGHT GLASS (31339102)
-OIL FILL PLUG (33611103)
-OIL DRAIN ASSEMBLY (33600107)
-EXHAUST NOZZLE FASTENER ASSEMBLY (33600105)
-STUD FOR RETRO-FITTING OLD STYLE ACTUATOR SHAFT (33010614)

DWG NO. A638A

FOR PREVIOUS VERSION SEE D328A
* DENOTES PARTS THAT CHANGED

OLD STYLE PARTS
-ACTUATOR SHAFT (33627313)
-ACTUATOR WASHER (33621322)
-ACTUATOR SCREW ASSEMBLY (33000372)
-BEARING COVER O-RING (30102230)
-PEDESTAL ZERK FITTING (31439101) OBSOLETE
-PEDESTAL GREASE RELIEF (31439105) OBSOLETE
-LOWER HOUSING DRAIN PETCOCK (USED ON EARLY MODELS)



NOTE:
PIONEER PUMP PART NUMBERS IN ( )

PART NUMBER FOR COMPLETE ASSEMBLY (33600101)

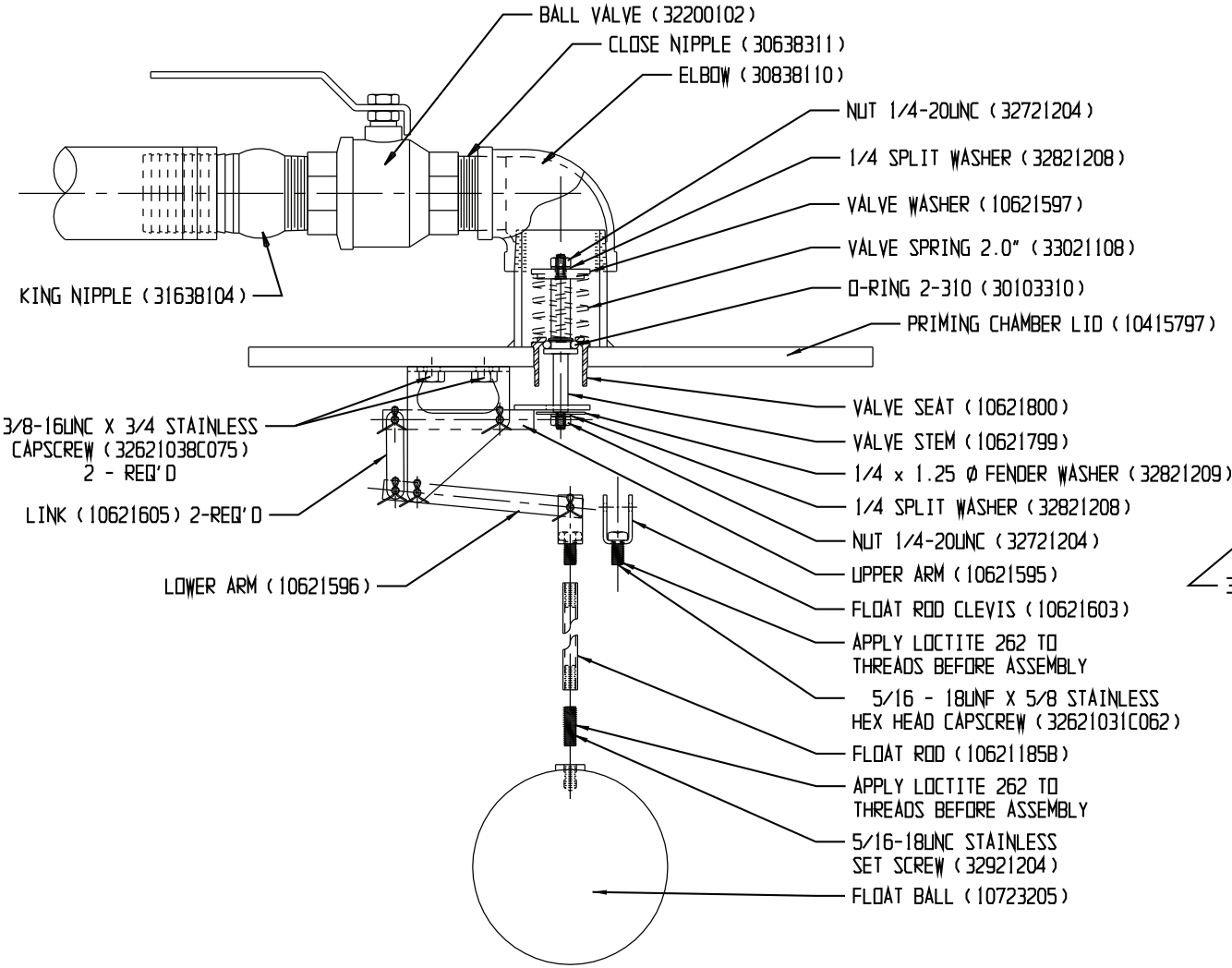
11/7/2002

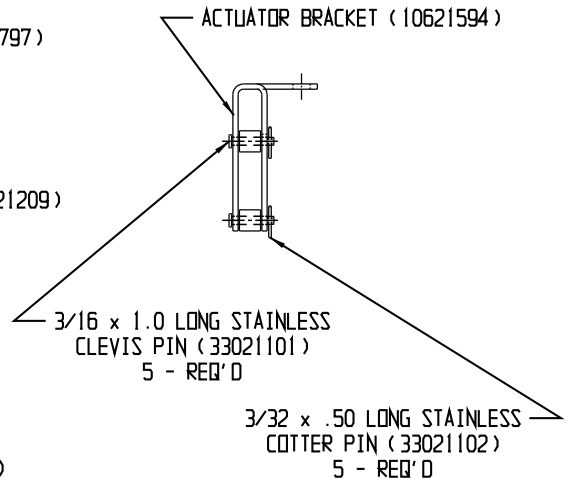
PIONEER PUMP, INC.

VACUUM PUMP

DWG NO. A638A

DWG NO.
A1459A





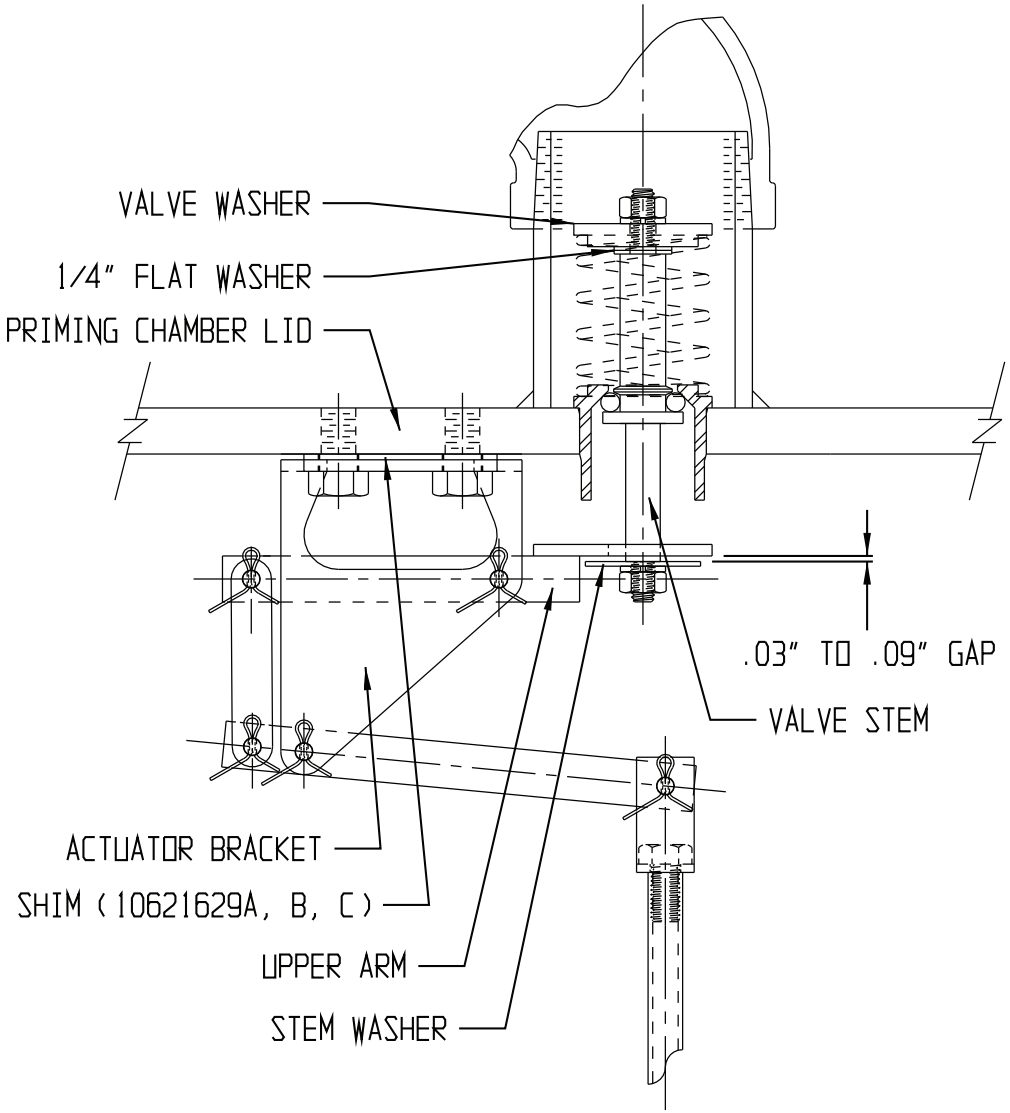
NOTE:
PIONEER PUMP PART NUMBERS IN ( )

PIONEER PUMP, INC.

PRIMING CHAMBER VALVE ASSEMBLY

DWG NO.
A1459A

DWG NO.
A1784A



ADJUSTMENT INSTRUCTIONS:

WITH THE FORKED PORTION OF THE UPPER ARM PARALLEL TO THE STEM WASHER, THE GAP BETWEEN THEM SHOULD BE .03" - .09".

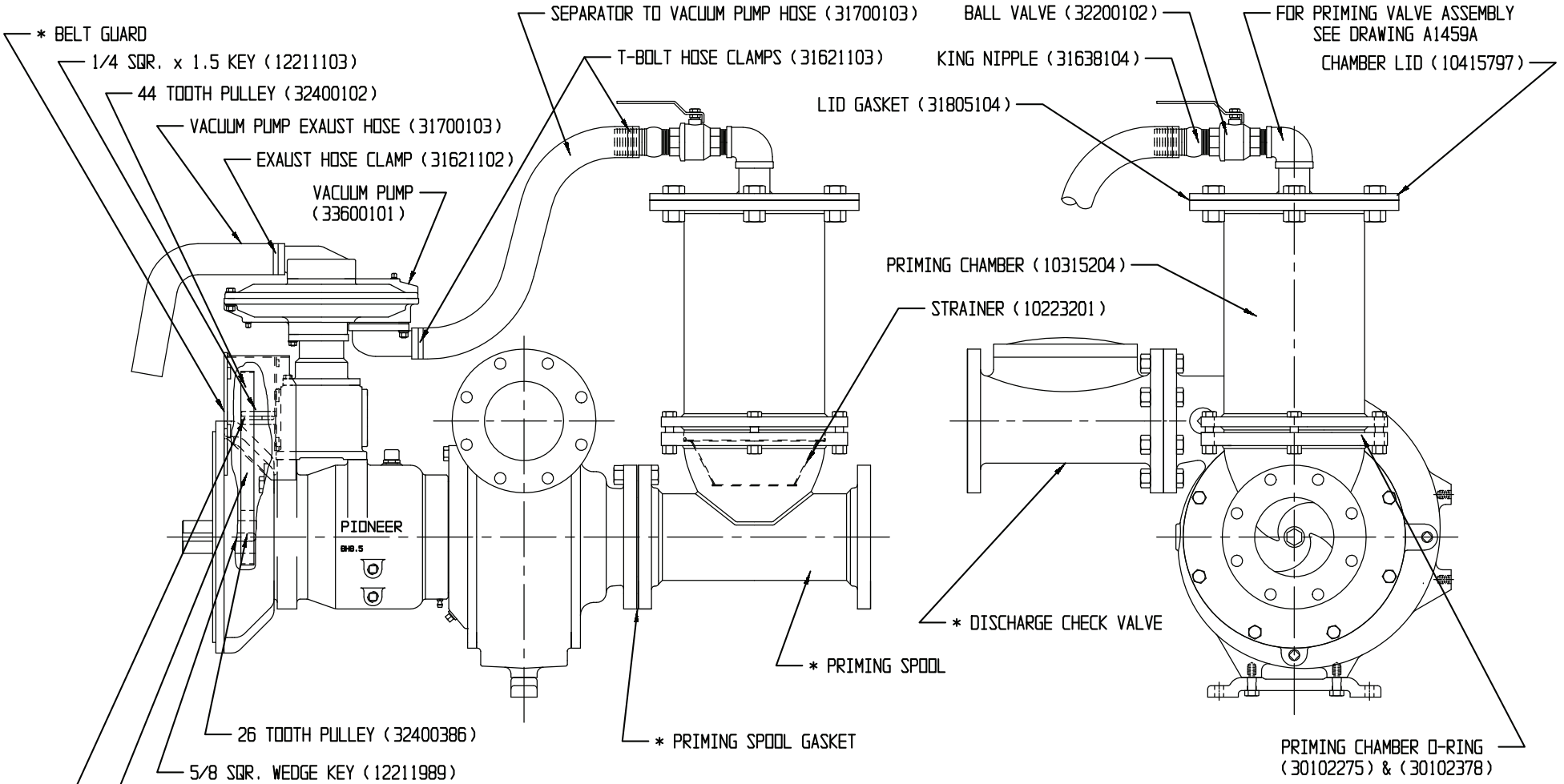
IF THIS GAP IS TOO LARGE, PLACE A SHIM BETWEEN THE THE ACTUATOR BRACKET AND THE PRIMING CHAMBER LID.

- (10621629A = 10 GAGE SHIM = .125" THICK),
- (10621629B = 16 GAGE SHIM = .062" THICK),
- (10621629C = 12 GAGE SHIM = .099" THICK)

THIS WILL LOWER THE BRACKET AND REDUCE THE GAP ALLOWING THE VALVE TO OPEN UP AS NECESSARY TO DRAW A VACUUM MORE EFFICIENTLY.

NOTE: THERE HAS BEEN SOME CASES WHERE THE VALVE HAS STILL FAILED TO OPEN PROPERLY WHEN THE GAP IS SHIMMED CORRECTLY. AT THIS POINT THE SPRING TENSION NEEDS TO BE REDUCED, THIS DONE BY ADDING ONE OR TWO 1/4" STAINLESS FLAT WASHERS (32821201) BETWEEN THE STEM AND VALVE WASHER.

DWG NO.
A2017A



NOTE:
-PIONEER PUMP PART NUMBERS IN ( )
-* CONTACT PIONEER PUMP FOR DIFERENT SIZES.
-SHIMS, AS REQUIRED FOR TENSIONING VACUUM PUMP BELT (NOT SHOWN)
0.03" (30300101, 0.06" (30300102), 0.12" (30300103)

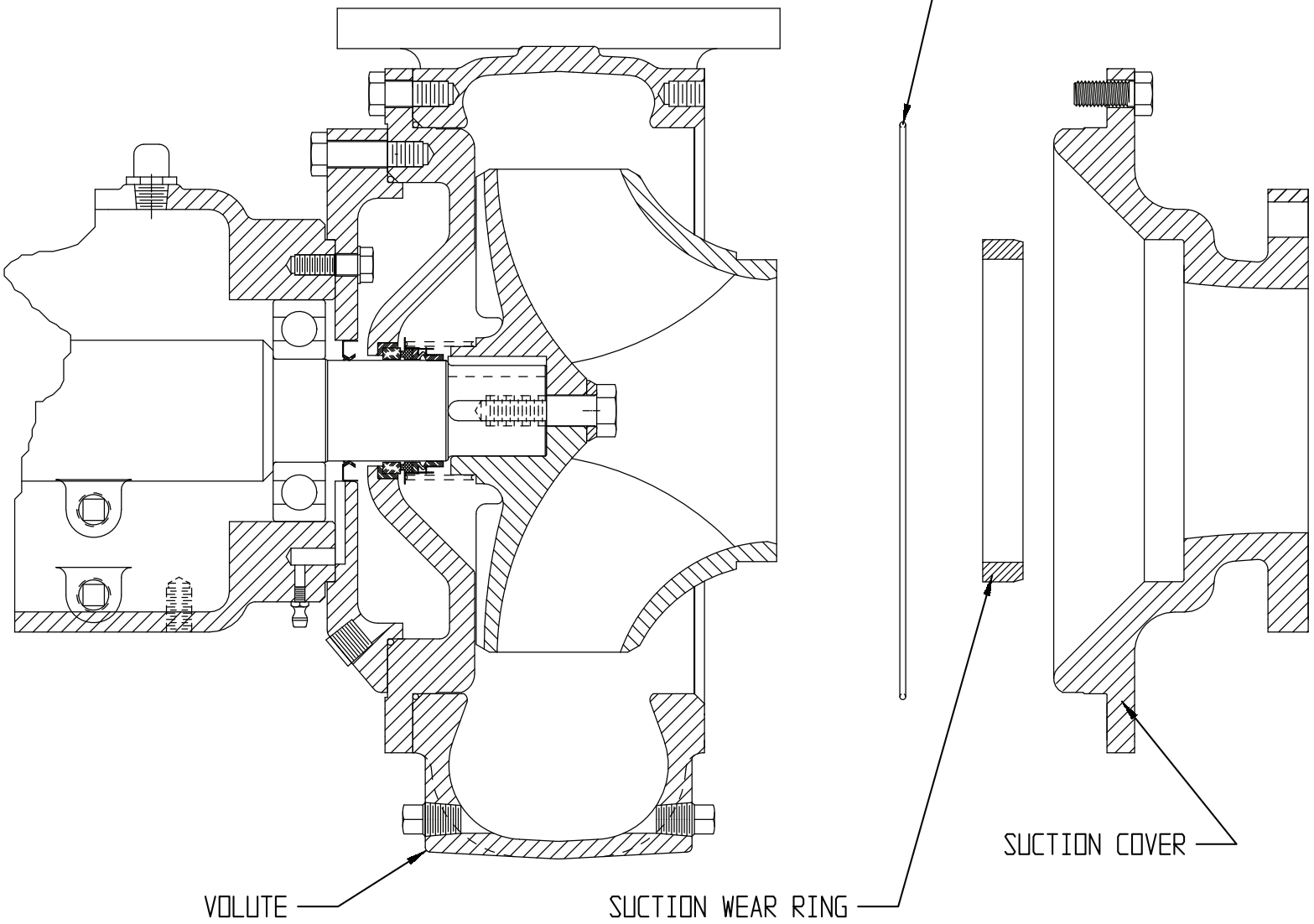
6/11/2003

PIONEER PUMP, INC.

VAC - ASSIST COMPONENTS

DWG NO.
A2017A

DWG NO. A2048M



REFERENCE DRAWINGS
PATTERN DWG.
MACHINE DWG.
HYDRAULIC DWG.
PATTERN NO.

TOLERANCES EXCEPT WHEN OTHERWISE SPECIFIED
.XXX = ±.003 ANGLES = ± 1°
.XX = ±.010 MAX MACH R. .03
.X = ±.03

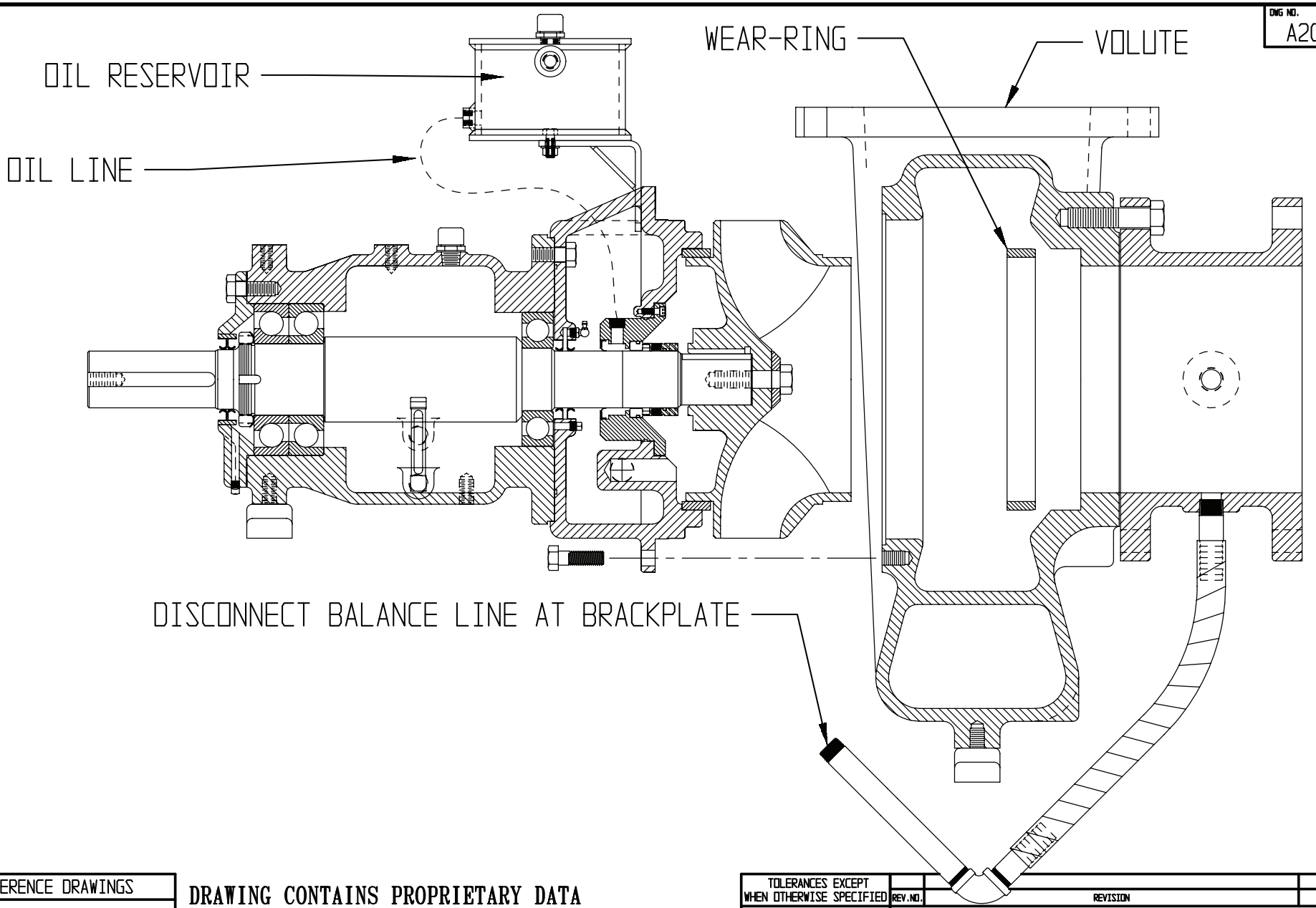
REV.NO.	REVISION	DATE

MANUAL ILLUS.- SUCTION COVER AND WEAR RING REMOVAL

DR. BC | CHECKED | DATE 8/19/02 | SCALE 1/4 | DWG NO. A2048M

PIONEER PUMP, INC. - CANBY, OREGON

DWG NO. A2049A



REFERENCE DRAWINGS
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MACHINE DWG.
HYDRAULIC DWG.
PATTERN NO.

TOLERANCES EXCEPT WHEN OTHERWISE SPECIFIED
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.XX = ±.010 MAX MACH R. .03
.X = ±.03

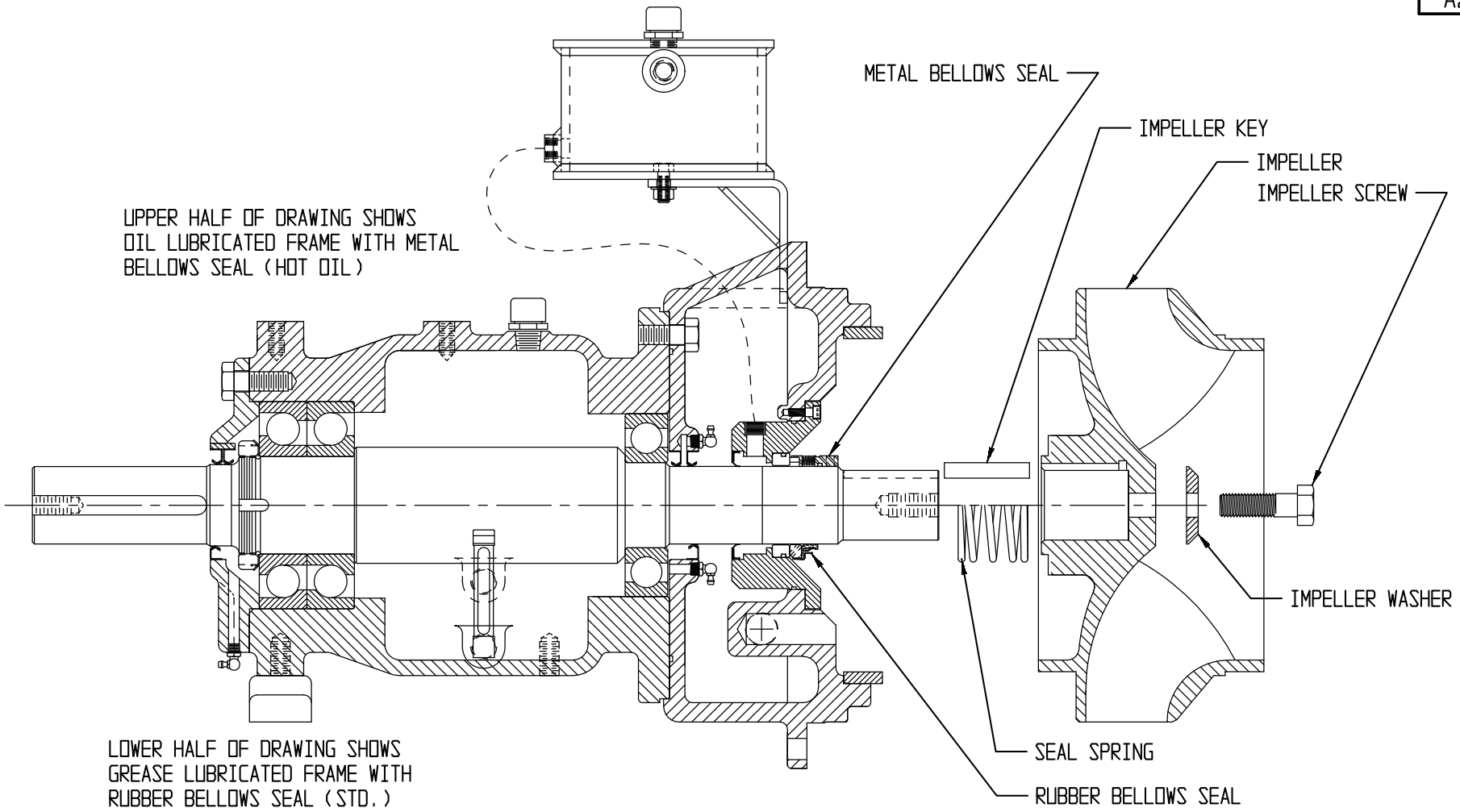
REV.NO.	REVISION	DATE

MANUAL ILLUSTRATION - VOLUTE / WEAR-RING REMOVAL

DR. BC | CHECKED | DATE 8/19/02 | SCALE 1/6 | DWG NO. A2049A

PIONEER PUMP, INC. - CANBY, OREGON

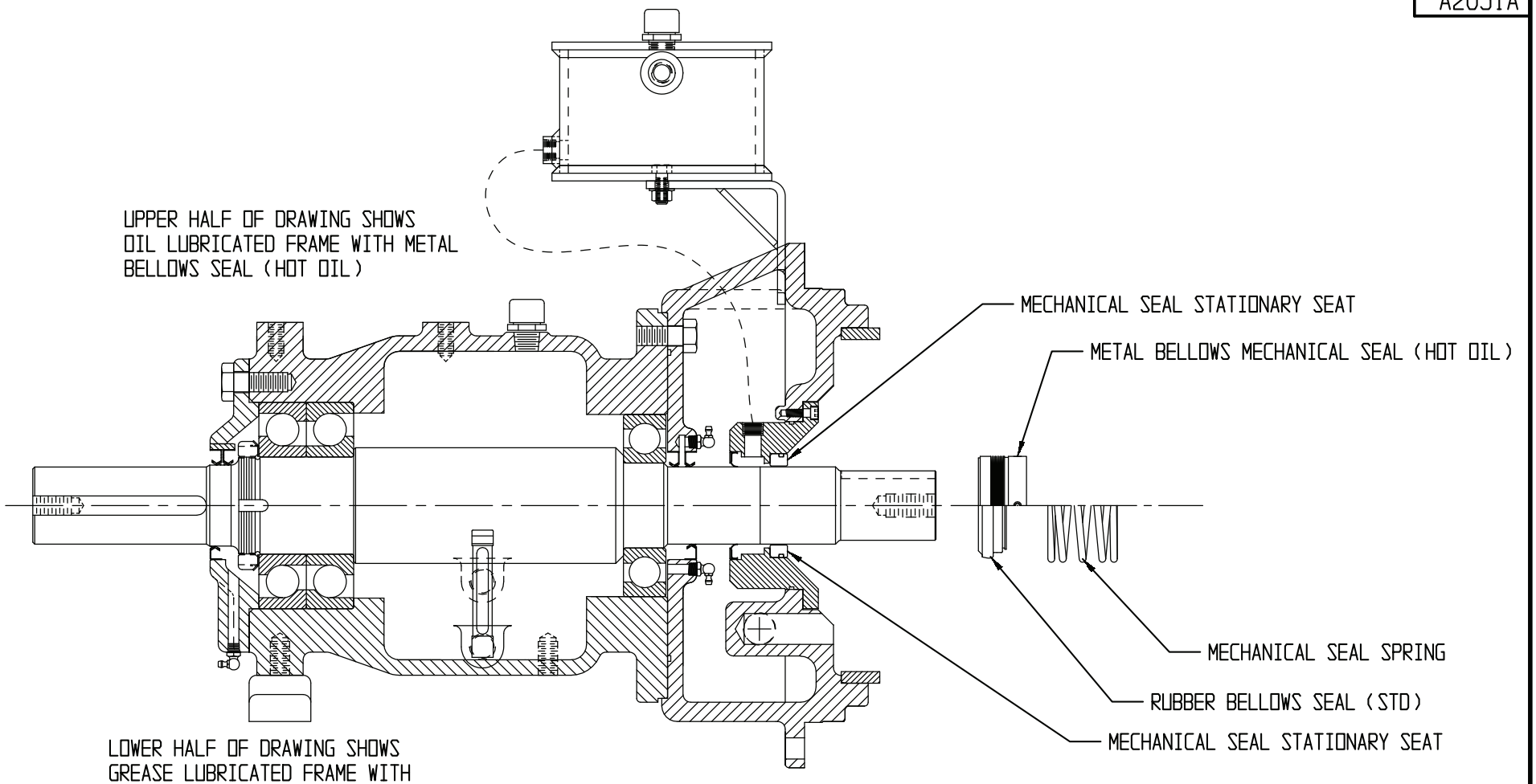
DWG NO. A2050A



REFERENCE DRAWINGS
PATTERN DWG.
MACHINE DWG.
HYDRAULIC DWG.
PATTERN NO.

TOLERANCES EXCEPT WHEN OTHERWISE SPECIFIED	REV. NO.	REVISION	DATE
.XXX = ±.003 ANGLES = ± 1° .XX = ±.010 MAX MACH R. .03 .X = ±.03	MANUAL ILLUSTRATION - IMPELLER REMOVAL		
DR. BC	CHECKED	DATE 6/18/01	SCALE 1/5
PIONEER PUMP, INC. - CANBY, OREGON			DWG NO. A2050A

DWG NO.
A2051A



REFERENCE DRAWINGS
PATTERN DWG.
MACHINE DWG.
HYDRAULIC DWG.
PATTERN NO.

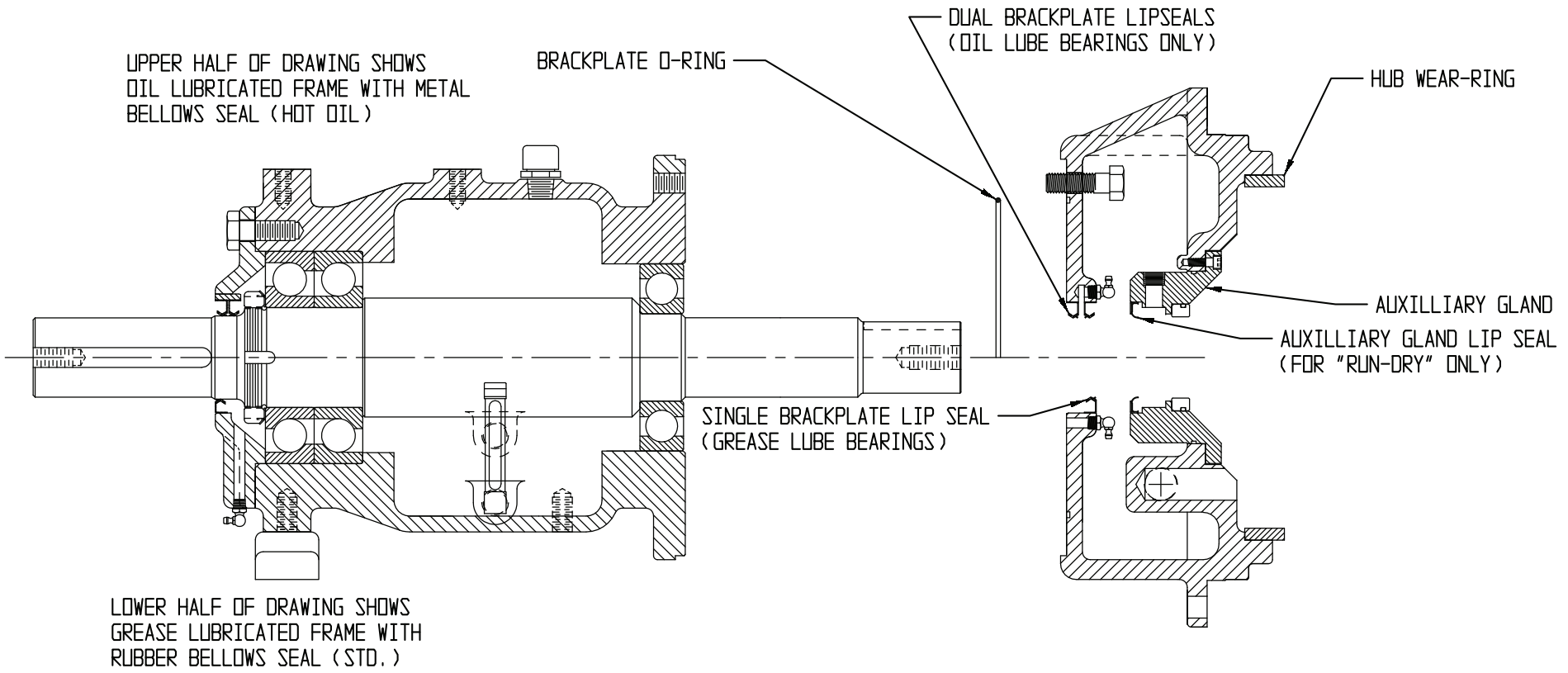
TOLERANCES EXCEPT WHEN OTHERWISE SPECIFIED	REV.NO.	REVISION	DATE
.XXX = ±.003 ANGLES = ± 1°			
.XX = ±.010 MAX MACH R. .03			
.X = ±.03			

MANUAL ILLUSTRATION - SEAL REMOVAL

DR. BC	CHECKED	DATE 6/18/01	SCALE 1/5	DWG NO. A2051A

PIONEER PUMP, INC. - CANBY, OREGON

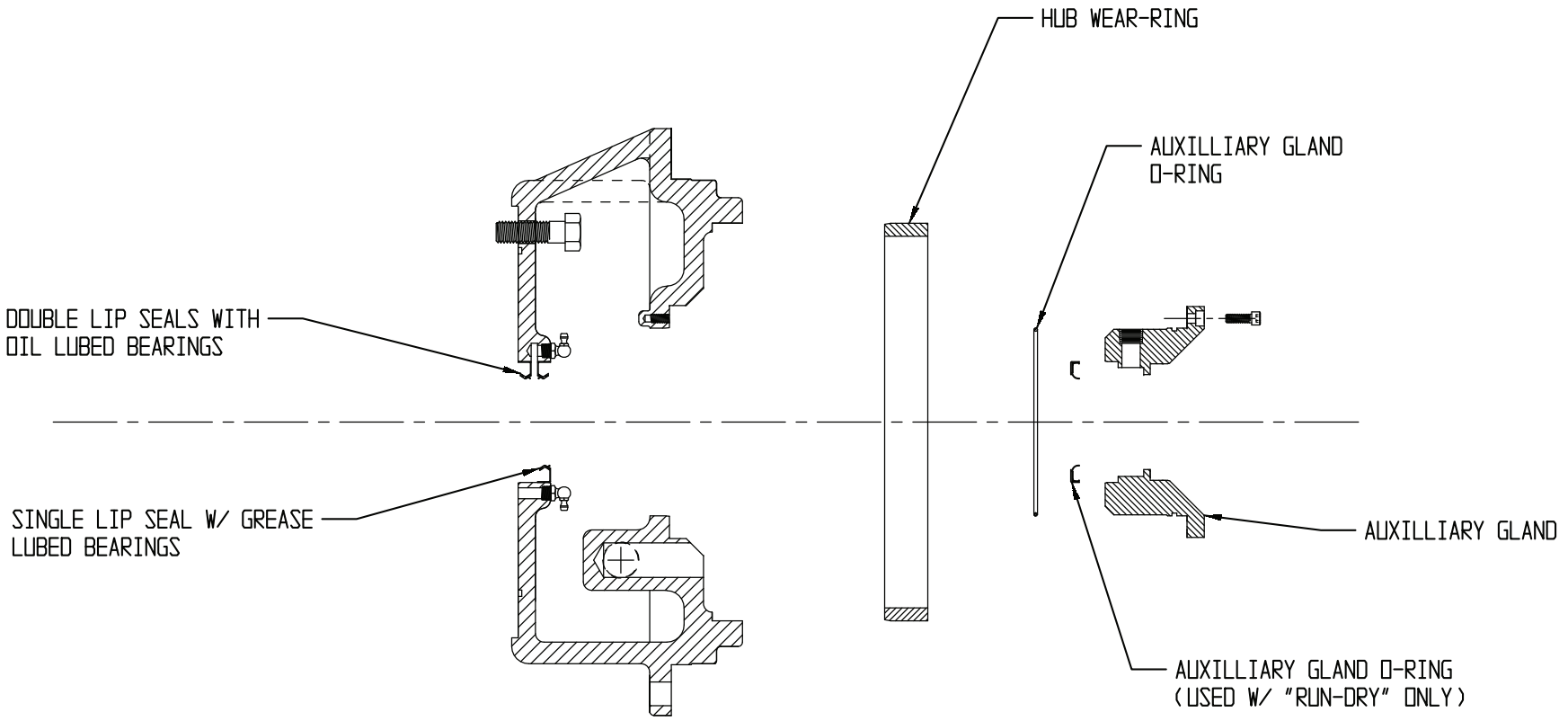
DWG NO.
A2052A



REFERENCE DRAWINGS
PATTERN DWG.
MACHINE DWG.
HYDRAULIC DWG.
PATTERN NO.

TOLERANCES EXCEPT WHEN OTHERWISE SPECIFIED	REV.NO.	REVISION	DATE
.XXX = ±.003 ANGLES = ± 1° .XX = ±.010 MAX MACH R. .03 .X = ±.03	MANUAL ILLUSTRATION - BRACKPLATE REMOVAL		
DR. BC	CHECKED	DATE 8/19/02	SCALE 1/5
PIONEER PUMP, INC. - CANBY, OREGON			DWG NO. A2052A

DWG NO.
A2053A



REFERENCE DRAWINGS
PATTERN DWG.
MACHINE DWG.
HYDRAULIC DWG.
PATTERN NO.

TOLERANCES EXCEPT WHEN OTHERWISE SPECIFIED
.XXX = ±.003 ANGLES = ± 1°
.XX = ±.010 MAX MACH R. .03
.X = ±.03

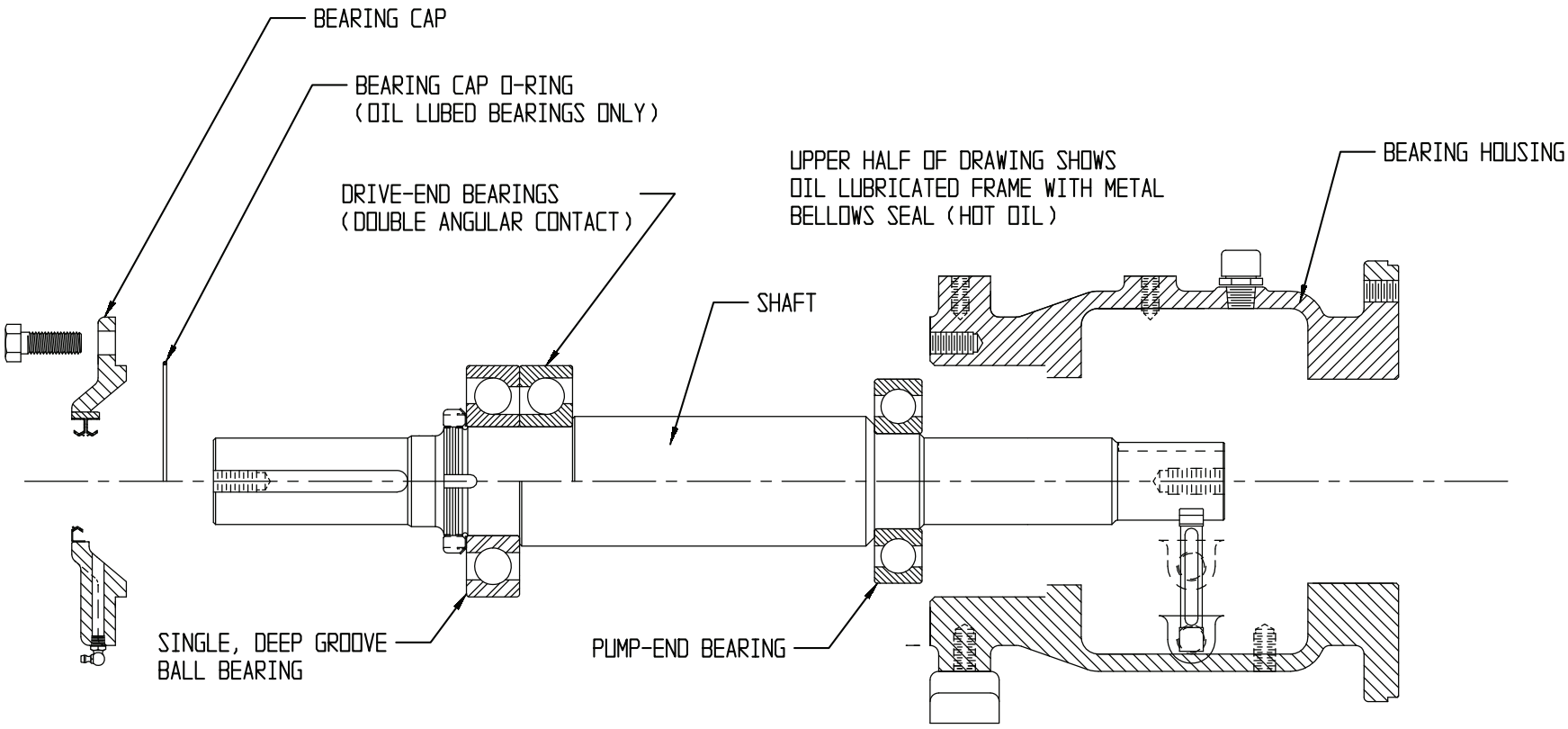
REV.NO.	REVISION	DATE

MANUAL ILLUSTRATION - BRACKPLATE DISASSEMBLY

DR. BC | CHECKED | DATE 8/19/02 | SCALE 1/5 | DWG NO. A2053A

PIONEER PUMP, INC. - CANBY, OREGON

DWG NO.
A2054A

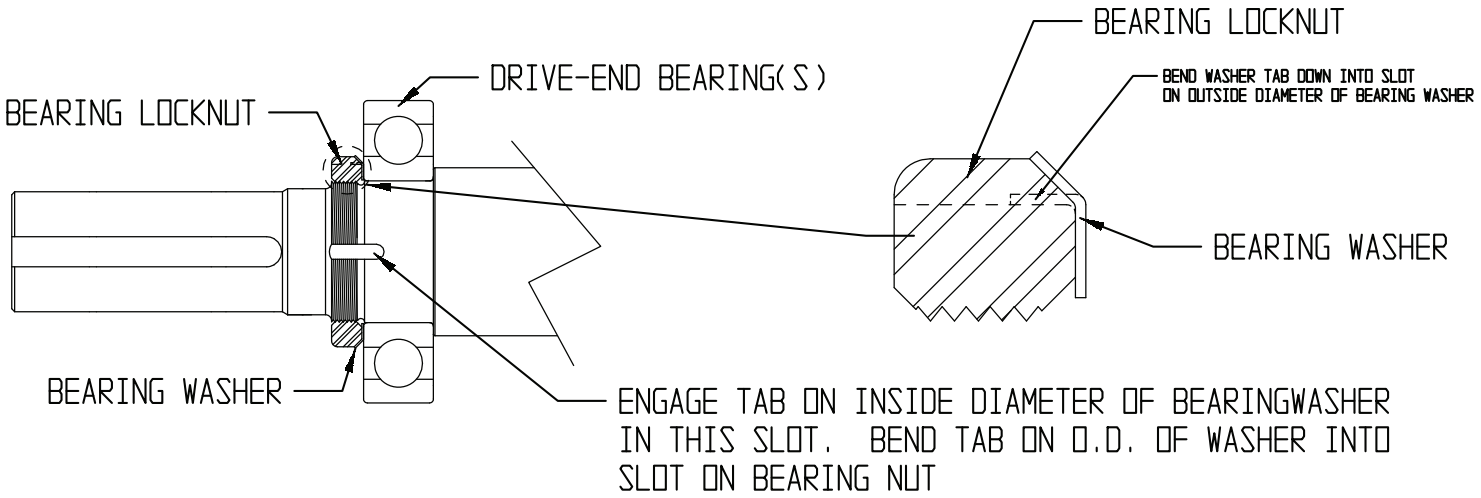


REFERENCE DRAWINGS
PATTERN DWG.
MACHINE DWG.
HYDRAULIC DWG.
PATTERN NO.

TOLERANCES EXCEPT WHEN OTHERWISE SPECIFIED	REV.NO.	REVISION	DATE
.XXX = ±.003 ANGLES = ± 1° .XX = ±.010 MAX MACH R. .03 .X = ±.03	MANUAL ILLUSTRATION - BEARING FRAME DISASSEMBLY		
	DR. BC	CHECKED	DATE 8/19/02
	SCALE 1/5	DWG NO. A2054A	

PIONEER PUMP, INC. - CANBY, OREGON

DWG NO.
A2055M



REFERENCE DRAWINGS
PATTERN DWG.
MACHINE DWG.
HYDRAULIC DWG.
PATTERN NO.

TOLERANCES EXCEPT WHEN OTHERWISE SPECIFIED	REV.NO.	REVISION	DATE
.XXX = ±.003 ANGLES = ± 1°			
.XX = ±.010 MAX MACH R. .03			
.X = ±.03			

MANUAL ILLUSTRATION - DRIVE-END BEARING ASSEMBLY

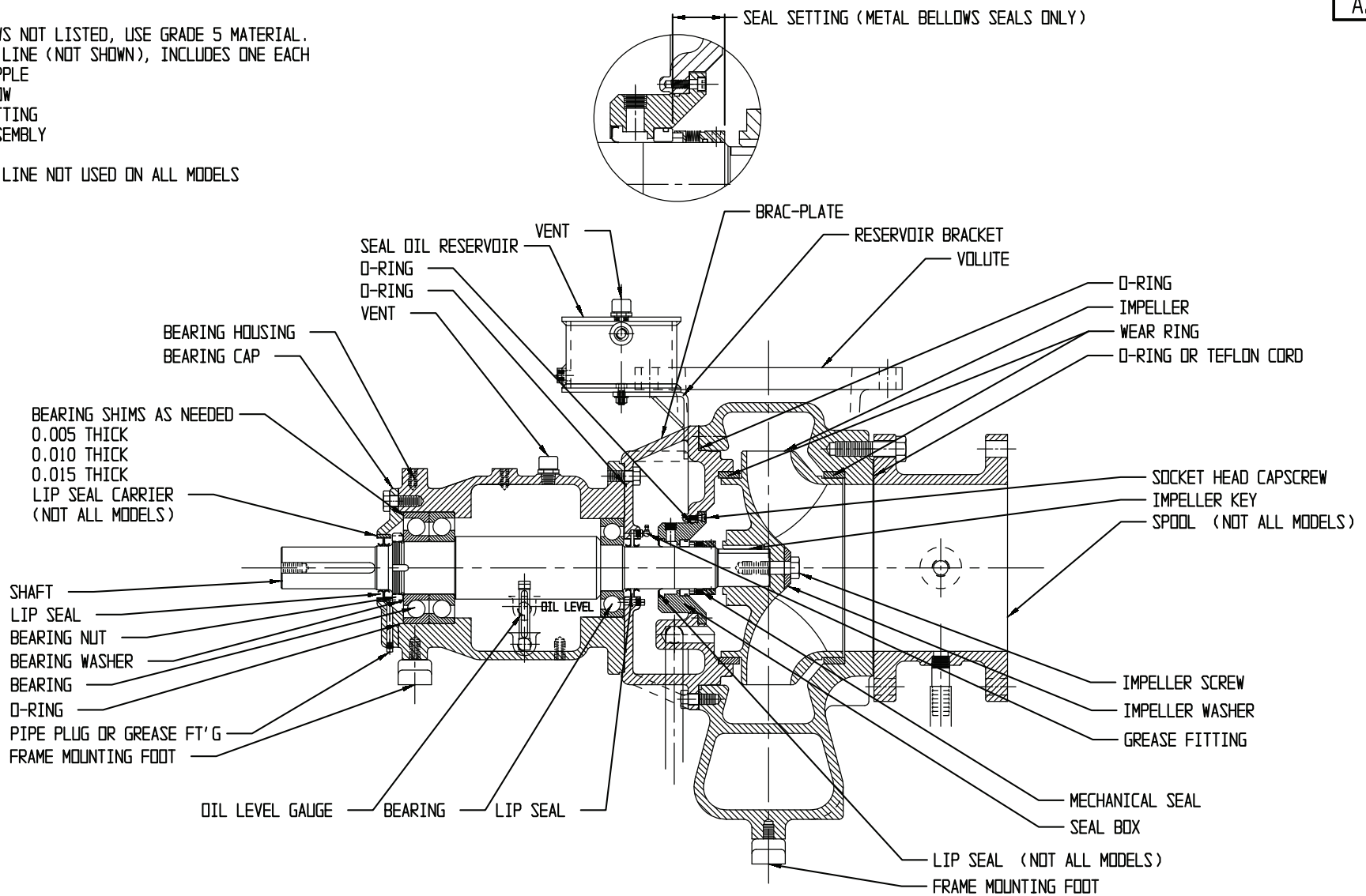
DR. BC	CHECKED	DATE 8/19/02	SCALE 1/4	DWG NO. A2055M

PIONEER PUMP, INC. - CANBY, OREGON

DWG NO.
A2056A

NOTES:
- CAPSCREWS NOT LISTED, USE GRADE 5 MATERIAL.
- BALANCE LINE (NOT SHOWN), INCLUDES ONE EACH
  PIPE NIPPLE
  90° ELBOW
  HOSE FITTING
  HOSE ASSEMBLY

  BALANCE LINE NOT USED ON ALL MODELS



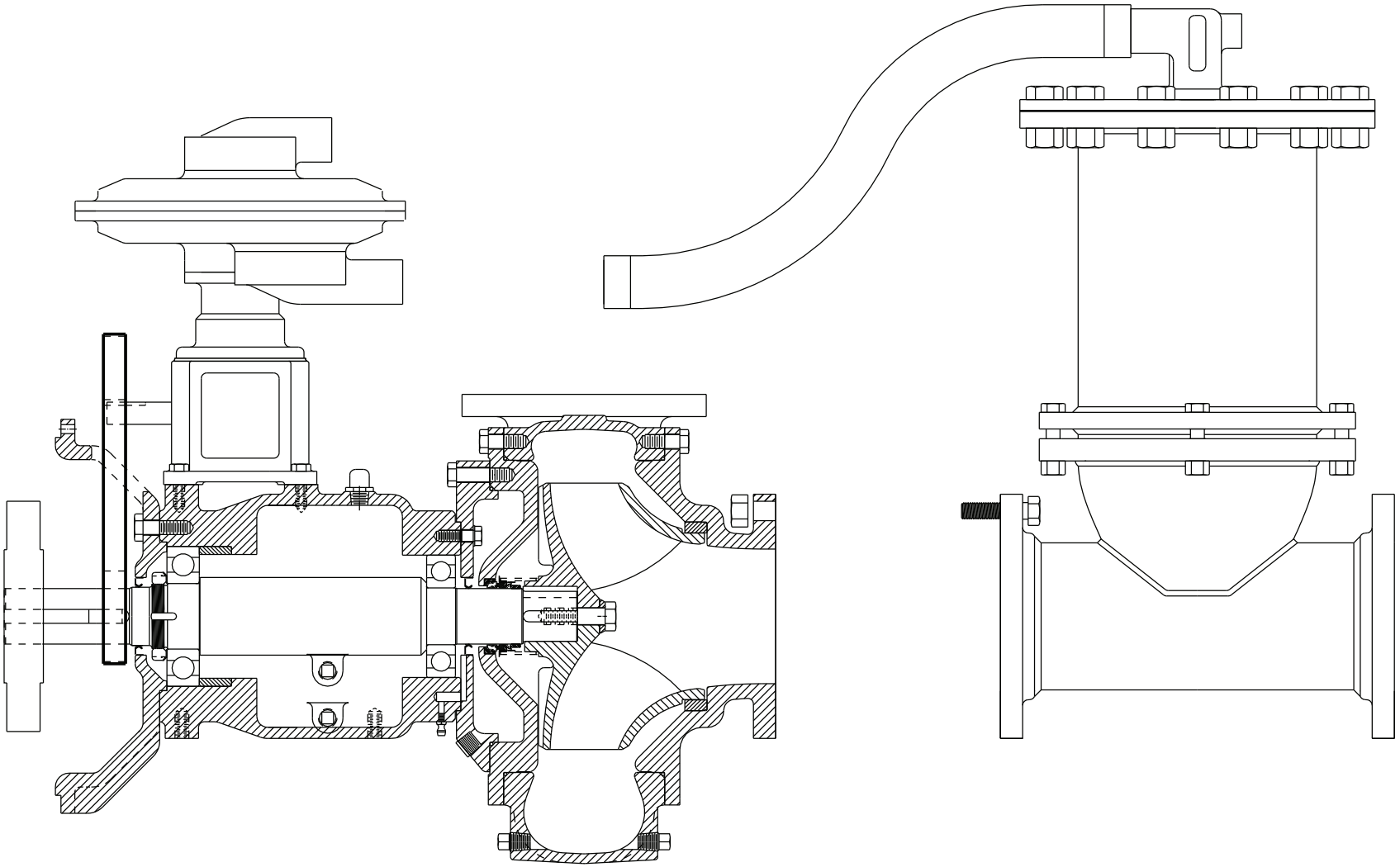
8/1/02

PIONEER PUMP, INC.

MODEL: FRAME MOUNTED "BRACKPLATE STYLE"

DWG NO.
A2056A

DWG NO.
A2169A

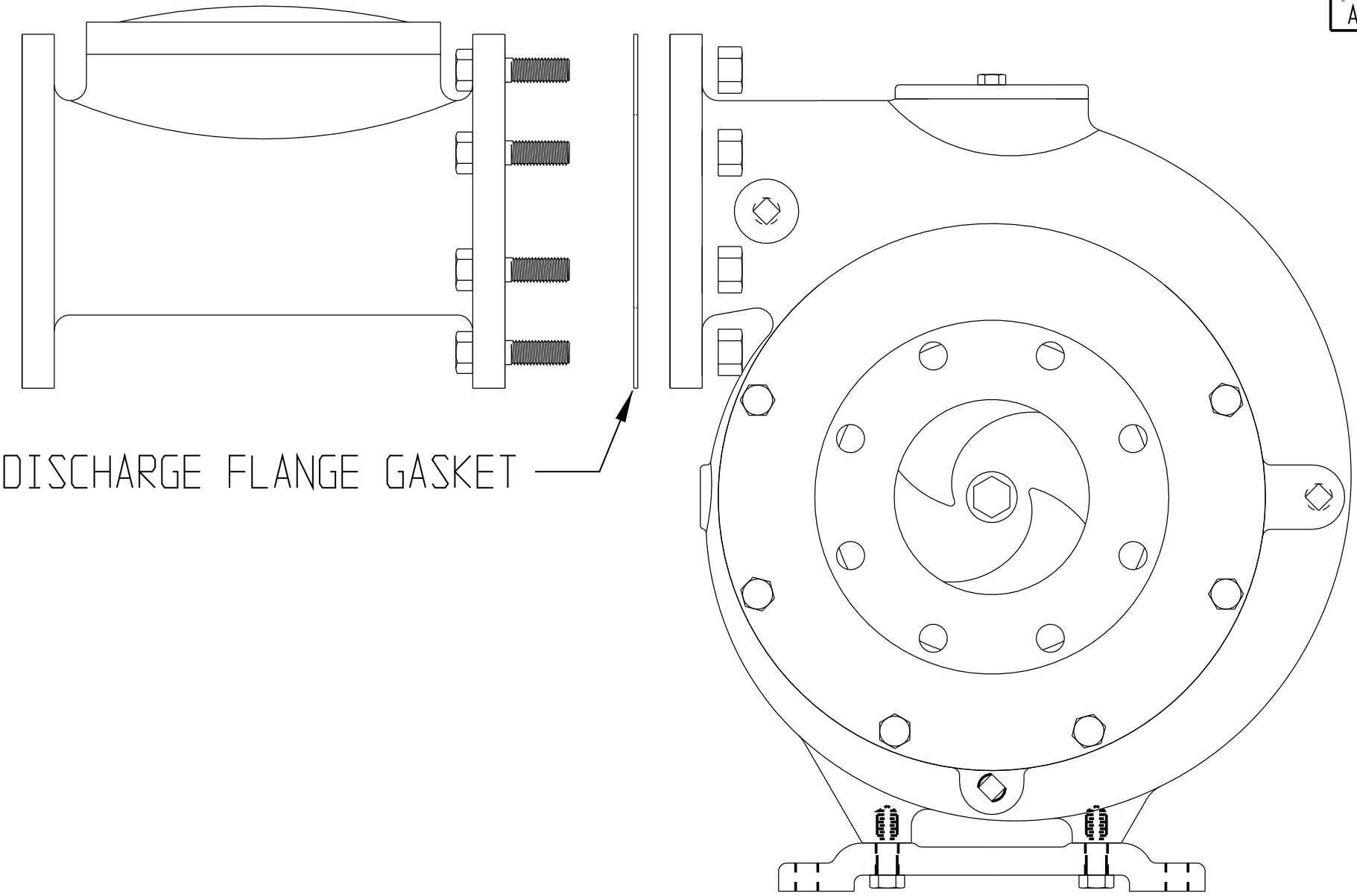


PIONEER PUMP, INC.

REMOVING PRIMING CHAMBER & SPOOL

DWG NO.
A2169A

DWG NO.
A2170A



PIONEER PUMP, INC.

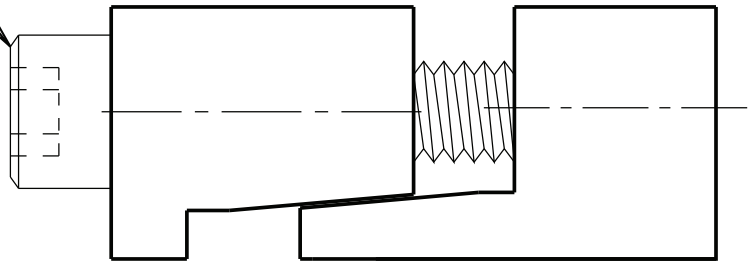
REMOVING DISCHARGE CHECK VALVE

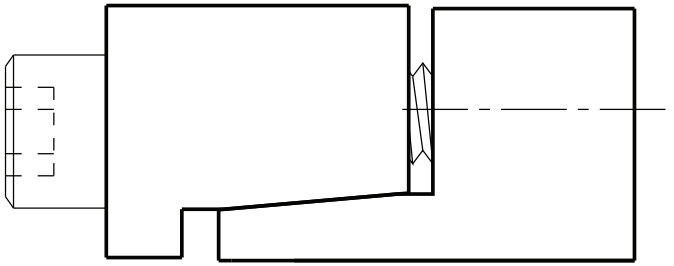
DWG NO.
A2170A

DWG NO.
A2183A

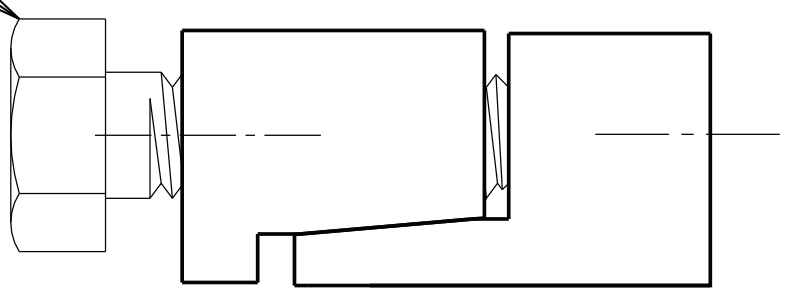
1/4-20UNC X 1.25
SOCKET CAPSCREW

APPROX. 1/4"





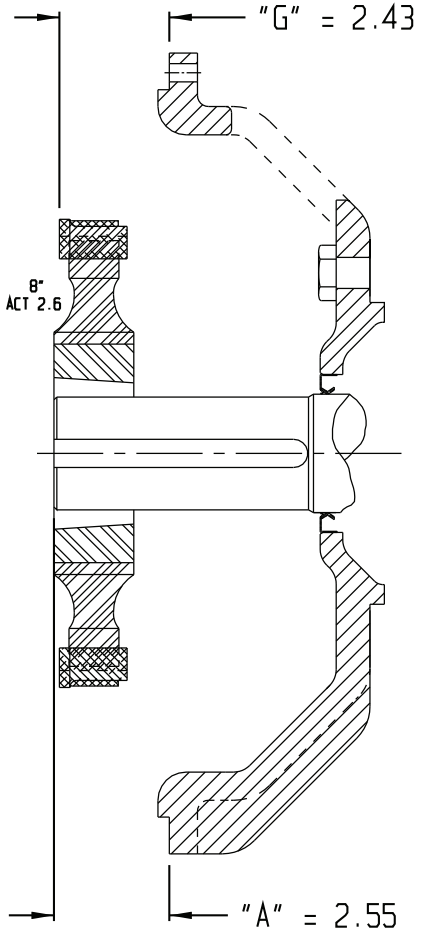
5/16-18UNC X 1.0
CAPSCREW

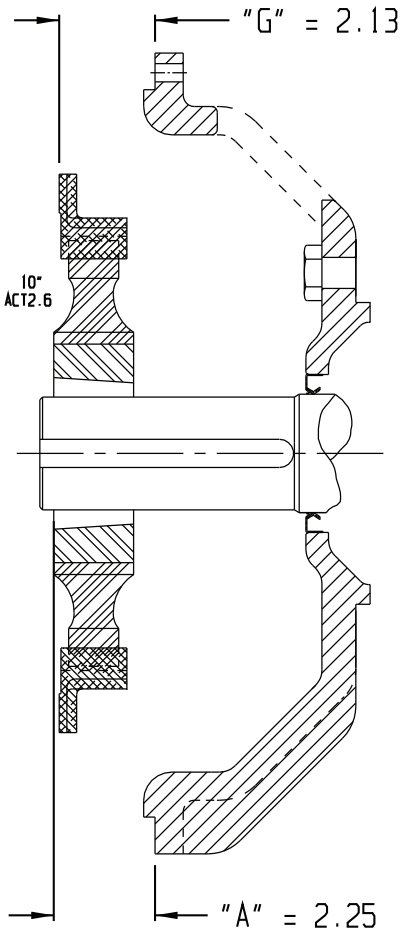


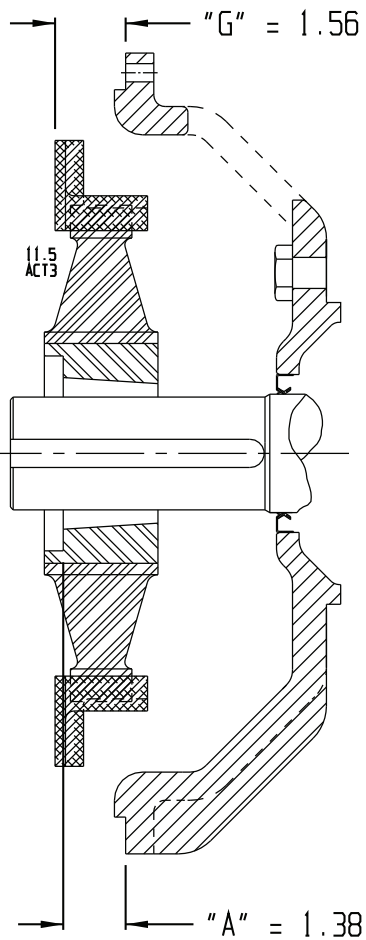
DWG NO.
A2184A

INSTALLER MUST CONFIRM THAT PUMP SHAFT MAKES NO DIRECT CONTACT WITH ENGINE FLYWHEEL OR CRANKSHAFT AND THAT COUPLING IS INSTALLED SO AS TO TRANSMIT NO AXIAL THRUST TO THE ENGINE FLYWHEEL OR CRANKSHAFT

DIMENSIONS SHOWN ARE BASED ON SAE STANDARD BELLHOUSING AND FLYWHEEL DIMENSIONS. INSTALLER ASSUMES FULL RESPONSIBILITY FOR VERIFYING DIMENSIONS CORRECT FOR ANY PARTICULAR ENGINE





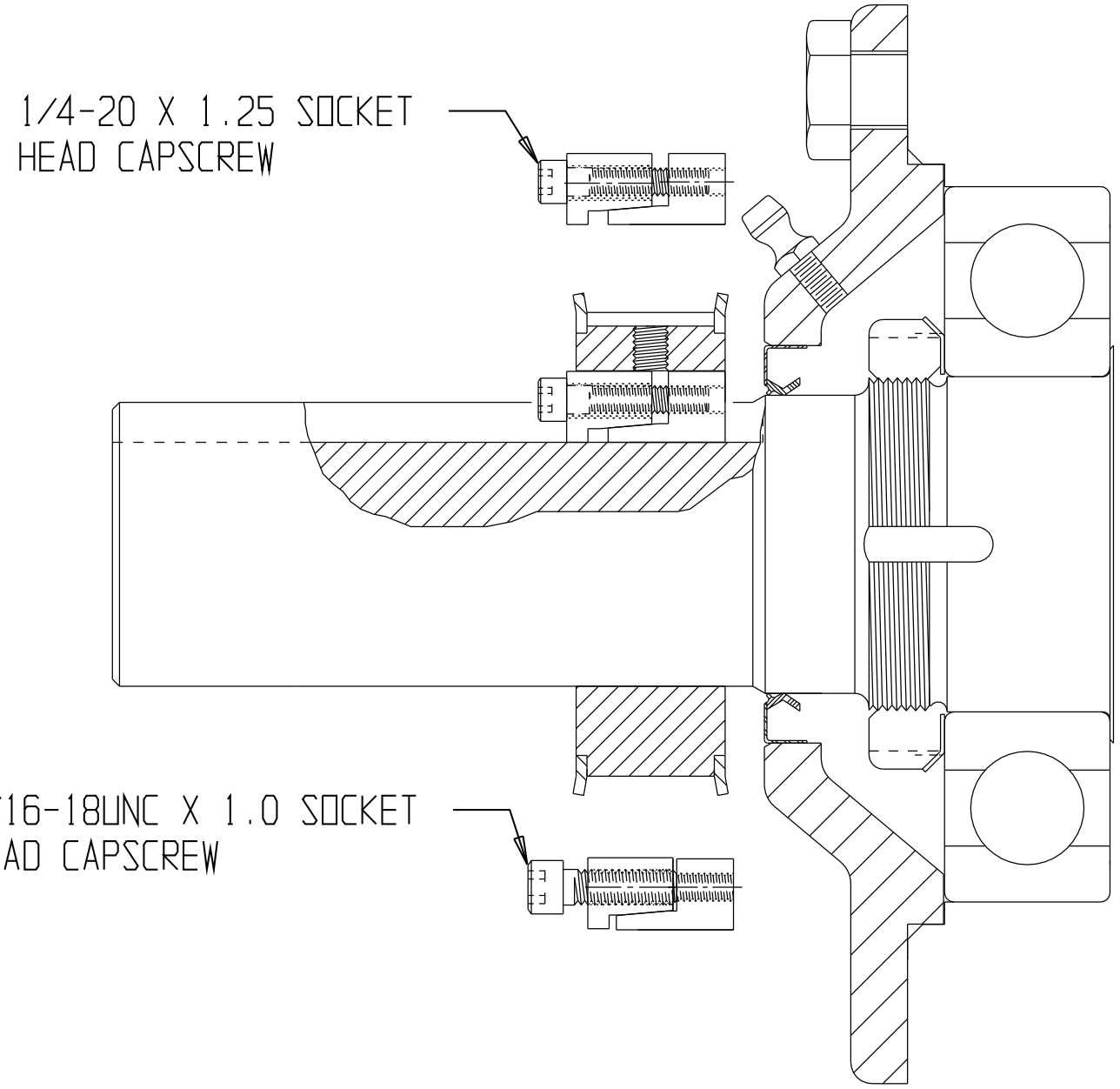


PIONEER PUMP, INC.

CORRECT COUPLING POSTION FOR SAE 3 & 4 W/8",10" & 11.5" DRIVES

DWG NO.
A2184A

DWG NO.
A2187A

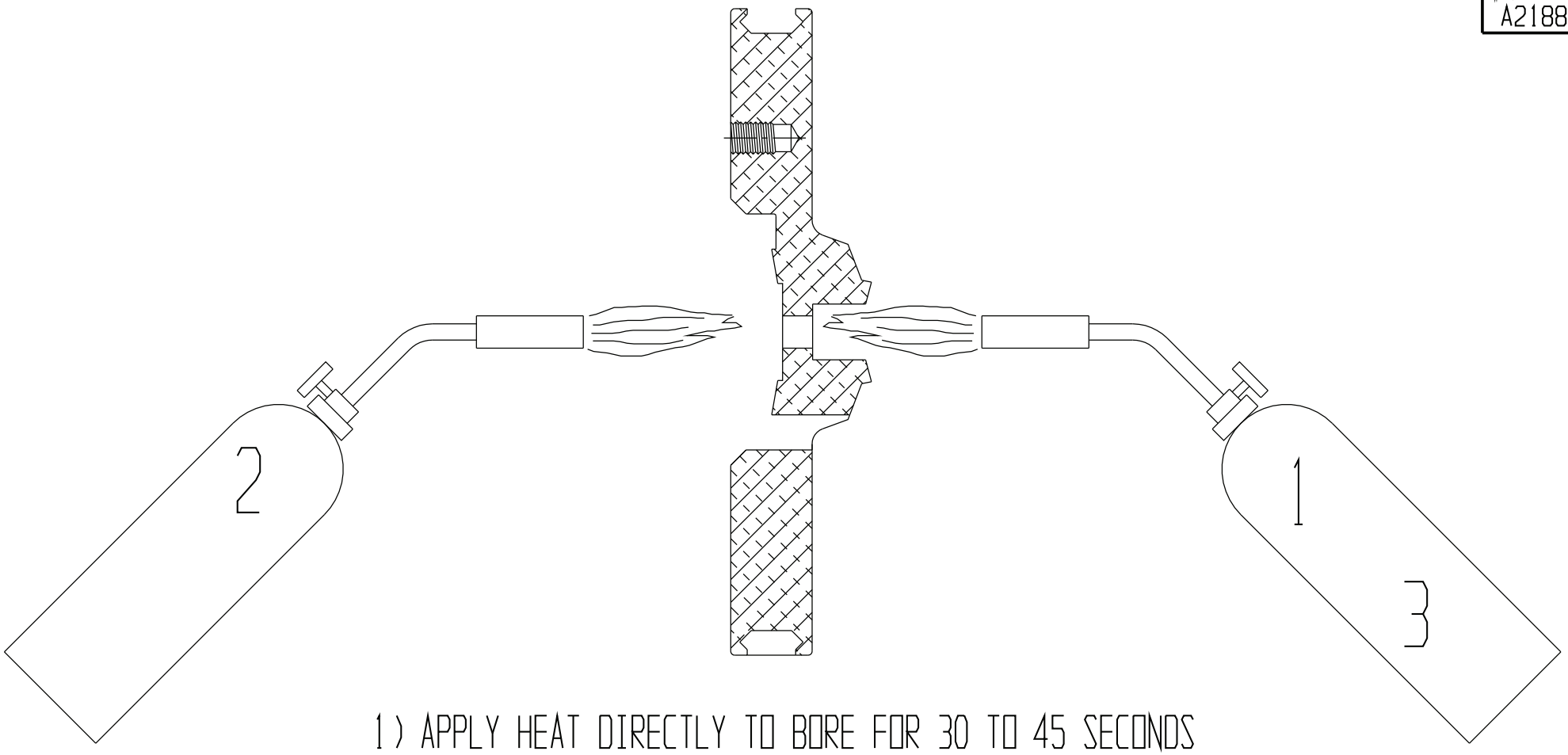


PIONEER PUMP, INC.

PULLEY AND WEDGE KEY INSTALLATION

DWG NO.
A2187A

DWG NO.
A2188A



1) APPLY HEAT DIRECTLY TO BORE FOR 30 TO 45 SECONDS

2) APPLY HEAT TO TOP OF ACTUATOR FOR 15 TO 20 SECONDS

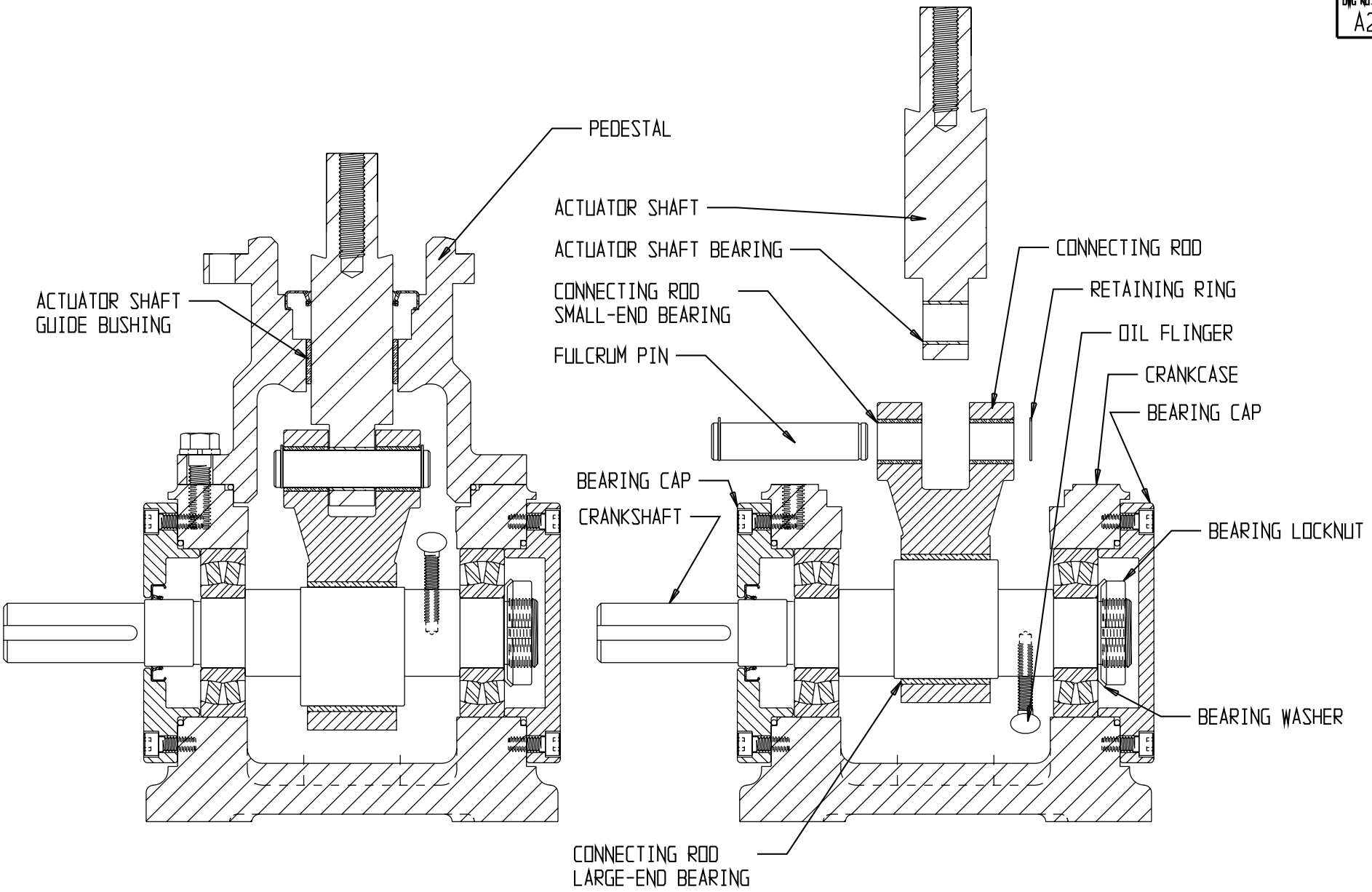
3) APPLY HEAT TO BORE AGAIN FOR 15 TO 20 SECONDS

PIONEER PUMP, INC.

INSTALLATION OF ACTUATOR

DWG NO.
A2188A

DWG NO.
A2189A



PIONEER PUMP, INC.

VACUUM PUMP DISASSEMBLY

DWG NO.
A2189A

PIONEER PUMP
PERFORMANCE THROUGH INNOVATION™

PIONEER PUMP, INC. LIMITED WARRANTY

PIONEER PRIME SERIES

LIMITED WARRANTY: Seller warrants for two years from the date of shipment Seller's manufactured products to the extent that Seller will replace those having defects in materials or workmanship when used for the purpose and in the manner which Seller recommends. If Seller's examination shall disclose to its satisfaction that the products are defective, and an adjustment is required, the amount of such adjustment shall not exceed the net sales price of the defective products and no allowance will be made for labor or expense of repairing or replacing defective products or workmanship or damage resulting from the same. Seller warrants the products which it sells of other manufacturers to the extent of the warranties of their respective makers. Where engineering design or fabrication work is supplied, buyer's acceptance of Seller's design or of delivery of work shall relieve Seller of all further obligation, other than as expressed in Seller's product warranty.

THIS IS SELLER'S SOLE WARRANTY. NO OTHER WARRANTIES, WRITTEN OR ORAL, EXPRESS OR IMPLIED, INCLUDING THE WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE AND MERCHANTABILITY, ARE MADE OR AUTHORIZED. NO AFFIRMATION OF FACT, PROMISE, DESCRIPTION OF PRODUCT OF USE OR SAMPLE OR MODEL SHALL CREATE ANY WARRANTY FROM MANUFACTURER, UNLESS SIGNED BY THE PRESIDENT OF THE MANUFACTURER.

Seller neither assumes, nor authorizes any person to assume for it, any other obligation in connection with the sale of its engineering designs or products. This warranty shall not apply to any products or parts of products which (a) have been repaired or altered outside of Seller's factory, in any manner; or (b) have been subjected to misuse, negligence or accidents; or (c) have been used in a manner contrary to Seller's instruction or recommendations. Seller shall not be responsible for design errors due to inaccurate or incomplete information supplied by Buyer or its representative.

TCD 3.6

Engine for Industrial Applications

50 - 90 kW | 67 - 120 hp at 2600 and 2300 min^{-1} | rpm

EU Stage III B / US EPA Tier 4 interim

The engine company.

DEUTZ®

Characteristics

4 cylinder in-line engines turbo charged, with or without charge air cooling | Water-cooled | Compact engine design | Advanced fuel injection and combustion system | External cooled exhaust gas recirculation | Full line customized options | Excellent cold starting ability for extreme climatic conditions | Full power at flywheel end for axial or radial drives | Two optional PTO's from gear end cover | In compliance to non-road emission standards EU Stage III B and US EPA Tier 4 interim

Your Benefits

- Compact 4 cylinder engine with high specific power and torque, a market leader in engine performance, specially designed for short and narrow machine installations.
- The modern common rail fuel injection system, the front gear drive and optional balancer shafts guarantee low noise, low vibration and smooth engine operation under all load conditions.
- Engine variant, without aftertreatment but with otherwise identical installations parameters, providing flexibility for export markets with lower emission requirements.
- Low fuel consumption via high pressure Common Rail System, 500 hr oil change interval and the maintenance free valve train provide durable productivity and life long low operating cost.
- The extensive network of DEUTZ distributors and dealers providing excellent technical backup and enviable global brand presence.
- An exhaust aftertreatment system tailored to meet all the requirements of Industrial Equipment and offer the opportunity of compact installation through the flexibility of loose or engine mounted options.
  The DVERT® 'wall flow' high efficiency system with active regeneration is suitable for all equipment applications with a minimum ash servicing period of 3000 hours.
  The DVERT® 'through flow' system offers the eligible feature of service free operation throughout the engine design life.
  Our modular design provides the benefits of competitive cost and robust compliant solutions for all applications, duty cycles and markets.
- Low fuel consumption, recyclable components and fluid change friendly systems, designed to protect the environment.

Engine Specifications

Cylinder:	4 cylinder in-line
Cooling system:	Water-cooled, belt driven water pump, with integrated, thermostat controlled bypass
Crankcase:	Ribbed, thin-wall grey cast iron, noise-optimised
Crankcase breather:	Closed-circuit system
Cylinder head:	Cast iron cross flow cylinder head with separate aluminium inlet manifold
Valve train:	Overhead valves in cylinder head, two valve per cylinder, actuated via rocker arms, push rods and hydraulic tappets, driven by low-noise straight cut gears and camshaft.
Charging:	Wastegate turbo charger and air-to-air charge cooling version
Piston:	3-ring piston with oil jet cooling
Connecting rod:	Drop-forged steel rod, fracture split
Crankshaft:	Casted, high grade SG iron with cast-on counterweights, fillet-rolled, bi-metal shell bearings
Camshaft:	Chilled cast iron
Lubrication system:	Gear driven rotor pump, integrated oil cooler with spin-on cartridge filter
Fuel injection system:	High pressure Common Rail, electronically controlled
Fuel filter:	Replaceable cartridge main filter and a pre-filter with water trap
Fuel lift pump:	Electrical pump
Alternator:	Three-phase alternator, 14 V / 55 - 120 A (depending on application)
Starter motor:	12 V / 2.6 - 4 kW (depending on applications)
Options:	Intake manifold connections, exhaust manifolds connections, hydraulic pumps drives, mass balancing shafts, engine mounts, multi oil pan drains, dipsticks, SAE flywheel housings, flywheels, oil filter position horizontal, vertical and remote, oil filler in cylinder head cover and low level fill on side of crankcase, electrics 12 V and 24 V

Technical Data

Engine model		T(C)D 3.6 L4	TCD 3.6 L4	TCD 3.6 L4
Number of cylinders		4	4	4
Bore/stroke	mm | in	98/120 | 3.86/4.72	98/120 | 3.86/4.72	98/120 | 3.86/4.72
Displacement	l | cu in	3.62 | 221	3.62 | 221	3.62 | 221
Compression ratio		18 : 1	18 : 1	18 : 1
Rated speed	min^{-1} | rpm	2600	2600	2300
Mean piston speed	m/s | ft-m	10.4 | 2045	10.4 | 2045	9.2 | 1809

EU Stage III B / US EPA Tier 4 interim

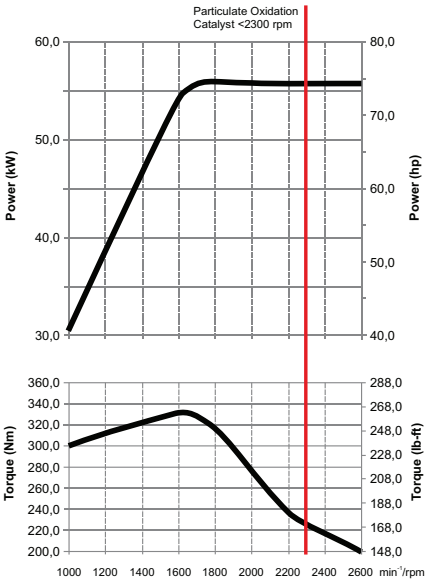
Power ratings[1)]		T(C)D 3.6 L4	TCD 3.6 L4	TCD 3.6 L4
Power acc. to ISO 14396	kW | hp	55.4 | 74	75 | 100	90 | 120
at engine speed	min^{-1} | rpm	2600	2600	2300
Mean effective pressure	bar | psi	7.06 | 115.74	10.84 | 177.67	12.97 | 198.56
Max. torque	Nm | ft-lb	330 | 244	390 | 288	480 | 354
at engine speed	min^{-1} | rpm	1600	1600	1600
Minimum idle speed	min^{-1} | rpm	900	900	900
Specific fuel consumption[2)]	g/kWh | lb/hph	220 | 0.36	210 | 0.34	210 | 0.34
Weight acc. to DIN 70020, Part 7A[3)]	kg | lbs	270 | 595[3)]	270 | 595[3)]	270 | 595[3)]

1) Power ratings at flywheel gross, without cooling system.
2) At optimal operating point. Specific fuel consumption based on diesel fuel with a specific gravity of 0.835 kg/dm³ at 15 °C (6.96 lb/US gallon at 60 °F).
3) Not including starter motor/alternator, radiator and operating fluids but including flywheel and flywheel housing.

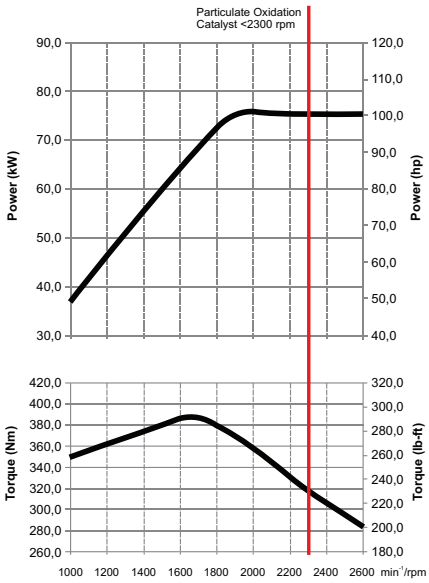
The values given in this data sheet are for information purposes only and not binding.
The information given in the offer is decisive.

Standard Engines

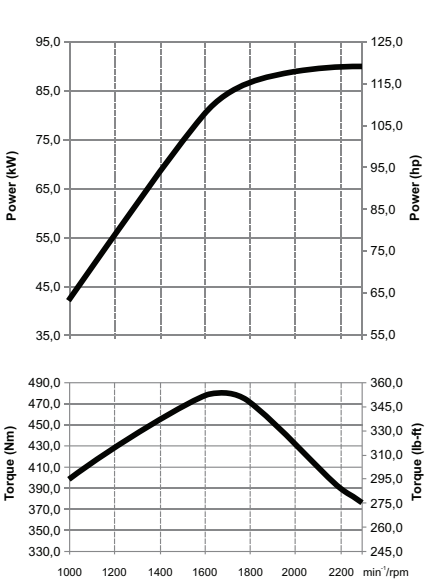
T(C)D 3.6 L4 55.4 kW



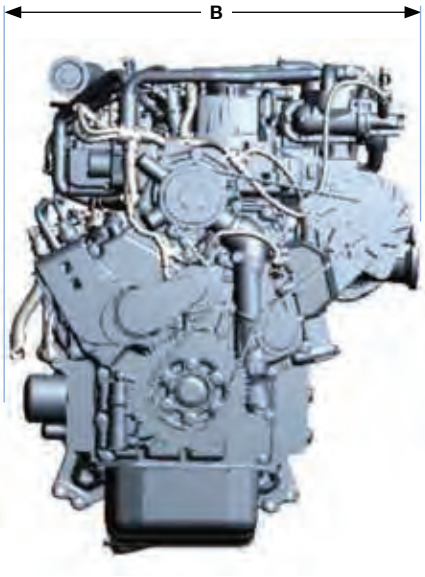
TCD 3.6 L4 75 kW

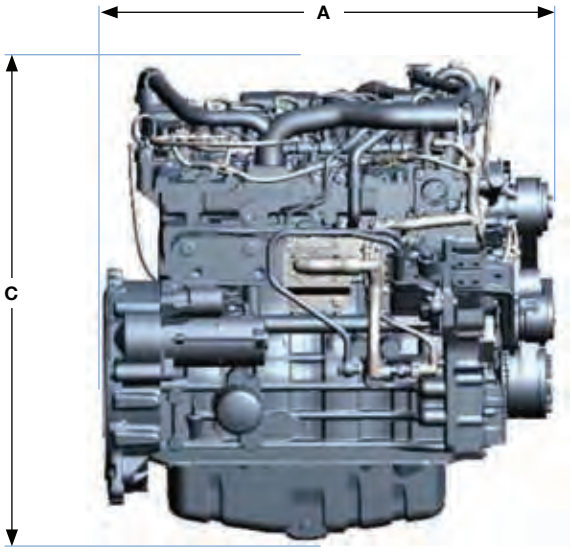


TCD 3.6 L4 90 kW



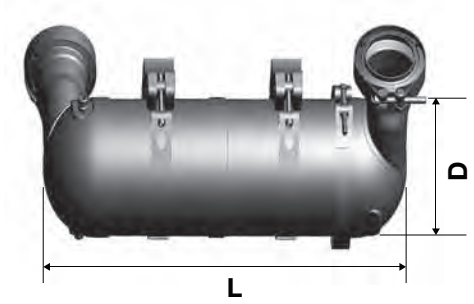
Dimensions		A	B	C
TD 3.6 L4	mm | in	716 | 28.2	595 | 23.4	792 | 31.2
TCD 3.6 L4	mm | in	716 | 28.2	595 | 23.4	792 | 31.2





Dimensions			D	L	DVERT® Systems		
					DOC only	‚Through Flow'	‚Wall Flow'
TD 3.6	< 56 kW	mm | in	190 | 7.5	400 | 15.7		■	■
TCD 3.6	< 56 kW	mm | in	190 | 7.5	590 | 23.2	■		■
TCD 3.6	< 90 kW	mm | in	190 | 7.5	600 | 23.6		■	■

DVERT® ‚through flow' system is not suitable for some specific market legislations.
For more information please contact DEUTZ AG, Cologne, or responsible regional sales organisation.
All connection variants are available in either 0° or 90° positions of both intake and outlet flanges.



These illustrative pictures showing the scale of EAT systems vs engine are for information purposes only and not binding.
The final design will be published via DEUTZ technical documentation systems.

Tier 4 – our driving force, your advantage.

Starting January 2012, diesel engines of mobile construction machines with power classes ranging from 56 to < 130 kW have to meet European regulations on exhaust emissions according to EU Stage III B or US EPA Tier 4 interim. The considerable reduction in particulate matter and NO_X requires that engines be equipped with additional exhaust emission treatment equipment.

The individual solution counts
Our Our goal as engine specialists is to provide our customers with engines that not only meet all of their power needs but also comply with the various emission regulations worldwide while meeting their demands for efficient and economical engine operation. We are therefore developing solutions oriented to meet individual customer requirements.

The modular DVERT® system developed by DEUTZ enables us to implement different emission-reducing techniques specifically tailored to fulfil those requirements while maintaining the performance of our engines, which include high fuel economy, dependability, and long life.
The DVERT® Oxidation Catalyst (DOC) only or combined with an open DVERT® ‚through flow' module is one of the technologies we implement for the 3.6 engine series below 56 kW complying with the EU exhaust emission Stage III B and the US EPA Tier 4 for many applications.
For more challenging applications and load profiles DEUTZ also offers the possibility to use a DOC and closed DVERT® ‚wall flow' system with throttle regeneration.

Operation mode and Regeneration of the Diesel Particulate Filter
The DVERT® Oxidation Catalyst (DOC) initially oxidizes gaseous pollutants such as HC, CO, and NO.
Soot particulates are then captured in an enclosed DVERT® particulate system installed after the catalyst. The DVERT® Particulate module (through or wall flow) via a temperature dependant continuous catalytic reaction burns off the deposits. In these types of system regeneration is possible for virtually all load patterns and represents by far the most cost-effective solution.
In addition the wall flow system offers active regeneration by means of an electronically controlled intake air throttle to achieve the required temperature level for the regeneration in the case of low exhaust temperatures.

DVERT® – solutions for the future
Only after exhaust emission Stage EU IV / US EPA Tier 4 take effect, it will be necessary to equip engines of this series over 56 kW with an additional SCR system, another DVERT® module already available today.

DEUTZ worldwide:

www.deutz.com

DEUTZ AG
Ottostr. 1
51149 Cologne, Germany
Phone: +49 (0) 221 822-0
Telefax: +49 (0) 221 822-3525
E-Mail: info@deutz.com
www.deutz.com

DEUTZ Corporation
3883 Steve Reynolds Blvd.
Norcross, GA 30093, USA
Phone: +1 770 564 7100
Telefax: +1 770 564 7222
E-Mail: engines@deutzusa.com
www.deutzusa.com

DEUTZ AG Beijing Office
207 CITIC Building
Jian Guo Men Wai Dajie,
100004 Beijing, P.R. China
Phone: +86 10 65 00 64 44
Telefax: +86 10 65 12 00 42
E-Mail: dbj@deutz.com.cn
www.deutz.com.cn

DEUTZ Asia-Pacific (Pte) Ltd.
11 Kian Teck Road
628768 Singapore
Phone: +65 62 68 53 11
Telefax: +65 62 64 17 79
E-Mail: dap@deutz.com
www.deutz.com

DEUTZ Australia Pty. Ltd.
41 Woodlands Drive
3195 Braeside Vic, Australia
Phone: +61 3 9586 9600
Telefax: +61 3 9580 4090
E-Mail: deutzoz@deutz.com
www.deutz.com

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The engine company.

DEUTZ®

Software Release: [App: 02.09.10051.00; Config: 2.9.20023; PowerVision Configuration Studio Version: 2.9.23029; BTL: 02.09.10015.00]

PowerCore®

MPC-10 Engine Controller & TEC-10 Panel Operations Manual

To see this manual in Spanish, German, French or Italian, please go to
support.enovationcontrols.com,
then search for MPC-10 or TEC-10.

In order to consistently bring you the highest quality, full-featured products, we reserve the right to change our specifications and designs at any time.

00-02-0939
2018-09-28
Section 40

Warranty - A limited warranty on materials and workmanship is given with this Murphy product.
A copy of the warranty may be viewed or printed by going to www.murphybyenovationcontrols.com/warranty

ENOVATION CONTROLS has made efforts to ensure the reliability of the MPC-10 / TEC-10 and to recommend safe use practices in system applications. Please note that in any application, operation and controller failures can occur. These failures might result in full control outputs or other outputs that might cause damage to or unsafe conditions in the equipment or process connected to the MPC-10 / TEC-10.

Good engineering practices, electrical codes and insurance regulations require that you use independent external protective devices to prevent potentially dangerous or unsafe conditions. Assume that the MPC-10 / TEC-10 can fail with outputs full ON; outputs full OFF; or that other unexpected conditions can occur.

Please read the following information before installing.

BEFORE BEGINNING INSTALLATION OF THIS MURPHY PRODUCT:

- A visual inspection of this product before installation for any damage during shipping is recommended.
- Disconnect all electrical power to the machine. Failure to disconnect all electrical power connections before welding can result in damage to the panel and/or its components.
- It is your responsibility to have a qualified technician install the unit and make sure installation confirms with local codes.
- Observe all Warnings and Cautions in each section of these instructions.
- The MPC-10 / TEC-10 is designed for use in industrial environments. There might be potential difficulties in ensuring electromagnetic compatibility in other environments due to conducted as well as radiated disturbances.
- Please contact ENOVATION CONTROLS immediately if you have any questions.

IMPORTANT! False or improper use and operation of electronic products could be dangerous. It is required that point-of-operation guarding devices be installed and maintained. All such devices must meet OSHA and ANSI Machine safety standards. The manufacturer shall not accept any responsibility for installation, application or safety of systems.

The MPC-10 can be set as an Auto-Start Controller. Please be cognizant at all times of hands and other objects that are in close proximity to the machine(s) being controlled as they may commence operation suddenly and without warning.

LENS CLEANING PROCEDURES

The lens on the MPC-10 and TEC-10 is composed of Polycarbonate materials. Use only mild soap and water to clean the lens/display window. Evidence of improper cleaning techniques or chemicals includes cracks, smear marks, scratches, or fogged/hazy lenses.

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Table of Contents

Introduction

This document is designed to familiarize a user with the MPC-10 / TEC-10 and how to navigate the interface and modify the settings when setting up and operating the controller. The Quick Set Up guide assists with establishing the different functions in the MPC-10 / TEC-10 System Controller. Before attempting to set up the controller, be sure to read and understand this manual in its entirety.

Murphy PowerCore 10 (MPC-10 / TEC-10)

The Murphy PowerCore 10 Controller (MPC-10 / TEC-10) is a general, all-purpose manual/auto start and manual/auto throttling engine controller designed with rental applications in mind. This is a powerful controller that supports J1939 CAN protocols on electronically governed engines as well as analog sensors on mechanical engines for monitoring and fault/safety shutdowns.

The MPC-10 / TEC-10 is flexible in many aspects, with the ability to:

- use in most applications where auto start or auto throttling is required or desired;
- use the same controller on electronically governed J1939 and mechanical engines;
- use the same controller on 12VDC or 24VDC systems;
- assign multiple levels of passcode protection to the menu;
- use as auto start or manual start controller;
- use as manual throttle or auto throttle controller;
- change the input sensor type for analog inputs;
- use analog inputs as digital ground inputs;
- assign functions and actions to digital inputs;
- use digital inputs as battery positive or ground inputs;
- be mounted in all-weather environments;
- be customer mounted in panel of choice (MPC-10 only).

Engine Application States and Delays

The Controller follows a standard operating sequence. This operating sequence is a set of machine states that happen in a fixed order. Machine states can be set to zero if not needed or adjusted to fit the application. The following states will be executed during the auto sequence, provided that the corresponding timer has not been set to 00:00:00 or the controller has not been placed in a manual mode of operation:

- **Stabilize:** This is a timed state to allow the controller to enable the ECU or any senders without warnings or errors. This timer can be disabled if set up for mechanical engine use.
- **Stopped:** This is a timed state where the engine is ready to be started manually or automatically.
- **Standby:** This is a timed state that will shut off the LCD backlight, heater and CAN transceiver to conserve power while the unit waits for a key press or an automatic start condition.
- **Wait To Start:** when an engine is not ready to start and sends a message across the J1939 communications stating it is not ready to start.
- **Auto Start Delay:** (**available in Auto Mode only)** The auto start condition is ignored and must remain active throughout this delay or the delay is reset to zero.
- **Prestart Delay 1:** After a start condition has been accepted by the controller, this delay begins timing, and the prestart output turns on. When this delay expires, the output is turned off, and the start sequence continues.
- **Check Safe To Start:** This is a non-timed state that will check to ensure the engine can start safely.

- **ECU Stabilize Timer:** This delay begins timing when the controller is powered up, in Spindown or when the Standby delays have expired. During this delay, the ECU-enabled output is turned on. The ECU output turns off when the Standby, ETS or Spindown delays begin timing.
- **Prestart Delay 2 (Precrank):** After a start condition has been accepted by the controller, this delay begins timing, and the prestart output turns on. When this delay expires, the output is turned off, and the start sequence continues. During this delay, the controller checks for faults, J1939 com, etc.
- **Prestart Delay 2 (Crank Through):** After a start condition has been accepted by the controller, this delay begins timing, and the prestart output turns on. When this delay expires, the output remains on, and the start sequence continues. The output turns off when the engine starts. During this delay, the controller checks for faults, J1939 com, etc.
- **Crank:** This is a timed state to try and start the engine.
- **Crank Rest:** This is a timed state to rest the starter between cranks in case the engine did not start during the crank state.
- **False Start Check:** This is a non-timed state that will ensure the engine stays above the crank cut RPM after cranking.
- **Warm-up:** (**available in Auto mode only)** This is a timed state that will allow the engine to change from idle to desired warm-up RPM after starting. Warm-up will only set as low as the minimum RPM set point.
- **Line Fill 1:** (**available in Auto mode only)** This is a timed state that will exit if the timer times out or the pressure set point for this state is reached.
- **Line Fill 2:** (**available in Auto mode only)** This is a timed state that will exit if the timer times out or the pressure set point for this state is reached.
- **Running Loaded:** This is a non-timed state that the controller will stay in until a stop condition occurs.
- **Auto Stop Delay: (available in Auto Mode only)** The auto stop condition is ignored and must remain active throughout this delay or the delay is reset to zero.
- **Cooldown:** (**available in Auto mode only)** This is a timed state that will allow the engine to run at a desired speed to cool down before allowing to go into a stopped state.
- **Spindown:** The time allotted for the engine to stop all revolutions and be in a stopped state with no frequency.

User Interface

The keypads on the MPC-10 / TEC-10 are comprised of 11 tactile buttons. This section describes the functions of each button.

Figure 1: User Interface

The buttons have the following functions:

- **Start Key** – Allows the operator to start sequence in Manual Mode or initiate an auto start sequence when in Auto Mode (do not use in Auto Mode when set to single contact auto start method).
- **Stop Key** – Allows the operator to initiate the stop sequence in either manual or auto mode of operation. As a safety feature, the stop key will skip the cool-down state when it is pressed twice or held in auto mode. Once shut down, the controller will enter manual mode to eliminate an auto crank condition if the auto start condition is still present.
- **Auto Key** – Allows the operator to change from Auto to Manual or Manual to Auto Mode by pressing the key. When changing from manual to auto mode a confirmation is required by the operator as shown on the display.
- **Alarm Silence Key** – Allows the operator to acknowledge alarms on the controller when warnings and shutdowns are present as well as silences the remote alarm output.
- **Manual Throttle Increase Key** – Allows the operator to manually increase the engine throttle in Manual Mode.
- **Manual Throttle Decrease Key** – Allows the operator to manually decrease the engine throttle in Manual Mode.
- **Menu Key** – Allows the operator to get in and out of the menu.
- **Back Key** – Allows the operator to move back one step while in the menu.
- **Enter Key** – Allows the operator to enter a value in the menu when selected and is used to acknowledge internal and external alarms/shutdowns.
- **Up Key** – Allows the operator to navigate up through the menu and page forward on the main pages.
- **Down Key** – Allows the operator to navigate down through the menu and page reverse on the main pages.

The TEC-10 Panel offering also has a keyswitch and a stop button on the front:

Figure 2: Panel stop button and on/off keyswitch

Accessing the Menu

The MPC-10 / TEC-10 have 3 menu security levels to restrict users from making changes after installation. The security levels are Low, Medium and High. One may consider these security levels as user, technician and OEM. By default the low level security has a small number of menu items a user can access. The medium level security has all the low level menu items plus other menu items a technician may change while in the field. The high security level has the entire menu visible to the operator or OEM.

To access the MPC-10 / TEC-10 menu, press the menu key. Review section Menu Glossary and Passcodes to understand the menu level presets in the controller. The following screen will display to enter the passcode: [Low=1111; Medium=5311; High=3482].

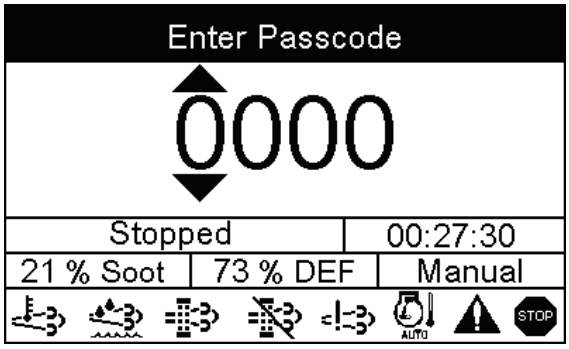


Figure 3: Enter Passcode

The password will be entered left to right. Utilize the up and down arrows, and press the Enter button after each correct number: Entering this password will allow full access to the menu. If you enter the wrong password, it will reset the display to 0000, allowing you to restart the entering process.

> **NOTE:** To learn more about passcode security and changing the security levels, please refer to the Configuration Tool manual for the MPC-10 / TEC-10.

Main Menu

The MPC-10 / TEC-10 controller is incredibly versatile within the menu structure. The operator is able to change most parameters and settings from the face without the need of a PC tool, if desired. **The controller must be in its stopped state in order to change a setting in the menu.** (The Tier 4 menu is the sole exception). Described below are the main sections of the controller's menu. **Cycling power to the controller is recommended after making changes to set points and input/output.**

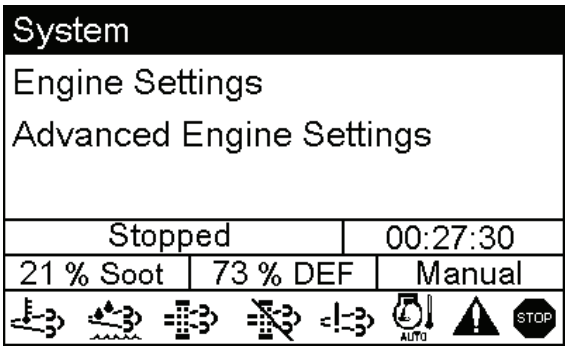


Figure 4: Main Menu, page 1

System

The controller System menu provides the operator with the ability to set the Date/Time, Units, Language, Brightness, Service Reminders and several other system settings. Review System under the Menu Glossary section of this manual for a full list and definition of each setting.

Engine Settings

The Engine Settings menu allows the operator to establish common user-configurable parameters that would be changed from factory default settings when pairing the controller to an engine. This menu allows the operator to choose whether the engine is J1939 or mechanical, the engine's speed source, the minimum and maximum RPM the operator requires/allows the engine to run, warm-up/cool-down settings and other common engine settings. Review Engine Settings under the Menu Glossary section of this manual for a full list and definition of each setting.

Advanced Engine Settings

The Advanced Engine Settings menu allows the operator to set up the less common user-configurable parameters that are not in the Engine Settings menu and which would be changed from factory default settings when pairing the controller to an engine. This menu allows the operator to set items such as the J1939 address claim for the controller, ECU Source Address, ECU hour select, crank attempts, crank disconnect speed and other user-specific engine settings. Review Advanced Engine Settings under the Menu Glossary section of this manual for a full list and definition of each setting.

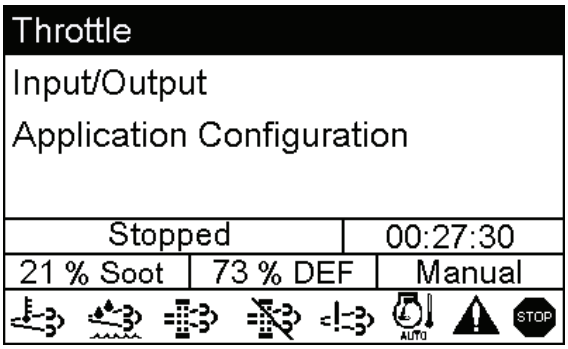


Figure 5: Main Menu page 2

Throttle

The Throttle menu allows the operator to set up the items for throttling the engine such as Manual Throttle Method, Throttle Type, Rate of RPM Increase/Decrease, Throttle Inc/Dec Pulse Time and other parameters pertaining to throttling of the engine. Review Throttle under the Menu Glossary section of this manual for a full list and definition of each setting.

Input / Output

The Input/Output menu allows the user to establish the I/O needed for the application. This includes Digital Inputs, Analog Inputs, Relay Outputs and Digital Outputs. This menu is tied to other aspects of the controller menu such as Auto Start Functions, Auto Throttling Methods, Analog Inputs for Mechanical Engine setup, Warning / Shutdown functions and all outputs needed for starting/controlling the engine and alerting the user.

The Digital Inputs of this menu can be configured from the face of the controller to accept three types of inputs as the Active state of the input.

- High, B(+)
- Low, B(-)
- Open

The Analog Inputs of this menu can be configured from the face of the controller to accept one of four types of senders:

- Resistive
- 4-20mA
- 0-5VDC
- Analog.Digital (B- for additional Digital Inputs)

The Outputs are configurable for the operator to choose which output function to use with the desired output type as shown below.

- Relay [10A, Form C]
- Digital Out [1A, B(+)]
- Digital Out [1A, B(-)]

> **NOTE:** Although the functionality exists to set all analog and digital inputs to the same function, Enovation Controls strongly advises against this.

Application Configuration

The Application Configuration menu is where an operator will set up the controller's Auto Start Functions and Auto Throttling Methods, if the intended use is an auto start and/or auto throttling controller. Depending on which application is chosen in the menu, there are certain auto start functions and auto throttling methods hidden that are not pertinent to the application chosen. This automatic hiding feature allows for a simpler, more intuitive controller menu in the MPC-10 / TEC-10. Review Application Configuration under the Menu Glossary section of this manual for the full list and definition of each setting.

Pump All Purpose

The Pump All Purpose application houses auto start functions and auto throttling methods of the controller for common pumps used in rental applications.

The auto start functions and auto throttle methods are:

Auto Start/Stop Functions

- Single Contact (requires a digital input for start and stop)
- Local Start (Green Start key)
- Two Contact Maintained (Dual Floats) (requires digital inputs for start and stop)
- Pressure Transducer (requires an analog input setting)
- Level Transducer (requires an analog input setting)

Auto Throttle Methods

- Running Loaded RPM
- Pressure Transducer (requires an analog input setting)
- Level Transducer (requires an analog input setting)

Air Compressor

The Air Compressor application houses the auto start functions and auto throttle methods meant to be used on all engine-driven air compressor applications. The MPC-10 / TEC-10 allows for the compressor to start/stop and maintain a desired pressure during operation.

The auto start functions and auto throttle methods to choose from are:

Auto Start/Stop Functions

- Single Contact (requires a digital input for start and stop)
- Local Start (Green Start key)
- Pressure Transducer (requires an analog input setting)

Auto Throttle Methods

- Running Loaded RPM
- Pressure Transducer (requires an analog input setting)

Hose Reel Irrigation

The Hose Reel Irrigation application houses the auto start functions and auto throttle methods meant to be used on hose reel irrigation systems. The MPC-10 / TEC-10 allows for the hose reel pump to auto start with several methods, including the Local Start key which may be the most used in this application. The key feature of this application is the auto throttling method. This feature allows the controller to manage the pump's throttle in order to maintain a pressure in the hose during irrigation.

The auto start functions and auto throttle methods to choose from are:

Auto Start/Stop Functions

- Single Contact (requires a digital input for start and stop)
- Local Start (Green Start key)
- Two Contact Maintained (requires digital inputs for start and stop)

Auto Throttle Methods

- Pressure Transducer (requires an analog input setting)

Frost Protection

The Frost Protection application houses the auto start functions and auto throttle methods meant to be used on frost protection systems. This application allows for a wind machine, sprinkler or other forms of frost protection using single contact or a temperature transducer.

The auto start functions and auto throttle methods to choose from are:

Auto Start/Stop Functions

- Single Contact (requires a digital input for start and stop)
- Temperature Transducer (requires an analog input setting)

Auto Throttle Methods

- Running Loaded RPM

Chipper

The Chipper application houses the auto start functions and engage/disengage methods meant to be used on Chippers. The operator can also choose between Chipper types, On-Off-On or Dumping.

The functions available are:

Auto Start/Stop Functions

- Local Start Key (Green Start key)

Engage RPM

Disengage RPM

Disengage Delay

Chipper Feed System

- On-Off-On
- Dumping

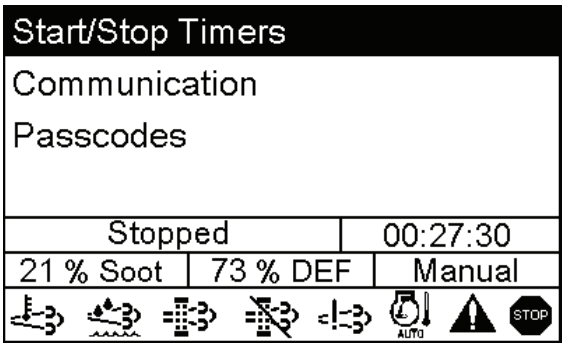


Figure 6: Main Menu page 3

Start / Stop Timers

The Start/Stop Timers menu provides the operator the ability to add a countdown timer, scheduled start/stop times, and an engine exercise timer. All Start/Stop timers only work when the controller is set to auto mode. The countdown timer allows for the operator to set a desired countdown time and walk away from the engine for a controlled shutdown when the timer expires. There are three Start/Stop Timers the operator can choose from within this menu that allows for the specific day and hour the controller will start and stop utilizing the internal clock. Review Start/Stop Timers under Menu Glossary section of this manual for full list and definition of each setting.

> **NOTE:** Start / Stop timers work in conjunction with other Start / Stop types. The Start / Stop times are independent of the other Auto Start methods. If the engine is already running from another Start / Stop type when a Start / Stop timer occurs, the Start / Stop timer is ignored. Once the engine is started by the Start / Stop timer the Auto Stop method is ignored and will be stopped by the set Stop time.

Communication

The Communications menu allows the operator to choose the type of RS485 communications such as PVA Gauge, Modbus or Local Display. The menu also allows for the operator to choose CAN termination and enabling of the CAN Parameter Map. Review Communication under the Menu Glossary section of this manual for a full list and definition of each setting.

Passcodes

The Passcodes menu is only available in the high security menu and allows the operator to see the three level of passcodes set in the controller. The passcodes are read only in this view. Passcodes are able to be changed from default passcode setting via PowerVision for Controllers configuration tool.

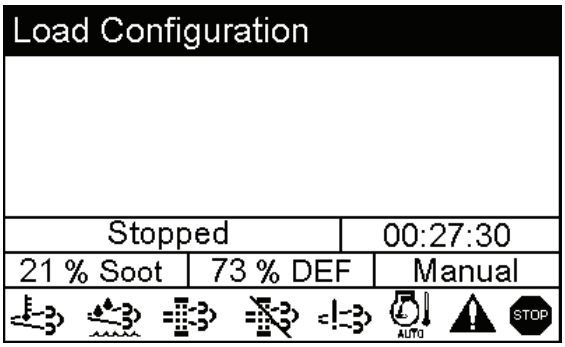


Figure 7: Main Menu page 4

Load Configuration

The Load Configuration menu is only available in the high security menu. This menu item allows the operator to choose a file to load onto the controller when a USB drive is attached to the programming harness of the controller. Review Load Configuration under the Menu Glossary section of this manual for a full list and definition of this item.

Auto Start/Stop Functions Defined

There are six automatic start/stop types in the MPC-10 / TEC-10. Each is detailed below:

Single Contact Start/Stop (commonly known as single float in pumping markets)

The Single Contact Start/Stop occurs when a remote contact is active for auto start and inactive for an auto stop as a digital input.

Two Contact Maintained Start/Stop (commonly known as dual floats in pumping markets)

The Two Contact Maintained Start/Stop occurs when both remote contacts are active for auto start and both contacts are inactive for an auto stop as a digital input (not momentarily).

Pressure, Level and Temperature Transducer Start/Stop

A transducer can be used for Auto Start/Stop when needed for the application. There are set points that allow the operator to enter the appropriate values.

> **NOTES:**
> The same transducer can be used for Auto Start/Stop and Auto Throttling if the application supports transducer control.

Local Start Key Start/Stop

The Local Start Key function uses the green and red buttons on the front interface for auto start and stop sequencing.

Quick-Start Setup

The following sections provide a walk-through of the steps necessary for some of the various configurations and settings available on the MPC-10 / TEC-10 Controller. **Cycling power to the controller is recommended after making changes to set points.**

Stepping through the Menu will be depicted as follows:

Menu/System/Contrast directs the operator to go into the Menu first, then look for a parameter titled System and press **[Enter]** to go into the System menu. Then look for a parameter titled Contrast and press **[Enter]** to go into the Contrast menu, etc.

Mechanical Engine Setup

1. Access **Menu/Engine Settings/Engine Type,** and select Mechanical then press **[Enter]**.
2. Press down arrow to **Engine Manufacturer**, select which engine manufacturer the controller is/will be used then press **[Enter]**.
3. Press down arrow to **Speed Source**, and select either Alternator or Magnetic Pickup then press **[Enter]**.
4. Press down arrow to **Speed Calibration,** press **[Enter]**.
5. Utilize the Up and Down arrows to establish the appropriate number of flywheel teeth or engine alternator pulses, and press **[Enter]**.
6. Press the **[Back]** key and down arrow to **Throttle**, and press **[Enter]**.
7. Press **[Enter]** to access **Manual Throttle Method,** select throttle type if throttling the engine from the controller for manually throttling the engine Inc/Dec, Run/Idle, Preset 3, or Preset 4 and press **[Enter]**.
8. Press down arrow to **Engine Throttle Type**, select Pulse Inc/Dec or None and press **[Enter]**.
9. Press down arrow to **Target RPM Step Size**, select appropriate step size then press **[Enter]**.
10. Press down arrow to **Throttle Deadband RPM**, select appropriate deadband then press **[Enter]**.
11. Press down arrow to **Throttle Inc/Dec Pulse**, select appropriate pulse time then press **[Enter]**.
12. Press down arrow to **Throttle Inc/Dec Pulse Delay**, select appropriate pulse delay then press **[Enter]**.
13. Press down arrow to **Throttle Inc Rate**, select appropriate throttle increment rate then press **[Enter]**.
14. Press down arrow to **Throttle Dec Rate**, select appropriate throttle decrement rate then press **[Enter]**.
15. Press the **[Back]** key, and down arrow to **Input/Output**, and press **[Enter]**.
16. Access **Analog Inputs** and assign one Analog input for Oil Pressure and one for Engine Temperature. Press **[Enter]** to save the settings.
17. Press **[Back]** and access Relay and Digital Outputs.
18. Press down arrow to **Relay1-3 or DO1-4**, and assign desired outputs for Crank, Fuel, and Inc/Dec outputs if throttle type selected was Inc/Dec.

> **NOTE:** DO3 and DO4 are factory set to Throttle Decrease and Throttle Increase to be used with the Murphy AT03069 Throttle Actuator.

19. Press the **[Back]** key and up arrow to **Advanced Engine Settings**, and press **[Enter].**
20. Press down arrow to **Warnings and Shutdowns**, press **[Enter]**.
21. Ensure all warnings and shutdowns are set to the appropriate settings for the engine for engine faults such as oil pressure and coolant temperature.
22. Press the **[Back]** key twice and up arrow to **System**, and press **[Enter].**
23. Press down arrow to **Set Machine Hours,** select desired machine/internal hours then press **[Enter]**.
24. Press the **[Menu]** key to exit the menu setup screens.

J1939 Electronic Engine Setup (Factory Default)

1. Access **Menu/Engine Settings/Engine Type** to ensure J1939 is selected.
2. Press down arrow to **Engine Manufacturer**, select which engine manufacturer the controller is/will be used then press **[Enter]**.
3. Press down arrow to **Engine Emission**, select the emissions level of the engine then press **[Enter]**.
4. Press down arrow to **Tier 4** (if a Tier 4 selection is made in Engine Emission menu), press **[Enter].**
    a. Press down arrow to **DEF Gauge**. Select Yes to show this gauge (if needed) then press **[Enter]**.
    b. Press down arrow to **Percent Soot Gauge**. Select Yes to show this gauge (if needed) then press **[Enter]**.
    c. Press down arrow to **Regen Screen**. Select Yes to show this screen (if desired) then press **[Enter]**.
5. Press the **[Back]** key and down arrow to **Speed Source**, ensure J1939 is selected for CANbus engine speed from ECU.
6. Press the **[Back]** key and down arrow to **Advanced Engine Settings**, and press **[Enter]**.
7. Ensure **Address Claim** is set to the CAN address that the TSC1 and Tier 4 regeneration is expected to be sent from to the engine ECU (this is often times designated by the manufacturer/distributor).
8. Press down arrow to **Warnings and Shutdowns**, press **[Enter]**.
9. Ensure all warnings and shutdowns are below or above ECU settings if required to have the ECU shutdown the engine instead of the MPC-10 / TEC-10 (for engine faults such as oil pressure and coolant temperature).

> **NOTE:** If requiring the engine ECU to shutdown the engine on any engine shutdown fault without help from the controller, select ECU Shutdowns in the System Menu and change the setting to ECU Only.

10. Press the **[Back]** key and down arrow to **Throttle**, ensure desired throttle method is selected then press **[Enter]**.
11. Press the **[Back]** key and down arrow to **Input/Output**, and press **[Enter]**.
12. Press down arrow to access **Analog Inputs,** ensure the analog inputs aren't set to oil pressure or coolant temp (disable or change to something different).
13. Press down arrow to **Relay1-3 or DO1-4**, and assign desired outputs for Crank, ECU Enable and Inc/Dec outputs if throttle type selected was Inc/Dec.
14. Press the **[Menu]** key to exit the menu setup screens.

Setting to Auto Start on a Single Contact Input (Single Float)

1. Access **Menu/Application Configuration.** Press the down arrow to **Auto Start/Stop Function** then press **[Enter]**.
2. Utilize the Up and Down arrows to select **Single Contact** then press **[Enter]**.
3. Press **[Back]** once, and select **Input / Output** then press **[Enter]**.
4. Press **[Enter]** to access **Digital Inputs** then assign the **Function** of **Single Contact Start/Stop** to one of the Digital Inputs.
5. Ensure no other Digital Inputs are set to a start/stop type.
6. Press the **[Menu]** key to exit the menu setup screens.

Setting to Auto Start on Local Start Key

1. Access **Menu/Application Configuration**. Press the down arrow to **Auto Start/Stop Function** then press **[Enter]**.
2. Utilize the Up and Down arrows to select **Local Start Key** then press **[Enter].**
3. Press **[Back]** once and arrow up to select **Input / Output/Digital Inputs**.
4. Ensure no Digital Inputs set to a start/stop type.
5. Press the **[Menu]** key to exit the menu setup screens.

Setting up to Auto Start/Stop for 2 Contact Inputs (Dual Floats)

1. Access **Menu/Application Configuration.** Press the down arrow to **Auto Start/Stop Function** then press **[Enter]**.
2. Utilize the Up and Down arrows to select **Two Contact Maintained** then press **[Enter].**
3. Press **[Back]** once and arrow up to select **Input / Output** then press **[Enter]**.
4. Press **[Enter]** to access **Digital Inputs**.
5. Assign the **Function** of **Auto Start Maintained** to one of the Digital Inputs then press **[Enter]**.
6. Assign the **Function** of **Auto Stop Maintained** to one of the Digital Inputs then press **[Enter]**.
7. Press the **[Menu]** key to exit the menu setup screens.

Setting to Auto Start on Pressure

1. Access **Menu/Application Configuration.** Press the down arrow to **Auto Start/Stop Function** then press **[Enter]**.
2. Utilize the Up and Down arrows to select **Pressure Transducer** then press **[Enter].**
3. Utilize the Up and Down arrows to select **Pressure Transducer** in the main application configuration menu.
4. Complete the parameters that apply. (Start/Stop Pressure, Pressure Maintain Type and Line Fill if needed. See Menu Glossary for explanation of settings.)
5. Press **[Back]** twice and access **Input_Output/Analog Inputs.**
6. Select the Analog Input to modify for the pressure transducer.
7. Assign the appropriate pressure input for the selected Analog Input (4-20mA Suction Pressure, 0-5V Suction Pressure, 4-20mA Discharge Pressure, 0-5V Discharge Pressure, Murphy Discharge Pressure or Suction Pressure).
8. Press **[Back]** once and arrow up or down to select **Discharge or Suction Pressure Units** then press **[Enter]**.
9. Select PSI, kPa or BAR as the pressure type then **press [Enter]**.
10. Press arrow up to **Sensor Setup** then press **[Enter]**.
11. Select the pressure input type to set up then press **[Enter]**.
12. Set the offset of the 4mA, if needed, then press **[Enter]**.
13. Now set the range of the transducer on the high side then press **[Enter].** (e.g., 0-100 PSI transducer would show 4mA at 0psi and 20mA at 100 PSI.)
14. Refer to step #13 above if setting for a 0-5V or Suction Pressure.
15. Press **[Back]** twice to get back to the main menu.
16. Utilize the Up and Down arrows to select **Advanced Engine Settings** then press **[Enter]**.
17. Utilize the Up and Down arrows to select **Warnings and Shutdowns** then press **[Enter].**
18. Utilize the Up and Down arrows to set the **High and Low Discharge/Suction Pressure** warnings and shutdowns.
19. Press the **[Menu]** key to exit the menu setup screens.

Setting up to Auto Start on Level

1. Access **Menu/Application Configuration.** Press the down arrow to **Auto Start/Stop Function** then press **[Enter]**.
2. Utilize the Up and Down arrows to select **Level Transducer** then press **[Enter].**
3. Utilize the Up and Down arrows to select **Level Transducer** in the main application configuration menu.
4. Complete the parameters that apply. (Start/Stop Level and Level Maintain Type, See Menu Glossary for explanation of settings.)
5. Press **[Back]** twice and access **Input_Output/Analog Inputs.**
6. Select the Analog Input to modify for the level transducer.
7. Assign 4-20mA System Level as the function for the selected Analog Input.
8. Press **[Back]** once to get back to the Analog Input menu.
9. Press the arrow up or arrow down key. Select **Sensor Setup** then press **[Enter]**.
10. Select System Level to set up then press **[Enter]**.
11. Set the offset of the 4mA if needed to calibrate the low side then press **[Enter]**.
12. Set the range of the transducer on the high side then press **[Enter].** (i.e., 0-10ft transducer would show 4mA at 0 ft. and 20mA at 10 ft.)
13. Press **[Back]** twice to return to the main menu.
14. Utilize the Up and Down arrows to select **Advanced Engine Settings** then press **[Enter]**.
15. Utilize the Up and Down arrows to select **Warnings and Shutdowns** then press **[Enter].**
16. Utilize the Up and Down arrows to set the **High and Low Level** warnings and shutdowns.
17. Press the **[Menu]** key to exit the menu setup screens.

Setting to Auto Start on Clock

> **NOTES:**
>
> **1)** Ensure the correct date and time are established in the System menu prior to establishing the Auto Start on Clock settings.
>
> **2)** The Clock start timer is independent of other auto start start/stop functions. When started from the clock the controller will shut down the engine from the clock.

1. Access **Menu/Start_Stop Timers**, and select the first Start/Stop Timer.
2. Select Start Day 1 and then select the appropriate day or Daily.
3. Select Start Time 1 and establish the hour, minute and second to start.
4. Establish the Stop Day and Time as in steps 2-3.
5. Press the **[Menu]** key to exit the menu setup screens.

> **NOTE:** The MPC-10 / TEC-10 has the ability to establish three different Start/Stop dates and times. If desired, repeat steps 1-3 for subsequent Timers.

Setting to Auto Start on Temperature

1. Access **Menu/Application Configuration.** Press the down arrow to **Auto Start/Stop Function** then press **[Enter]**.
2. Utilize the Up and Down arrows to select **Temperature Transducer** then press **[Enter].**
3. Utilize the Up and Down arrows to select **Temperature Transducer** in the main application configuration menu.
4. Establish a Start and Stop Temperature, and press **[Back]** twice.
5. Utilize the Up and Down arrows to select **Input_Output/Analog Inputs** then press **[Enter].**
6. Select the Analog Input to modify for the temperature transducer.

7. Assign 4-20mA, 0-5V Ambient Temperature or Model 12 as the function for the selected Analog Input.
8. Press **[Back]** once to return to the Analog Input menu.
9. If 4-20mA or 0-5V Ambient Temperature was selected follow the subsequent procedures below for sensor setup.
10. Press the arrow up or arrow down key. Select **Sensor Setup** then press **[Enter]**.
11. Select Ambient Temp to set up then press **[Enter]**.
12. Set the offset of the 4mA if needed to calibrate the low side then press **[Enter]**.
13. Set the range of the transducer on the high side then press **[Enter].** (e.g., 32°F -150°F transducer would show 4mA at 32°F and 20mA at 150°F).
14. Press the **[Menu]** key to exit the menu setup screens.

> **NOTE:** If an auto stop condition occurs during the warm-up delay, the controller will enter an auto stop sequence.

Setting up to Stop the Engine from Utilizing the Countdown Timer

The MPC-10 / TEC-10 will only utilize this timer when starting in Auto mode. The control and the running of the engine will continue until the chosen stop condition is met or until the Countdown timer runs out of time. Once set, the operator will be required to disable or change the timer in the menu in order to eliminate the countdown timer being active on every auto startup.

1. Access **Menu/Start_Stop Timers/Countdown Timer**.
2. Set the hours, minutes and seconds desired for the running of the engine, and press **[Enter]**.
3. Press the **[Menu]** key to exit the menu setup screens.

> **NOTE:** When the Countdown Timer is set for a countdown, the controller will always countdown upon an auto start until the timer is set to 0.

Screen Examples

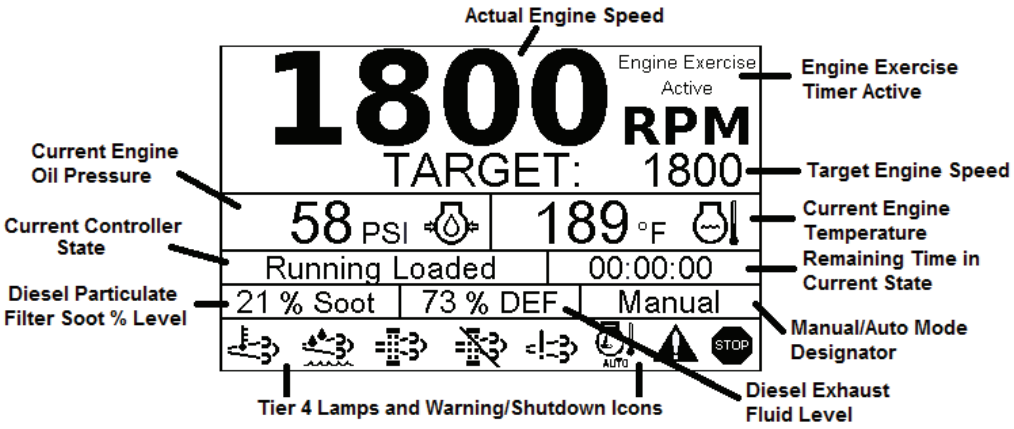


Figure 8: Screen Example

Additional Screens

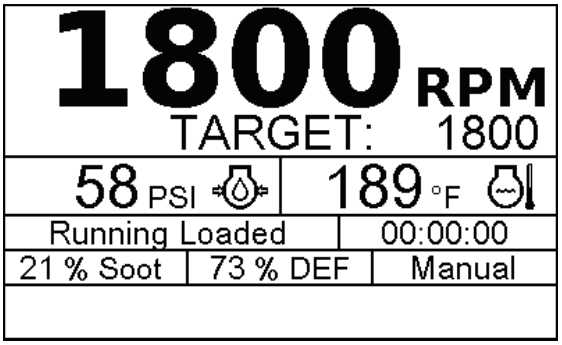


Figure 9: Main Screen

This is the main screen, and it displays actual and target RPM, Mode of Operation, Timer progress, % Soot Level, % DEF Level and current State, along with icons and warnings.

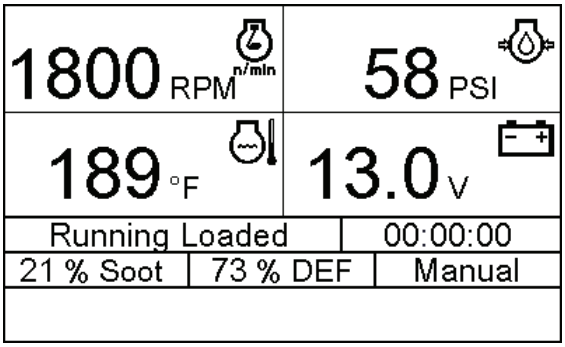


Figure 10: First 4-Up Screen

This is the first 4 up screen, displaying engine RPM, oil pressure, engine temperature and battery voltage. If alternate parameters are desired, these may be changed using the free MPC-10 / TEC-10 software configuration tool.

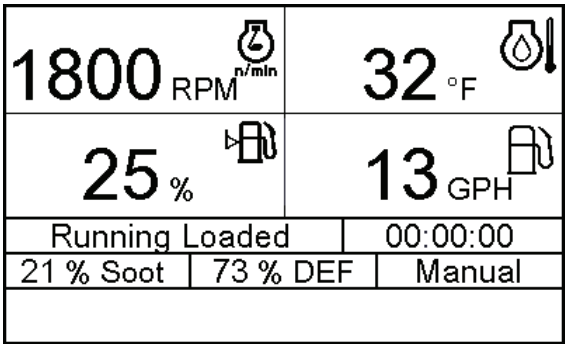


Figure 11: Second 4-Up Screen

This is the second 4 up screen, displaying engine RPM, engine temperature, fuel level and GPH. If alternate parameters are desired, these may be changed using the free MPC-10 / TEC-10 software configuration tool.

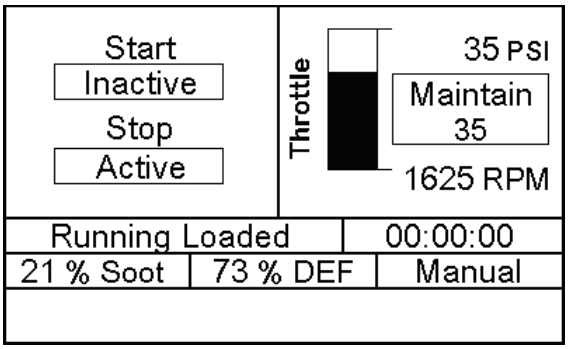
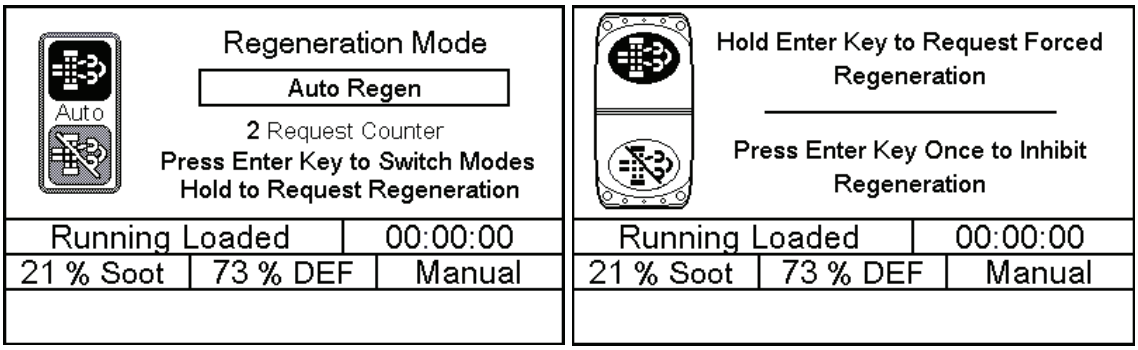


Figure 12: Application Screen

This screen displays the auto start/stop type and will also illustrate the throttling method for the auto start/stop.



Figures 13: Regeneration Mode Screen & CAT/Perkins Regeneration Screen

This is the Tier 4 Regeneration screen that is selected to be shown in the Tier 4 menu. This screen shows and allows the user to select the regeneration mode without accessing the menu, if desired.

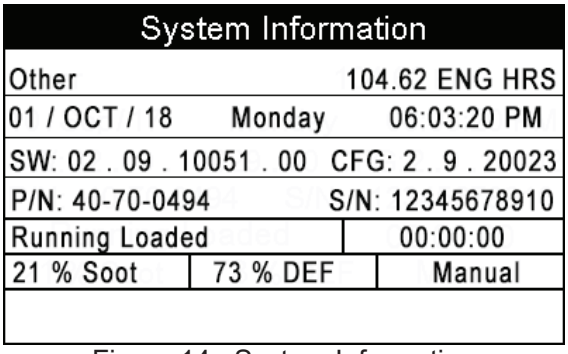


Figure 14: System Information

This screen displays the Engine Manufacturer, Engine Hours, date, day, time, software version number, configuration number, part number (if available) and serial number (if available). This page will assist Technical Services Support should their services be needed.

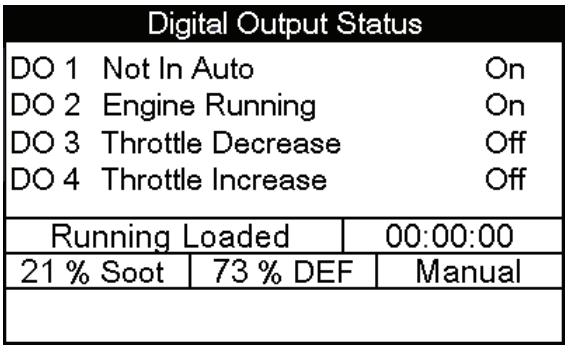


Figure 15: Digital Output Status

This screen will allow the operator to see what the digital output functions are set to without accessing the menu and the active setting which informs the user of the output status.

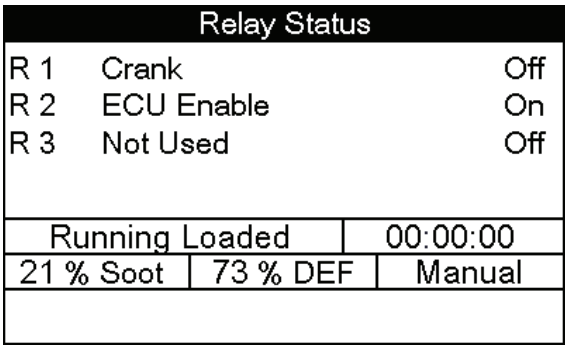


Figure 16: Relay Status

This screen will allow the operator to see what the relay status functions are set to without accessing the menu and the active setting which informs the user of the relay status.

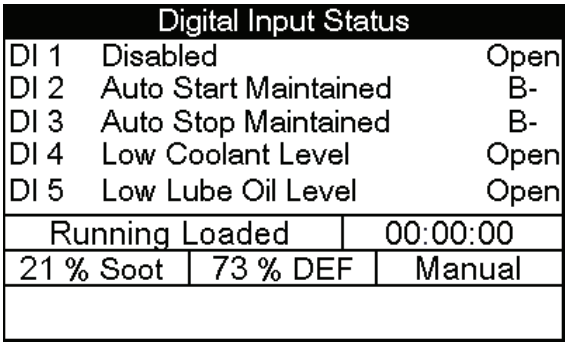


Figure 17: Digital Input Status

These two screens will allow the operator to see what the digital input functions are set to without accessing the menu and the active setting which informs the user of the input status.

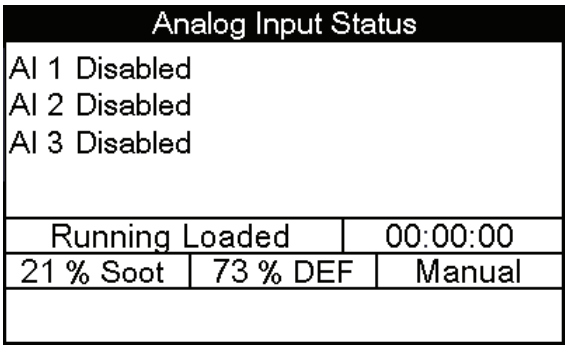


Figure 18: Analog Input Status

This screen displays the Analog Input's function selected in the menu for each input.

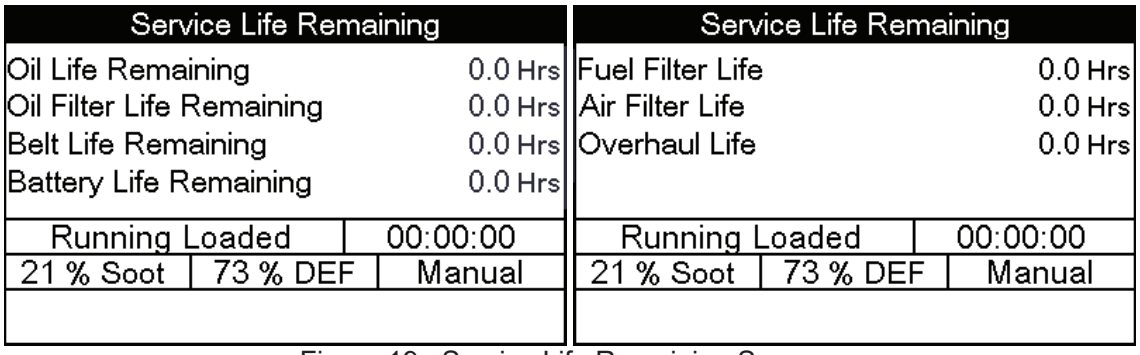


Figure 19: Service Life Remaining Screens

These two screens provide a list of service reminders and the hours left until the internal alarm will display the services needed. All the reminders are set to 0.0 Hrs to disable by default and the screens are hidden by default. The screens can be shown by setting the Show Service Reminders Screens to "Show" in the service reminders menu.

ISO Icons

The following ISO icons can be displayed on the controller to designate specific parameters and Tier 4 Emission Alerts, as well as Warnings and Shutdowns.

Icon	Description
	Displays when High Exhaust System Temperature (HEST) is active and exhaust temperature is above normal operating condition.
	Low diesel exhaust fluid. Displays when the DEF is low.
	Displays when engine aftertreatment is in need of regeneration. This is due to the aftertreatment filter reaching the engine manufacturer's set soot level for a regeneration to occur.

	Displays when the Engine ECU has inhibited a regeneration from occurring. This should also be shown when inhibiting regeneration selection is made in the menu.
	Displays when an emissions aftertreatment malfunction has occurred. Contact your local engine manufacturer's service department for direction.
	Deutz – Engine Aftertreatment Override Active Status.
	Deutz – Wash Bit Ash Load High. Status 1 Solid, Status > 1 Flashing.
	CAT/ PERKINS DPF Burner Temp (HEST). Exhaust System High Temperature Lamp Command.
	CAT/PERKINS - Delayed Engine Shutdown. Required for C7.1 ACERT engines having DES enabled.
	FPT (DEF Level – Operator Warning) – Warning DEF Level below 10%
	FPT (DEF Level – Mid Level Inducement) – 65% of torque reduction; 40% engine speed reduction ramped within 40 minutes
	FPT (DEF Level – Severe Inducement) – Engine commanded to low idle within 30 minutes
	JCB/Deutz - Emissions Malfunction Low
	JCB/Deutz - Emissions Malfunction High
	JCB - Catalyst Tank Level below 15%
	JCB - Catalyst Tank Level below 5%
	JCB – DPF Emissions Filter Above 80%. Engine Refresh Required

	JCB – DPF Emissions Filter Above 90%. Engine Overloaded
	JCB – DPF Emissions Filter at 100%. Engine Plugged
	JCB – Inducement Level 2,3 or Final.
	Displays when an active or unacknowledged warning fault exists. The icon will disappear if the fault is acknowledged and is no longer active.
	Displays when an active or unacknowledged shutdown fault exists. The icon will disappear if the fault is acknowledged and no longer active.
	Gear Box Pressure
	Fuel Rate
	Fuel Level
	Pump Flow Rate
	Engine Oil Level
	Discharge Pressure
	Current Oil Pressure
	Current RPM
	Ambient Temperature
	Oil Temperature
	System Level

	Suction Pressure
	Percent Load at Current RPM
	Current Engine Temperature
	Battery Voltage

Icon Troubleshooting

The warnings and shutdowns internally generated by the controller will show an Internal Fault on the top of the screen when a fault is displayed. Check all fluid levels and pressures. Ensure the cooling system and engine are functioning properly.

The warnings and shutdowns the ECU generates will also be accompanied by a cause for the error. Consult with the engine manufacturer regarding fault codes shown on the screen.

If the fault states it is internal and everything checks out normal, consider checking the set points or the bypass timer(s) to ensure the ranges are within normal operating settings for the engine and application.

Menu Glossary

System (Low Security)

Date/Time (Low Security)**:** allows the setting of the controller's date and time.

Units (Medium Security)**:** allows the setting of the units of measurement for information presented on the display.

> **Pressure Units** (Medium Security)**:** allows the selection of PSI, kPa or BAR for pressure designation. **Factory set to PSI.**
>
> **Temperature Units** (Medium Security)**:** allows the selection of Fahrenheit or Celsius for temperature designation. **Factory set to Fahrenheit.**
>
> **Level Units** (Medium Security)**:** allows the selection of Feet or Meters for Level designation. **Factory set to Feet.**
>
> **Flow Units** (Medium Security)**:** allows the selection of gal/min (US), gal/min (UK), lpm (Liters per Minute), lps (Liters per Second), m3/h (Meters Cubed per Hour) and m3/s (Meters Cubed per Second) for flow designation. **Factory set to gal/min (US).**
>
> **Fuel Rate Units** (Medium Security): allows the selection of gal/hr (US), gal/min (US), gal/hr (UK), gal/min (UK), lph (Liters per Hour), lpm (Liters per Minute), m3/h (Meters Cubed per Hour) for fuel rate designation. **Factory set to gal/hr (US).**

Language (Medium Security)**:** select: English, French, German, Spanish, and Italian. **Factory set to English.**

Brightness (Medium Security)**:** allows the backlight of the screen to be adjusted. **Factory set to 90.**

Parameter Setup (Low Security)**:** allows four-up Page 1 and Page 2 parameters to be changed without using a PC.

Backlight Control (Medium Security)**:** turns off (disables) or on (enables) the screen's backlight. **Factory set to Enable.**

Standby Timer (Medium Security)**:** allows the screen the designated amount of time before the controller goes into Standby mode. Standby is also referred to as sleep mode. **Factory set to 00:30:00.**

Service Reminders (Medium Security)**:** when the service reminder is set to 0, the alarms will be disabled; however, the countdown will continue and will show the numbers as (-) numbers as it counts down past 0 for the following parameters: **All service reminders factory set to 0.0 Hrs. If service reminders are desired they should be set within this menu.**

Show Service Screens (Medium Security)**:** factory set to Hide.

Oil Life (Medium Security)**:** factory set to 0 Hrs

Reset Oil Life (Medium Security)**:** resets Oil Life reminder to factory setting.

Oil Filter Life (Medium Security)**:** factory set to 0 Hrs

Reset Oil Filter Life (Medium Security)**:** resets Oil Filter Life reminder to factory setting.

Belt Life (Medium Security)**:** factory set to 0 Hrs

Reset Belt Life (Medium Security)**:** resets Belt Life reminder to factory setting.

Battery Life (Medium Security)**:** factory set to 0 Hrs

Reset Battery Life (Medium Security)**:** resets Battery Life reminder to factory setting.

Fuel Filter Life (Medium Security)**:** factory set to 0 Hrs

Reset Fuel Filter Life (Medium Security)**:** resets Fuel Filter Life reminder to factory setting.

Air Filter Life (Medium Security)**:** factory set to 0 Hrs

Reset Air Filter Life (Medium Security)**:** resets Air Filter Life reminder to factory setting.

Overhaul Life (Medium Security)**:** factory set to 0 Hrs

Reset Overhaul Life (Medium Security)**:** resets Overhaul Life reminder to factory setting.

Reset All (Medium Security)**:** Resets all service reminders to factory setting.

ECU Fault Codes (Medium Security)**:** allows the operator to request stored fault codes from the ECU and request to clear active as well as stored codes in the ECU.

Stored Fault Codes (Medium Security)**:** allows the operator to query the Engine ECU for review of its stored fault codes.

Clear Active ECU Fault Codes (High Security)**:** Clears any active fault codes broadcast from the ECU as long as the ECU accepts the request.

Clear Stored ECU Fault Codes (High Security)**:** Clears any stored fault codes in the ECU as long as the ECU accepts the request.

Auto / Manual (Low Security)**:**

Manual Only (Medium Security)**:** allows the operator to lock anyone out of placing the controller in Auto mode of operation. **Factory set to Disable**

Power Up Auto/Manual (High Security)**:** allows the controller to power up in either Manual or Auto Mode of operation depending on the selection chosen. The operator can enable Manual only and disable the choice of auto on power up. **Factory set to Manual**

Show Auto Start Confirmation (Low Security)**:** ensures the operator knows the controller is in auto by making the operator accept the Auto mode on power up. This is only shown if Power Up in Auto/Manual is set to Auto. **Factory set to Yes**

Green LED (High Security)**:** select either Auto Operation or Running Loaded for the built-in green LED.

Restore Factory Defaults (Medium Security)**:** allows the operator to reset all settings back to default.

Set Machine Hours (High Security)**:** allows the operator to set the internal hours of the controller if Engine Type is set to Mechanical or ECU Hour Select is set to Internal.

Event History (Medium Security)**:** allows the operator to view up to 32 previous alarms with date and time stamp. Also allows the operator to clear the event history log.

View Event History (Medium Security)**:** allows the viewing of controller stored alarms.

Clear Event History (High Security)**:** allows the clearing of controller stored events (alarms).

Alternator Excite Setup (High Security)**:** allows the operator to set the dedicated alternator excite output to desired control. The alternator excite pulses the output and senses for feedback. If feedback is not received from the alternator in terms of a charge the MPC-10 / TEC-10 will allow for a Warning or shutdown. If there is a diode in the harness between the alternator and the controller, but still need to excite the alternator the operator is able to set the Show Alt Excite Warning to No to allow for the pulsing without feedback. If the alternator is self-exciting or this output is not needed the control can be set to Disable to ensure no voltage is live on the output.

Alt/Excite Control (High Security)**:** allows the operator to enable or disable the dedicated output for Alt Excite. **Factory set to Enable**

Alternator Excite Alert (High Security)**:** allows the operator to select if Alt Fail is a warning or shutdown. **Factory set to Warning.**

Show Alt Excite Warning (High Security)**:** allows the controller to ignore the warning if excitation of the alternator is not sensed to eliminate the Alt Fail Warning. **Factory set to Yes**

Alt Excite Frequency (High Security)**:** allows the operator to set how the Alternator excite out behaves. During setup for the engine the operator can choose Pulse 50ms, Pulse 100ms, or Steady for the frequency the alternator excite output turns on for exciting the field on a non-self-exciting alternator. The Alt Failure Warning will only work with the pulse setting. If setting to Steady (on during all running states) the Show Alt Excite Warning will need to be set to No. **Factory set to Pulse 50ms**

J1939 Shutdowns – (High Security): this parameter allows the user to set whether they want the controller to help facilitate a shutdown for the engine if the ECU broadcasts a Red lamp (DM1 Shutdown) across the CANbus. When set to ECU Only the controller will show the fault while completely relying on the engine to shutdown the engine when the fault is broadcast on the CANbus. When set to Controller and ECU the

controller will turn off the ECU enable output when a red lamp status is broadcast on the CANbus. **Factory set to Controller & ECU**.

Engine Settings (Low Security)

Engine Type (High Security)**:** allows the selection between J1939 and Mechanical. If Mechanical is chosen, some parameters associated with J1939 will no longer appear in the menu. **Factory set to J1939.**

Engine Manufacturer (High Security)**:** allows the selection of the specific engine manufacturer (i.e., Caterpillar (M-T4F), Cummins (M-T4F), John Deere (M-T4F), Deutz (M-T4F), Kubota (M-T4i, Gaseous), JCB (T4F), Volvo (T3-T4F), FPT (T4F), Isuzu (M), PSI (EControls ECU), Scania (T3-T4F), FORD (EControls ECU), Perkins (M-T4F), Other, HATZ (M-T4F), GM (MEFI ECU), Yanmar (T4F). **Factory set to Other.**

Engine Emission (High Security)**:** allows the selection of the emissions controls (i.e., Tier 3 or Less, Interim Tier 4 or Tier 4 / EU Stage IIIA, IIIB, IV). **Factory set to Tier 3 or Less.**

Tier 4 (Low Security)**:** (only appears if Interim Tier 4 or Tier 4 / EU Stage IIIA, IIIB, IV is chosen) allows the automatic or inhibition of after treatment regeneration and/or the requesting of a regeneration.

> **Auto/Inhibit regen** (Low Security)**:** allows the operator to inhibit an after treatment regeneration by setting to inhibit. **Factory set to Auto**
>
> **Request Regen** (Low Security)**: s**ends a request to the engine ECU for regeneration. **Factory set to No**
>
> **DEF Gauge** (High Security)**: s**hows the DEF gauge when set to Yes. **Factory set to No**
>
> **Percent Soot Gauge** (High Security)**:** shows the % Soot gauge when set to Yes. **Factory set to No**
>
> **Regen Screen** (High Security)**:** shows the regeneration screen in the main screens when set to Yes. **Factory set to No**

> **NOTE:** Inhibiting the Regen may cause the engine to de-rate or shut down if the soot level is too high. Recommend leaving this setting in Auto Regen. The ECU may not allow the Regen request if certain parameters do not meet the engine manufacturers' requested levels.

Speed Source (High Security)**:** allows the selection of the appropriate speed source of the engine (i.e., J1939, Alternator or Magnetic Pickup). **Factory set to J1939**

Speed Calibration (High Security)**:** allows the setting of the correct number of flywheel teeth or engine alternator pulses for mechanical engines when speed source is set to Alternator or Magnetic Pickup. **Factory set to 150**

Warm Up Speed (Medium Security)**:** allows the setting of the speed of the engine during the warm-up phase. This speed setting must be at or above the minimum engine speed setting. **Factory set to 900 RPM**

Warm Up Delay (Low Security)**:** allows the operator to set the desired warm-up time/delay for the engine. This is the length of time the engine will run at a lower speed for its warm-up cycle. **Factory set to 3 minutes**

Minimum Engine Speed (Medium Security)**:** allows the setting of the lowest engine speed for continual operation. The controller will not allow the engine to throttle under the minimum engine speed when maintaining pressure or level. **Factory set to 700 RPM**

Maximum Engine Speed (Medium Security)**:** allows the setting of the highest engine speed for continual operation. The controller will not allow the engine to throttle above the maximum engine speed when maintaining pressure or level. **Factory set to 2200 RPM**

Cooldown Speed (Medium Security)**:** allows the setting of the speed of the engine while it is cooling down. This speed setting must be at or above the minimum engine speed setting. **Factory set to 900 RPM**

Cooldown Delay (Low Security)**:** allows the operator to set the desired cool-down time/delay for the engine. This is the length of time the engine will run at a lower speed for its cool-down cycle. **Factory set to 3 minutes**

Advanced Engine Settings (Low Security)

Address Claim (High Security)**:** allows the operator to set the address claim of the controller when used on the CANbus. This address is relative to the address the ECU requires the TSC1 to be broadcast from along with any Tier 4 messaging. Consult your engine manufacturer or dealer to obtain the correct source address the controller should be set to communicate correctly with the engine ECU. **Factory set to 3 and changed per Engine Manufacturer setting**

ECU Source Address (High Security)**:** source address of the ECU being connected to. Normally set to 0, 1 or 2 per SAE J1939 specifications. This menu item is only shown if J1939 is selected for the Engine Type. **Factory set to 0**

ECU Hour Select (High Security)**:** choose from ECU Hours (engine hours reported by the ECU) or Internal (hours calculated internally by the MPC-10 / TEC-10) provided the RPM>50. This menu item is only shown if J1939 is selected for the Engine Type. **Factory set to ECU Hours**

Crank Attempts (High Security)**:** format of 1.00 to 20.00. The number of times the engine will attempt to start before providing an overcrank shutdown. **Factory set to 3**

Crank Disconnect Speed (Medium Security)**:** the speed at which the crank will disconnect barring other input parameters. **Factory set to 500 RPM**

Run To Destruct (High Security)**:** this feature is used when the controller is not able to shut down the engine, but allows faults to be shown on screen and LEDs per application requirement. **Factory set to Disable**

Timers/Delays (Low Security)**:** establish operational settings for:

> **Auto Start Delay** (Medium Security)**:** the auto start condition must remain active throughout this delay for an auto start to occur. If the auto start condition is removed during this delay, the delay is reset to zero. **Factory set to 3 seconds**
>
> **Auto Stop Delay** (Medium Security)**:** this auto stop condition must remain active throughout this delay for an auto stop to occur. If the auto stop condition is removed during this delay, the delay is reset to zero. **Factory set to 3 seconds**

ECU Stabilize Timer (High Security)**:** on start-ups, this delay allows the ECU to stabilize and broadcast on the CAN bus prior to actual cranking. **Factory set to 5 seconds**

Crank Time (High Security)**:** this is the length of time the crank output is turned on during cycle cranking. **Factory set to 10 seconds**

Crank Rest (High Security)**:** this is the length of time the crank output is turned off during cycle cranking. **Factory set to 10 seconds**

Prestart Delay 1 (Low Security)**:** after a start condition has been accepted by the controller, this delay begins timing, and the prestart #1 output turns on. When this delay expires, the output is turned off, and the auto sequence continues.

Auto Only (Medium Security)**: Factory set to Disabled.**

Prestart Delay (Low Security)**: Factory set to 00.00.00**

Prestart Delay 2 (Low Security)**:** after a start condition has been accepted by the controller, this delay begins timing, and the prestart #2 output turns on.

Auto Only (Medium Security)**: Factory set to Disabled.**

Prestart Delay (Low Security)**: Factory set to 00.00.00**

Prestart Delay 2 Mode (High Security)**:** this setting determines if the prestart #2 output is active through the crank state or only through the prestart #2 state. **Factory set to PreCrank**

Spindown Timer (Medium Security)**:** this delay begins timing when there is no call to run and the engine speed is zero. No auto start functions will occur until this delay expires. **Factory set to 30 seconds** (Unable to set below 5 seconds)

Post Crank Lockout Setup (Medium Security)**:** this is a setup for a delay that begins timing after crank disconnect at startup. During this delay, the selected functions are ignored. When this delay expires, the selected functions are armed. During the duration of this delay, the selected functions can cycle from active to not active and not reset the delay.

Post Crank Lockout Time (Medium Security)**: Factory set to 30 seconds**
Post Crank Lockout 1 (Medium Security)**: Factory set to Low Oil Pressure**
Post Crank Lockout 2 (Medium Security)**: Factory set to High Engine Temperature**
Post Crank Lockout 3 (Medium Security)**: Factory set to Disabled**
Post Crank Lockout 4 (High Security)**: Factory set to Disabled**
Post Crank Lockout 5 (High Security)**: Factory set to Disabled**

Post Warm-up Lockout Setup (Medium Security)**:** this is a setup for a delay that begins timing when the warm-up delay expires. During this delay, the selected functions are ignored. When this delay expires, the selected functions are armed. During the duration of this delay, the selected functions can cycle from active to not active and not reset the delay.

Post Warm-up Lockout Time (Medium Security)**: Factory set to 00.00.00**
Post Warm-up Lockout 1 (Medium Security)**: Factory set to Disabled**
Post Warm-up Lockout 2 (Medium Security)**: Factory set to Disabled**
Post Warm-up Lockout 3 (Medium Security)**: Factory set to Disabled**
Post Warm-up Lockout 4 (High Security)**: Factory set to Disabled**
Post Warm-up Lockout 5 (High Security)**: Factory set to Disabled**

Bubble Lockout Setup (Medium Security)**:** this is a setup for a delay that begins timing when the selected functions are active. If the selected functions are removed during this delay, the delay resets to zero. If the selected functions remain active throughout this delay, the selected action for the parameter will occur.

Bubble Lockout Time (Medium Security)**: Factory set to 00.00.00**
Bubble Lockout 1 (Medium Security)**: Factory set to Disabled**
Bubble Lockout 2 (Medium Security)**: Factory set to Disabled**
Bubble Lockout 3 (Medium Security)**: Factory set to Disabled**
Bubble Lockout 4 (Medium Security)**: Factory set to Disabled**
Bubble Lockout 5 (Medium Security)**: Factory set to Disabled**

Warnings and Shutdowns (Low Security)**:** establish alerts for the listed parameters. When values reach the set points in this menu the controller will show **INTERNAL FAULT** on the top left of the screen. If nuisance faults keep occurring lower or raise the set point within this menu.

Low Oil Pressure Shutdown (High Security)**:** a shutdown will occur when the pressure reaches this set point. **Factory set to 10 PSI.**

Low Oil Pressure Warning (High Security)**:** an alarm will occur when the pressure reaches this set point. **Factory set to 15 PSI.**

High Engine Temp Shutdown (Medium Security)**:** a shutdown will occur when the temperature reaches this set point. **Factory set to 225 F.**

High Engine Temp Warning (Medium Security)**:** an alarm will occur when the temperature reaches this set point. **Factory set to 210 F.**

High Oil Temp Shutdown (Medium Security)**:** a shutdown will occur when the temperature reaches this set point. **Factory set to 225 F.**

High Oil Temp Warning (Medium Security)**:** an alarm will occur when the temperature reaches this set point. **Factory set to 210 F.**

Low Fuel Level Shutdown (Medium Security)**:** a shutdown will occur when the level reaches this set point. **Factory set to 5%.**

Low Fuel Level Warning (Medium Security)**:** an alarm will occur when the level reaches this set point. **Factory set to 10%.**

High Battery Warning (Low Security)**:** an alarm will occur when the VDC reaches this set point. **Factory set to 16.0 VDC.**

Low Battery Warning (Low Security)**:** an alarm will occur when the VDC reaches this set point. This setting is armed after crank disconnect upon startup. **Factory set to 8.0 VDC.**

Weak Battery Warning (Low Security)**:** an alarm will occur when the VDC reaches this set point. **Factory set to 6.0 VDC.**

Underspeed Shutdown (Medium Security)**:** a shutdown will occur when the engine speed reaches this set point. **Factory set to 0 RPM**

Overspeed Shutdown (Medium Security)**:** a shutdown will occur when the engine speed reaches this set point. **Factory set to 2400 RPM.**

High Level Warning (Medium Security)**:** an alarm will occur if the level reaches this set point. Menu setting shown after analog input is set. **Factory set to 0.0 FT**

High Level Shutdown (Medium Security)**:** a shutdown will occur if the level reaches this set point. Menu setting shown after analog input is set. **Factory set to 0.0 FT.**

Low Level Warning (Medium Security)**:** an alarm will occur if the level reaches this set point. Menu setting shown after analog input is set. **Factory set to 0.0 FT.**

Low Level Shutdown (Medium Security)**:** a shutdown will occur if the level reaches this set point. Menu setting shown after analog input is set. **Factory set to 0.0 FT.**

High Flow Warning (Medium Security)**:** an alarm will occur if the flow reaches this set point. Menu setting shown after analog input is set. **Factory set to 0 GPM.**

High Flow Shutdown (Medium Security)**:** a shutdown will occur if the flow reaches this set point. Menu setting shown after analog input is set. **Factory set to 0 GPM.**

Low Flow Warning (Medium Security)**:** an alarm will occur if the flow reaches this set point. Menu setting shown after analog input is set. **Factory set to 0 GPM.**

Low Flow Shutdown (Medium Security)**:** a shutdown will occur if the flow reaches this set point. Menu setting shown after analog input is set. **Factory set to 0 GPM**.

High Discharge Pressure Warning (Medium Security)**:** an alarm will occur when the pressure reaches this set point. **Factory set to 0 PSI.**

High Discharge Pressure Shutdown (Medium Security)**:** a shutdown will occur when the pressure reaches this set point. Menu setting shown after analog input is set. **Factory set to 0 PSI.**

Low Discharge Pressure Warning (Medium Security)**:** an alarm will occur when the pressure reaches this set point. Menu setting shown after analog input is set. **Factory set to 0 PSI**

Low Discharge Pressure Shutdown (Medium Security)**:** a shutdown will occur when the pressure reaches this set point. Menu setting shown after analog input is set. **Factory set to 0 PSI**

High Suction Pressure Warning (Medium Security)**:** an alarm will occur when the pressure reaches this set point. Menu setting shown after analog input is set. **Factory set to 0 PSI.**

High Suction Pressure Shutdown (Medium Security)**:** a shutdown will occur when the pressure reaches this set point. Menu setting shown after analog input is set. **Factory set to 0 PSI.**

Low Suction Pressure Warning (Medium Security)**:** an alarm will occur when the pressure reaches this set point. Menu setting shown after analog input is set. **Factory set to 0 PSI**

Low Suction Pressure Shutdown (Medium Security)**:** a shutdown will occur when the pressure reaches this set point. Menu setting shown after analog input is set. **Factory set to 0 PSI**

High Gearbox Pressure Warning (Medium Security)**:** an alarm will occur when the pressure reaches this set point. Menu setting shown after analog input is set. **Factory set to 0 PSI.**

High Gearbox Pressure Shutdown (Medium Security)**:** a shutdown will occur when the pressure reaches this set point. Menu setting shown after analog input is set. **Factory set to 0 PSI.**

Low Gearbox Pressure Warning (Medium Security)**:** an alarm will occur when the pressure reaches this set point. Menu setting shown after analog input is set. **Factory set to 0 PSI**

Low Gearbox Pressure Shutdown (Medium Security)**:** a shutdown will occur when the pressure reaches this set point. Menu setting shown after analog input is set. **Factory set to 0 PSI**

Throttle Menu (Medium Security)

Manual Throttle Method (Medium Security)**:**

Throttle Type: allows the operator to choose how they prefer to throttle the engine in manual mode of operation. There are four settings to choose from when throttling in manual. Inc/Dec, Run/Idle, Preset 3, and Preset 4 **Factory set to Inc/Dec**

Inc/Dec: this throttle method allows the operator to manually increase and decrease the engine rpm by the Target RPM Step Size chosen.

Run/Idle: this throttle method allows the operator to manually increase and decrease the engine rpm with 2 presets. When in manual mode this setting will only allow for two throttle set points.

Preset 3: this throttle method allows the operator to manually increase and decrease the engine rpm with 3 presets. When in manual mode this setting will only allow for three throttle set points.

Preset 4: this throttle method allows the operator to manually increase and decrease the engine rpm with 4 presets. When in manual mode this setting will only allow for four throttle set points.

Engine Throttle Type (High Security)**:** allows the selection of J1939 TSC1, Pulse Inc/Dec as the throttle type for the engine. **Factory set to J1939 TSC1.**

J1939 TSC1: this setting will be used when an electronic engine is used for J1939 Throttling. (Verify with Engine Dealer this type of throttling is accepted on the specific engine.)

Pulse Inc/Dec: this setting will be used when throttling a mechanical engine, when using a throttle actuator and also on an electronic engine using digital pulses into the ECU for throttling.

None: when None is selected as throttle type the controller will not show Target RPM on the front screen and does not try to throttle the engine. This is set when another form of throttling is used outside of the MPC-10 / TEC-10 such as a fixed speed engine or a manually controlled hand throttle.

Thomson – (High Security): this setting will be used when throttling a mechanical engine, using a Thomson Throttle Linear Actuator via CAN communications.

Target RPM Step Size (Medium Security)**: t**his is the step size of the target RPM when increasing and decreasing. The actual rate of change is much higher when throttling in auto vs. manually with the push buttons. **Factory set to 25 RPM.**

Throttle Deadband RPM (Medium Security)**:** format of # RPM. Plus/minus value added to the target to provide a range of RPM during which the throttle is not active. No throttling will occur when the engine RPM is within the RPM deadband. **Factory set to 25 RPM.** (Only appears when Pulse Inc/Dec is chosen for the Throttle Type)

Throttle Inc/Dec Pulse (High Security)**:** format of # mS. The amount of time to pulse the throttle. Increase this value for faster engine response, or decrease this value for slower engine response. **Factory set to 50mS.** (Only appears when Pulse Inc/Dec is chosen for the Throttle Type)

Throttle Inc/Dec Pulse Delay (High Security)**:** format of # mS. The amount of delay time before pulsing the throttle. Increase this value for slower engine response, or decrease this value for faster engine response. **Factory set to 250mS.** (Only appears when Pulse Inc/Dec is chosen for the Throttle Type)

Throttle Inc Rate (Medium Security)**:** the rate the engine is signaled to increase in RPM. When using Thomson Engine Throttle Type the setting will be shown as a gain value. **Factory set to 100 RPM/s.**

Throttle Dec Rate (Medium Security)**:** the rate the engine is signaled to decrease in RPM. When using Thomson Engine Throttle Type the setting will be shown as a gain value. **Factory set to 100 RPM/s.**

Torque Control (High Security)**:** when Volvo is selected as the engine manufacturer this menu item becomes active. This menu allows for enabling or disabling torque control of the engine as well as the limit percentage of control.

Enable/Disable Torque Control: Factory set to Disabled

Torque Limit Control: Torque Control **Factory set to 125%**

Set Throttle to Zero (Low Security): This setting allows to zero the Thomson actuator when selected as the Engine Throttle Type.

Throttle Direction (Low Security): This setting allows the user to set whether the Thomson Actuator Extends to Increase the RPM or Extends to Decrease RPM. **Factory set to Extend to Decrease.**

Input / Output Menu

Digital Inputs (1-5) (Medium Security)**:** for each of the digital inputs, the ability to select the following parameters exists:

Digital input 1 (Medium Security)**: Factory set to Function: Disabled, Active: B-, Action: Not Used**
Digital Input 2 (Medium Security)**: Factory set to Function: Auto Start Maintained, Active: B-, Action: Not Used**
Digital Input 3 (Medium Security)**: Factory set to Function: Auto Stop Maintained, Active: B-, Action: Not Used**
Digital Input 4 (Medium Security)**: Factory set to Function: Low Coolant Level, Active: B-, Action: Shutdown**
Digital Input 5 (Medium Security)**: Factory set to Function: Low Lube Oil Level, Active: B-, Action: Shutdown**

Function (Medium Security)**:**

Disabled
Single Contact Start/Stop
Auto Start Maintained (Auto Start Maintained must have Auto Stop Maintained Set)
Auto Stop Maintained (Auto Stop Maintained must have Auto Start Maintained Set)
Remote Alarm Acknowledge
Low Fuel Level
Fuel Leak
Fuel Filter Restriction
Low Lube Oil Level
Low Coolant Level
Remote Stop
Remote Manual/Auto
Idle Engine
Water in Fuel
No Flow
User 1
User 2
Remote Throttle Inc (allows increasing engine speed remotely)
Remote Throttle Dec (allows decreasing engine speed remotely)
Kubota Parking Brake (needed when Kubota engine and Tier 4 is selected)
Kubota Neutral Switch (needed when Kubota engine and Tier 4 is selected)
Pivot Alignment (allows a warning or shutdown when a pivot becomes misaligned)
Air Damper Closed
Air Filter Restriction
Battery Charger Fail
Oil Filter Restriction
Disable TSC1 (allows the operator to disable the TSC1 message to the engine when active)
Remote Throttle Active (allows the operator to activate the remote throttle of the analog inputs)

Active (Medium Security)**:**

B- (when input closes to ground it enables action of digital function)
B+ (when input closes to battery positive it enables action of digital function)
Open (when input opens it enables action of digital function)

Action (Medium Security)**:**

Not Used: (chosen when using digital input for anything except a fault)
Warning: (chosen for an immediate warning to the operator when function is active)
Shutdown: (chosen for an immediate shutdown of engine when function is active)
Shutdown, Controlled: (chosen to allow the controller to shutdown through the normal sequence of operation including cooldown when function is active. User acknowledgement of the fault is required to restart in Auto after shutdown occurs)
Relay Control: (chosen for control of one of the relay outputs when function is active)
Shutdown, Controlled, Restart: (chosen to allow the controller to shutdown through the normal sequence of operation including cooldown when function is active. User acknowledgement of the fault is **NOT** required to restart in Auto after shutdown occurs if active shutdown is removed from controller)

Analog Inputs (1-3) (Medium Security)**:** for each of the analog inputs, the ability to select the following parameters exists:

Analog input 1 (Medium Security)**: Factory set to Function: Disabled**
Analog Input 2 (Medium Security)**: Factory set to Function: Disabled**

Analog Input 3 (Medium Security)**: Factory set to Function: Disabled**

Function (Medium Security)**:**

Disabled
4-20mA Suction Pressure
0-5V Suction Pressure
4-20mA Discharge Pressure
0-5V Discharge Pressure
4-20mA System Level
4-20mA Flow Rate
4-20mA Ambient Temp
0-5V Ambient Temp
4-20mA Gear Box Pressure
0-5V Gear Box Pressure
Datcon Oil Pressure
Murphy Oil Pressure (ES2P-100)
VDO5 Bar Oil Pressure
VDO7 Bar Oil Pressure
Murphy Engine Temp (ES2T-250/300)
Datcon Engine Temp
VDO Engine Temp
Murphy Fuel Level (ES2F)
VDO Fuel Level
Datcon Fuel Level
Murphy Oil Temp (ES2T-250/300)
Datcon Oil Temp
VDO Oil Temp
Murphy PMK-400 Pressure (Gear Box Pressure, Murphy PMK-400 Sensor)
Analog.Digital1
4-20mA Remote Throttle: (4mA = Min Engine Speed, 20mA = Max Engine Speed, Remote Throttle Digital Input must be active to allow analog to work properly)
0.5-4.5V Remote Throttle: (0.5V = Min Engine Speed, 4.5V = Max Engine Speed, Remote Throttle Digital Input must be active to allow analog to work properly)
Model 12 Air Temp Sensor: (Murphy 0-5V Model 12 preset Ambient Temp Sensor)

Sensor Setup (Medium Security)**:** (This menu only appears when a transducer [4-20mA or 0-5V] is selected for an analog input.)

Ambient Temp (0-5V) or (4-20mA)
Discharge Pressure (0-5V) or (4-20mA)
Suction Pressure (0-5V) or (4-20mA)
Flow Rate (4-20mA)
System Level (4-20mA)

Relay (1-3) and Digital (1-4) Outputs (Medium Security)**:** these same parameters are used for both the Relay and Digital Outputs.

Relay 1 (Medium Security)**: Factory set to Crank, Starter Relay**
Relay 2 (Medium Security)**: Factory set to ECU Enable**
Relay 3 (Medium Security)**: Factory set to Not Used**
DO1 (B+, 1A) (Medium Security)**: Factory set to Not in Auto**
DO2 (B+, 1A) (Medium Security)**: Factory set to Engine Running**
DO3 (B-, 1A) (Medium Security)**: Factory set to Throttle Decrease**
DO4 (B-, 1A) (Medium Security)**: Factory set to Throttle Increase**

Not Used: This function does not allow the output to turn on when chosen.
Prestart 1 Delay: Output turns on when in Prestart 1 state. See Timers on page 23.
Prestart 2 Delay: Output turns on when in Prestart 2 state. See Timers on page 23.
Crank: Output turns on when in Crank state. See Timers on page 23.
Fuel: Output turns on when cranking and turns off after cooldown. See Timers on page 23.
ECU Enable Used for enabling the ECU on electronic engines. This output turns on anytime the controller is powered up or in the crank/run state. It's turned off if the controller is in spindown or standby states.
Excite Engine Alternator This output can be used if the dedicated Alt Excite output is not used.
Shutdown This output turns on when a fault shutdown occurs.
Common Alarm This output turns on when either a shut-down or a non-shutdown warning occurs.
Remote Alarm This output turns on when a either a shutdown or a non-shutdown warning occurs.
Not in Auto This output turns on when the controller is in the manual mode.
Engine Running This output turns on after the engine actually starts and off when the engine stops.
Throttle Increase The increase outputs are used for the pulse increment throttling type.
Throttle Decrease The decrease outputs are used for the pulse decrement throttling type.
Digital Input (1-5) A digital input can be assigned to turn on a digital output.
Analog (1-3) Digital An analog input configured to be a digital input can be assigned to turn on a digital output.
Feed Engage This output is used for Chipper control to engage the feed wheel.
Feed Disengage This output is used for Chipper control to disengage the feed wheel.
Pivot Power This output turns on anytime the engine is above crank disconnect RPM to allow voltage to a center pivot.
Failed to Start This output turns on when the cranking cycles have completed and the engine fails to start in an overcrank situation.
Ignition On (off in standby) This output turns on any time the controller is keyed on with the exception of standby. This output is disabled during standby (sleep mode) to help reduce parasitic loads.
Ignition On (on in standby) This output turns on any time the controller is keyed on. Be cautious of using where a parasitic load can drain the battery and not allow the engine to start.

Application Configuration (Low Security)

Application (Medium Security)**: Factory set to Pump All Purpose**

Pump All Purpose: The Pump All Purpose application houses the auto start functions and auto throttle methods meant to be used on most engine-driven pump applications. This application allows for pumps of many variations to be used in a manual/auto start environment utilizing the more common auto start and throttling functions.

Air Compressor: The Air Compressor application houses the auto start functions and auto throttle methods meant to be used on most engine-driven air compressor applications. The MPC-10 / TEC-10 allows for the compressor to start/stop and/or maintain a desired pressure during operation.

Hose Reel Irrigation: The Hose Reel Irrigation application houses the auto start functions and auto throttle methods meant to be used on hose reel irrigation systems. The MPC-10 / TEC-10 allows for the hose reel pump to auto start with several methods, including the Local Key Start

which may be the most used in this application. The key feature of this application is the auto throttling method. This feature allows the controller to manage the pump's throttle in order to maintain a pressure in the hose during irrigation.

Frost Protection: The Frost Protection application houses the auto start functions and auto throttle methods meant to be used on frost protection systems. This application allows for wind machine, sprinkler or other forms of frost protection using single contact or a temperature transducer.

Chipper: The MPC-10 / TEC-10 must be in the Manual mode for both Chipper Auto and Chipper Manual (Autofeed Override). The Chipper application has settings required for the operation:

Auto Start / Stop Function (Medium Security)**: Factory Set to Two Contact Maintained**

Single Contact (Pump All Purpose, Air Compressor, Hose Reel Irrigation, Frost Protection, Chipper)

Local Start Key (Pump All Purpose, Air Compressor, Hose Reel Irrigation, Chipper)

Two Contact Maintained (Pump All Purpose)

Pressure Transducer (Pump All Purpose & Air Compressor)

Level Transducer (Pump All Purpose)

Temperature Transducer (Frost Protection)

Auto Throttle Method (Medium Security)**: Factory Set to Running Loaded**

Running Loaded RPM (Pump All Purpose, Air Compressor, Frost Protection) allows the controller to adjust the speed of the engine to maintain a RPM setpoint in Auto mode.

Pressure Transducer (Pump All Purpose, Air Compressor, Hose Reel Irrigation) allows the controller to adjust the speed of the engine to maintain a pressure setpoint in Auto mode.

Level Transducer (Pump All Purpose) allows the controller to adjust the speed of the engine to maintain a level setpoint in Auto mode.

Running Loaded Inc/Dec (Pump All Purpose) allows the controller to ramp the engine speed up and down using the Inc/Dec buttons on the keypad while using the controller for auto start.

Auto Throttle Type (High Security)**: Factory set to NON PID Auto Throttle.**

NON PID Auto Throttle: this throttle type does not use the PID adjustments found in the Transducer setups in the Application menu and uses the ramp rates to control the engine speed.

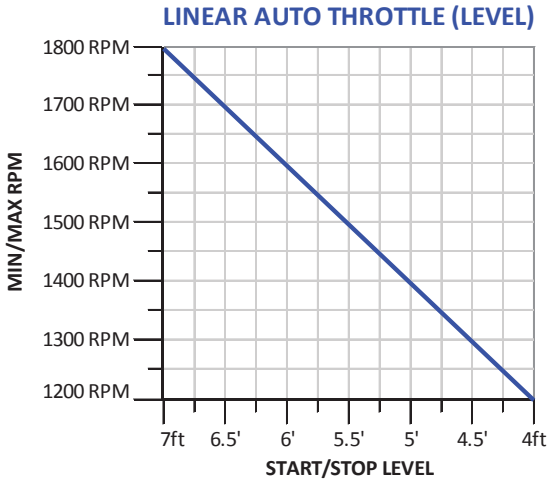
PID Auto Throttle: this throttle type uses the PID adjustments found in the Transducer setups within the Application menu. This setting should only be used by a technician who understands in detail the method of tuning the proportional-integral-derivative control loop commonly used in PLC programming language.

> **NOTE:** When selecting PID Auto Throttle as the auto throttle type the Ramp Inc Rate and Ramp Dec Rate in the Throttle menu should be set to 0 RPM per Second so the PID does not combat the ramp rates set in the controller. This will require the user to manually adjust the throttle rate in manual mode.

Linear Auto Throttle: this throttle type uses the Pressure or Level start and stop setpoints as well as the minimum and maximum RPM setpoints to linearly/proportionally throttle the engine from start to stop depending on pressure or level. The throttle increases or decreases depending on the

setting of the transducer type selected. The linear tie to the start/stop should be used when desiring to decrease throttle approaching the stop setting. See figure below as an example.

Example, Linear Auto Throttle: This example shows level with the transducer type set to Empty with auto level start at 7ft and auto level stop at 4ft. This example also shows a maximum RPM of 1800 and a minimum RPM of 1200. As the pump starts it ramps up to 100% (maximum throttle) then slows linearly/proportionally as the level decreases until set stop level is reached with a 0% minimum throttle.



NOTE: In order for linear auto throttle to work correctly the auto start/stop function and auto throttle method need to be set to the same transducer type.

Auto Running Loaded Speed (Medium Security): this selection is present when selecting Running Loaded RPM as the Auto Throttle Method. This setting will set the speed at which the controller will run in auto mode when in the Running Loaded state. **Factory set to 2000 RPM.**

Pressure Transducer (Medium Security): This selection is only present when selecting Pressure Transducer in the Auto Start / Stop Function or Auto Throttle Method.

Start Pressure (Medium Security): This selection is present when selecting Pressure Transducer as the Auto Start / Stop Function. When the pressure reaches this set point, an auto start will occur. **Factory set to 0 psi**

Stop Pressure (Medium Security): This selection is present when selecting Pressure Transducer as the Auto Start / Stop Function. When the pressure reaches this set point, an auto stop will occur. **Factory set to 0 psi**

Maintain Pressure (Medium Security): This selection is present when selecting Pressure Transducer as the Auto Throttling Method. The engine will be throttled between the min. and max. RPM set points to maintain this pressure. **Factory set to 0 psi**

Deadband Pressure (Medium Security): This selection is present when selecting Pressure Transducer as the Auto Throttling Method. This extends above and below the maintain set point, no throttling occurs while the pressure is in the deadband. **Factory set to 0 psi**

Pressure Type (Medium Security): **Factory set to Discharge**

Discharge: When the Auto Start/Stop is selected as Pressure Transducer and the Pressure Type is set to **(Discharge)**, it is necessary to set the pressure to start on a low value (falling ↓) then stop on high value (rising ↑) in order to work correctly. When the Auto Throttle Method is selected to Pressure Transducer and the Pressure Type is set to **(Discharge)**, the controller throttles the engine by increasing the RPM below the deadband and decreasing the RPM above the deadband to maintain the desired level of Pressure.

Suction: When the Auto Start/Stop is selected as Pressure Transducer and the Pressure Type is set to **(Suction)**, it is necessary to set the pressure to start on a high value (rising ↑) then stop on low value (falling ↓) in order to work correctly. When the Auto Throttle Method is selected to Pressure Transducer and the Pressure Type is set to **(Suction)**, the controller throttles the engine by decreasing the RPM below the deadband and increasing the RPM above the deadband to maintain the desired level of Pressure.

Line Fill 1 Speed (Medium Security): The engine is throttled to this speed after warm-up to purge the line. **Factory set to 900 RPM**

Line Fill 1 Delay (Medium Security): This is the time the engine is held at the Line Fill 1 speed. **Factory set to 00.00.00**

Line Fill 1 Pressure (Medium Security): The engine is held at the Line Fill 1 Speed until either this pressure set point is reached or the Line Fill 1 Delay expires. **Factory set to 0 psi**

Line Fill 2 Speed (Medium Security): This selection is present when Hose Reel is selected in the Applications menu. The engine is throttled to this speed after Line Fill 1 to fill the line. **Factory set to 900 RPM**

Line Fill 2 Delay (Medium Security): This selection is present when Hose Reel is selected in the Applications menu. This is the time the engine is held at the Line Fill 2 speed before advancing to pressure throttle control. **Factory set to 00.00.00**

Line Fill 2 Pressure (Medium Security): This selection is present when Hose Reel is selected in the Applications menu. The engine is held at the Line Fill 2 Speed until either this pressure set point is reached or the Line Fill 2 Delay expires before advancing to pressure throttle control. **Factory set to 0 psi**

Pressure P (High Security): This selection is present when PID Auto Throttle Type selected and allows adjustment of the Proportional setting of the PID loop when throttling. **Factory set to 0.020**

Pressure I (High Security): This selection is present when PID Auto Throttle Type selected and allows adjustment of the Integral setting of the PID loop when throttling. **Factory set to 0.020**

Pressure D (High Security): This selection is present when PID Auto Throttle Type selected and allows adjustment of the Derivative setting of the PID loop when throttling. **Factory set to 0.001**

Level Transducer (Medium Security): This selection is only present when selecting Level Transducer in the Auto Start / Stop Function or Auto Throttle Method.

Start Level (Medium Security): This selection is present when selecting Level Transducer as the Auto Start / Stop Function. When the level reaches this set point, an auto start will occur. **Factory set to 0.0 ft**

Stop Level (Medium Security): This selection is present when selecting Level Transducer as the Auto Start / Stop Function. When the level reaches this set point, an auto stop will occur. **Factory set to 0.0 ft**

Maintain Level (Medium Security): This selection is present when selecting Level Transducer as the Auto Throttling Method. The engine will be throttled between the min. and max. RPM set points to maintain this level. **Factory set to 0.0 ft**

Deadband Level (Medium Security): This selection is present when selecting Level Transducer as the Auto Throttling Method. This extends above and below the maintain set point, no throttling occurs while the level is in the deadband. **Factory set to 0.0 ft**

Level Type (Medium Security): **Factory set to Empty**

Fill: When the Auto Start/Stop is selected as Level Transducer and the Level Type is set to **(Fill)**, it is necessary to set the flow to start on a low value (falling ↓) then stop on high value (rising ↑) in order to work correctly. When the Auto Throttle Method is selected to Level Transducer and the Level Type is set to **(Fill)**, the controller throttles the engine by increasing the RPM below the deadband and decreasing the RPM above the deadband to maintain the desired level.

Empty: When the Auto Start/Stop is selected as Level Transducer and the Level Type is set to **(Empty)**, it is necessary to set the level to start on a high value (rising ↑) then stop on low value (falling ↓) in order to work correctly. When the Auto Throttle Method is selected to Level Transducer and the Level Type is set to **(Empty)**, the controller throttles the engine by decreasing the RPM below the deadband and increasing the RPM above the deadband to maintain the desired level.

Level P (High Security): This selection is present when PID Auto Throttle Type selected and allows adjustment of the Proportional setting of the PID loop when throttling. **Factory set to 0.020**

Level I (High Security): This selection is present when PID Auto Throttle Type selected and allows adjustment of the Integral setting of the PID loop when throttling. **Factory set to 0.020**

Level D (High Security): This selection is present when PID Auto Throttle Type selected and allows adjustment of the Derivative setting of the PID loop when throttling. **Factory set to 0.001**

(Flow Transducer): The controller supports this transducer for display and alarms only. No control such as start stop or throttling is available. Auto Flow is available in the MPC-20 controller if required.

Temperature Transducer (Medium Security): only present when selecting Temperature Transducer in the Auto Start / Stop Function.

Start Temperature (Medium Security)**:** When the temperature drops to this set point, an auto start will occur. **Factory set to 32 F**

Stop Temperature (Medium Security)**:** When the temperature rises to this set point, an auto stop will occur. **Factory set to 32 F**.

Engage RPM. In the Chipper Auto mode, the engine speed when the Feed Engage output will be activated. **Factory set to 2200 RPM.**

Disengage RPM. In the Chipper Auto mode, the engine speed when the Feed Disengage output will be activated. **Factory set to 1800 RPM.**

Disengage Delay. The amount of time the Feed Disengage output is active. **Factory set to 50mSec.**

Chipper Feed System. Operation of the outputs. **Factory set to ON-OFF-ON.**

Chipper type: ON-OFF-ON:

CHIPPER AUTO MODE

1. (2) Control outputs, Engage and Disengage are off prior to start up.
2. The engine is started manually using the MPC-10 / TEC-10 and throttled manually up to the Engage RPM set point:
   a. The Engage output turns on.
3. If during normal operation, the engine speed drops to the Disengage RPM set point:
   a. The Engage output turns off.
   b. The Disengage output turns on.
   c. The Disengage delay begins timing. This is the amount of time the disengage (reverse) output is turned on for Chipper applications. **Factory set to 50 mS.**
4. When the Disengage delay expires:
   a. The Disengage output turns off.
5. When the engine speed rises to the Engage RPM set point:
   a. The Engage output turns on.

CHIPPER MANUAL MODE (AUTOFEED OVERRIDE)

1. The engine speed must be below the Disengage RPM set point to use the Autofeed Override feature. An RPMs TOO HIGH warning will appear if the Autofeed Override menu is accessed while the engine speed is higher than the Disengage RPM set point.
2. The operator enters the password to access the main menu.
3. Once in the main menu, the operator holds down the Enter button for 5 seconds.
4. The Autofeed Override menu will appear in the Feed Off mode.
5. For Feed Forward, the operator first presses and holds the Up Arrow, then presses and holds the Enter button, holding both for 5 seconds:
6. The Engage output turns on.
7. The display will read Feed Forward.
8. For Feed Reverse, the operator first presses and holds the Down Arrow, then presses and holds the Enter button, holding both for 5 seconds:
9. The Engage output turns off.
10. The Disengage output turns on.
11. The display will read Feed Reverse.
12. For Feed Off, the operator presses and holds the Enter button for 5 seconds.
13. If on, the Engage output turns off.
14. If on, the Disengage output turns off.
15. The display will read Feed Off.
16. To exit the Autofeed Override feature, press and hold the Back button for 5 seconds. This will return the controller to the main menu. Press the menu button to return to the front display.

Chipper type: DUMPING:

CHIPPER AUTO MODE

1. (2) Control outputs, Engage and Disengage are off prior to start up.
2. The engine is started manually using the MPC-10 / TEC-10 and throttled manually up to the Engage RPM set point:
3. The Engage output turns on.
4. If during normal operation, the engine speed drops to the Disengage RPM set point:
   a. The Engage output remains on.
   b. The Disengage output turns on.
   c. The Disengage delay begins timing.
5. When the Disengage delay expires:
   a. The Engage output turns off.
   b. The Disengage output turns off.
6. When the engine speed rises to the Engage RPM set point:
   a. The Engage output turns on.

CHIPPER MANUAL MODE (AUTOFEED OVERRIDE)

1. The engine speed must be below the Disengage RPM set point to use the Autofeed Override feature. An RPMs TOO HIGH warning will appear if the Autofeed Override menu is accessed while the engine speed is higher than the Disengage RPM set point.
2. The operator enters the password to access the main menu.
3. Once in the main menu, the operator holds down the Enter button for 5 seconds.
4. The Autofeed Override menu will appear in the Feed Off mode.
5. For Feed Forward, the operator first presses and holds the Up Arrow, then presses and holds the Enter button, holding both for 5 seconds:
   a. The Engage output turns on.
   b. The display will read Feed Forward.
6. For Feed Reverse, the operator first presses and holds the Down Arrow, then presses and holds the Enter button, holding both for 5 seconds:
   a. The Engage output remains on.
   b. The Disengage output turns on.
   c. The display will read Feed Reverse.
7. For Feed Off, the operator presses and holds the Enter button for 5 seconds:
   a. The Engage output turns off.
   b. If on, the Disengage output turns off.
   c. The display will read Feed Off.
8. To exit the Autofeed Override feature, press and hold the Back button for 5 seconds. This will return the controller to the main menu. Press the menu button to return to the front display.

Start / Stop Timers (Low Security)

> **NOTE:** When the engine is started using one of the start timers, the timer which started the engine is the timer which will stop the engine. Other start/stop timers will be ignored if they happen to overlap from the timer that starts the engine.

This section allows the setting of the timers to start and stop the engine. There are three timers, each with a Start Day and a Stop Day, a Start Time and a Stop Time. This is based on the internal real-time clock.

Countdown Timer (Low Security)**:** the countdown timer will be active upon every auto start up until the time is changed or disabled. It is used when it is desirable for a machine to run for a specific amount of

time unmonitored and then shut itself off when that time has expired or when a local key stop occurs. Format of HH:MM:SS. Maximum countdown time is 120 hours. **Factory set to 00:00:00**

> **NOTE:** The countdown timer is only active when starting in Auto mode. This timer will not start counting when starting the engine in manual mode and switching to auto mode after the engine is running.

Start / Stop Timer (1-3) (Low Security)**:** each of the three timers contains the ability to select from the following parameters:

Start Day (Low Security)**: Factory set to Off**
- Sunday
- Monday
- Tuesday
- Wednesday
- Thursday
- Friday
- Saturday
- Daily
- Off

Start Time: format of HH:MM:SS (Low Security): **Factory set to 12.00.00 AM.**

Stop Day (Low Security)**: Factory set to Off**
- Sunday
- Monday
- Tuesday
- Wednesday
- Thursday
- Friday
- Saturday
- Daily
- Off

Stop Time: format of HH:MM:SS (Low Security): **Factory set to 12.00.00 AM.**

Engine Exerciser (Medium Security)**:** This feature allows the operator to set a voltage point for when the battery voltage drops below for a given period of time the controller will provide an auto start for a defined period of time to energize the battery using the engine alternator.

> **NOTE:** The exerciser is only active when the controller is in Auto mode. If the exerciser starts the engine the exerciser is the only auto stop method to stop the engine. This holds true with all the Start/Stop Timers.

Exercise Mode (Medium Security)**:** Set point for the operator to enable the voltage exerciser of the engine. **Factory set to Disabled**

Low Voltage Set Point (Medium Security)**:** Voltage the operator sets for the battery voltage to drop below before an auto start will initiate to exercise the engine for recharging the battery. **Factory set to 9.5V**

Low Voltage Time (Medium Security)**:** Time the operator sets for the voltage to be below the low voltage set point before an auto start is initiated. **Factory set to 10 minutes**

Exercise Running Loaded Time (Medium Security)**:** Time the operator sets for the engine to run if voltage drops below the low voltage set point. **Factory set to 15 minutes**

Communication (High Security)

Communication Type (High Security)**:**

PVA Gauge: this function will be used if utilizing PVA Gauges on the RS485 Communications Port.

Modbus: this function will be used if using a SCADA or telemetry device for polling the Modbus register list on the RS485 Communications Port. See Modbus Register Map. **Factory Default.**

Local Display: (for future use) this function will be used to connect the display to a remote viewing application. This can be a program running on a PC or another MPC-10 / TEC-10 with a custom configuration set up as a remote viewer.

Slave Address (High Security)**:** This is the RS485 Modbus slave node number. **Factory set to 1**.

Serial Setup (High Security)**:** Allows the operator to change the controller's RS485 serial communication settings.

Baudrate (High Security)**: Factory set to 19200**
- 9600
- 19200
- 38400
- 57600
- 115200

Stopbits (High Security)**: Factory set to 1**
- 0
- 1
- 2

Parity (High Security)**: Factory set to None**
- None
- Odd
- Even

PV CAN Backlight Enable (High Security)**:** allows the MPC-10 / TEC-10 to control the backlights of the PVCAN gauges when used with the controller. **Factory set to Off**

CAN Termination (High Security)**:** allows the operator to enable or disable the controller's internal 120 ohm terminating resistor. This should be enabled if the MPC-10 / TEC-10 is located at the end of the CAN bus and the end terminating resistor is not in the harness. **Factory set to Enable.**

CAN Parameter Map (High Security)**:** allows the operator to enable or disable the proprietary CAN parameter map. The CAN Parameter Map can be used in place of the Modbus map when using a CAN device to talk to the controller for starting, stopping and control functions via telematics or another CAN based system. See CAN Parameter Map Section below for definition of the mapping. **Factory set to Disable.**

CAN Baud rate (High Security)**: Factory set to 250 Kbps**
- 10 Kbps
- 20 Kbps
- 50 Kbps
- 100 Kbps
- 125 Kbps

250 Kbps
500 Kbps
800 Kbps
1 Mbps

Passcodes (High Security)

This menu allows the operator using the High Security passcode to see the three 4-digit passcodes for Low, Medium and High security. This is a visual menu only. The security passcodes are only able to be altered via PowerVision for Controllers PC tool.

Load Configuration (High Security) MPC-10 ONLY

> **NOTE:** It is essential that the USB Drive is formatted to a FAT file system before using to load software. If the drive is not formatted to FAT and left in another format the file may not load correctly.

This menu allows the MPC-10 operator using the High Security passcode to select a file from a USB drive plugged into the programming harness for the controller. Once the files are stored on the drive after generated in PowerVision for Controllers the file will show as long as the software was for the MPC-10 hardware and has the file extension .gcibin. Once the file is found it will show in the screen. Follow directions on the screen to load desired file. The screen will turn off then all three LEDs will come on then the Amber LED will begin flashing. Once the file is finished loading the Green LED stays on stead while the Amber and Red LEDs flash. The USB drive can now be removed to initiate a reboot of the controller or simply cycle power off then back on.

> **NOTE:** If the file does not fully load due to the file being corrupt, the controller turned off during installing file, or the USB drive removed during drive the operator will be required to load a file created for the MPC-10 named configurationFull.gcibin to recover the controller from its bootloader mode. Once this is done the operator will be able to load a file from the menu again following power up.

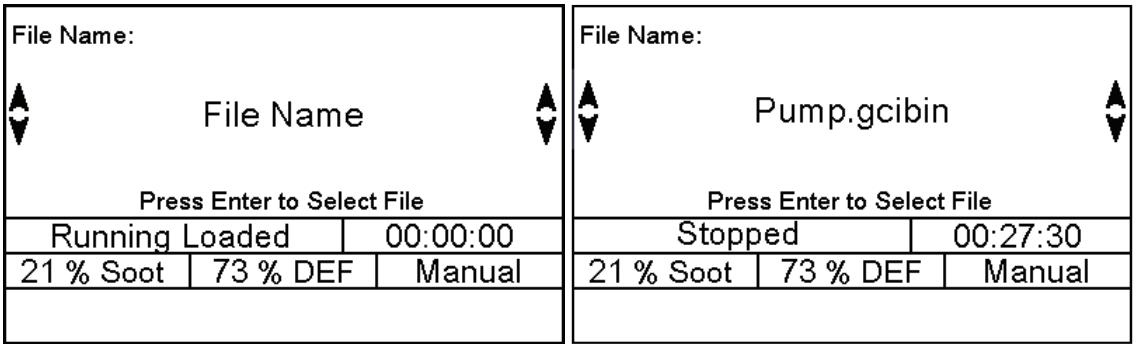


Figure 20: File Selection

Communication Mapping

This section outlines the RS485 Modbus Register Map and CAN Parameter Map.

Modbus Registers

> NOTE: The registers labeled Read/Write will allow the operator to change values through the Modbus as a temporary modification. If power is cycled to the MPC-10 / TEC-10, the values changed via Modbus will revert back to the last value entered locally.

REGISTER #	TYPE	DESCRIPTION	UNITS
40001-40002	Read Only	Current Engine Hours (32 Bit)	Hours
40003	Read Only	Actual Engine Speed	RPM
40004	Read Only	System Voltage (12.5 will read 125)	VDC
40005	Read Only	Actual Engine Oil Pressure	kPa
40006	Read Only	Actual Engine Temperature	Celsius
40007	Read Only	Controller State (Active State: Numeral Indicated)	Numerals
		0 = ECU Stabilize Delay	
		1 = Engine Stopped	
		2 = Controller in Standby	
		3 = Prestart 1 Delay	
		4 = Check Safe to Start	
		5 = Prestart 2 Delay	
		6 = Crank On	
		7 = Crank Rest	
		8 = False Start Check	
		9 = Engine Warmup Delay	
		10 = Line Fill 1 Delay	
		11 = Line Fill 2 Delay	
		12 = Running Loaded	
		13 = Running Cooldown Delay	
		14 = Energize to Stop Delay	
		15 = Engine Spindown Delay	
		16 = Wait to Start Delay	
40008	Read Only	Active Shutdown Status (Active Fault: Bit = 1, Inactive: Bit = 0)	
		0 = Overspeed SD	(0 or 1)
		1 = Underspeed SD	(0 or 1)
		2 = Overcrank SD	(0 or 1)
		3 = Low Oil Pressure SD	(0 or 1)
		4 = High Engine Temp SD	(0 or 1)
		5 = Low Fuel SD	(0 or 1)
		6 = Low Discharge Pressure SD	(0 or 1)
		7 = High Discharge Pressure SD	(0 or 1)
		8 = Speed Signal Lost SD	(0 or 1)
		9 = Low Lube Level SD	(0 or 1)
		10 = Fuel Leak SD	(0 or 1)
		11 = Fuel Filter Restriction SD	(0 or 1)
		12 = Reserved	Reserved
		13 = Reserved	Reserved

		14 = Reserved	Reserved
		15 = Remote Stop SD	(0 or 1)
40009	Read Only	Active Shutdown Status (Active Fault: Bit = 1, Inactive: Bit = 0)	
		0 = Coolant Level SD	(0 or 1)
		1 = High Level SD	(0 or 1)
		2 = Low Level SD	(0 or 1)
		3 = High Flow SD	(0 or 1)
		4 = Low Flow SD	(0 or 1)
		5 = Reserved	Reserved
		6 = Reserved	Reserved
		7 = Water in Fuel SD	(0 or 1)
		8 = Low Suction SD	(0 or 1)
		9 = High Suction SD	(0 or 1)
		10 = Reserved	Reserved
		11 = High Engine Oil Temp SD	(0 or 1)
		12 = Low Gear Box Pressure SD	(0 or 1)
		13 = High Gear Box Pressure SD	(0 or 1)
		14 = Reserved	Reserved
		15 = Red Lamp Status	(0 or 1)
40010	Read Only	Active Shutdown Status (Active Fault: Bit = 1, Inactive: Bit = 0)	
		0 = Pivot Alignment SD	(0 or 1)
		1 = Reserved	Reserved
		2 = Reserved	Reserved
		3 = Reserved	Reserved
		4 = Reserved	Reserved
		5 = Reserved	Reserved
		6 = Reserved	Reserved
		7 = Reserved	Reserved
		8 = Reserved	Reserved
		9 = Reserved	Reserved
		10 = Reserved	Reserved
		11 = Reserved	Reserved
		12 = Reserved	Reserved
		13 = Reserved	Reserved
		14 = Reserved	Reserved
		15 = Reserved	Reserved
40011	Read Only	Actual System Level	Feet
40012	Read & Write	Modbus Engine Start/Stop Auto Mode Only (Stop = 0, Start = 1)	(0 or 1)
40013	Read & Write	Maximum Engine Speed Setpoint	RPM
40014	Read Only	Actual Ambient Temp	Celsius
40015	Read & Write	Auto/Manual Mode (Manual = 0, Auto = 1)	(0 or 1)
40016	Read & Write	Running Loaded Speed in Auto Setpoint	RPM
40017	Read & Write	Manual Only (Manual Only Enabled = 1, Disabled = 0)	(0 or 1)
40018	Read & Write	Prestart 1 Auto Only (Prestart Auto Only = 1, Prestart Auto & Manual = 0)	(0 or 1)
40019	Read & Write	Prestart 2 Auto Only (Prestart Auto Only = 1, Prestart Auto & Manual = 0)	(0 or 1)
40020	Read Only	J1939.Actual Engine Torque	Percent

40021	Read Only	Reserved	Reserved
40022	Read Only	J1939.Diesel Particulate Filter Outlet Temperature	Celsius
40023	Read Only	J1939.Diesel Particulate Filter Intake Temperature	Celsius
40024	Read Only	J1939.Exhaust Temperature	Celsius
40025	Read Only	J1939.Engine Exhaust Manifold Bank 1 Temperature	Celsius
40026	Read Only	J1939.Boost Pressure	kPa
40027	Read Only	J1939.Engine Fuel Temperature	Celsius
40028	Read Only	J1939.Engine Intercooler Temperature	Celsius
40029	Read Only	J1939.Diesel Particulate Filter Ash Load Percent	Percent
40030	Read Only	J1939.Diesel Exhaust Fluid Tank Temperature	Celsius
40031	Read Only	J1939.Engine Fuel Delivery Pressure	kPa
40032	Read Only	J1939.Barometric Pressure	kPa
40033	Read Only	J1939.Air Filter Diff. Pressure	kPa
40034	Read Only	J1939.Exhaust Gas Temperature	Celsius
40035	Read Only	J1939.Hydraulic Pressure	kPa
40036	Read Only	J1939.Hydraulic Temperature	Celsius
40037	Read Only	J1939.Diesel Particulate Filter Active Regeneration Status: The following is a description of enumeration values.	Numerals
		0 = Not Active	
		1 = Active	
		2 = Regeneration Needed	
		3 = Not Available	
40038	Read & Write	System Level Engine Start (Auto)	Feet
40039	Read & Write	System Level Engine Stop (Auto)	Feet
40040	Read & Write	System Level Maintain Value (Auto)	Feet
40041	Reserved	Reserved	Reserved
40042	Reserved	Reserved	Reserved
40043-40044	Read Only	Actual Discharge Pressure	kPa
40045-40046	Read & Write	Pressure Engine Start (Auto)	kPa
40047-40048	Read & Write	Pressure Engine Stop (Auto)	kPa
40049-40050	Read & Write	Pressure Maintain Value (Auto)	kPa
40051-40200	Read Only	Reserved	Reserved
40201	Read Only	Version.App.1	Numerals
40202	Read Only	Version.App.2	Numerals
40203	Read Only	Version.App.3	Numerals
40204	Read Only	Version.App.4	Numerals
40205	Read Only	Version.Config.1	Numerals
40206	Read Only	Version.Config.2	Numerals
40207	Read Only	Version.Config.3	Numerals
40208	Read Only	Reserved	Reserved
40210	Read Only	J1939.Engine Catalyst Tank Level	Percent
40211	Read Only	J1939.Diesel Particulate Filter 1 Soot Load Percent	Percent
40212	Read Only	J1939.Diesel Particulate Filter Regeneration Inhibit Switch (Inhibit Switch Active = 1)	(0 or 1)
40213	Read Only	The following is a description of bits:	
		0 = J1939.Diesel Particulate Filter Active Regeneration Inhibited Due to Inhibit Switch (Inhibited = 1)	(0 or 1)
		1 = Reserved	Reserved

		2 = Reserved	Reserved
		3 = Reserved	Reserved
		4 = Reserved	Reserved
		5 = Reserved	Reserved
		6 = Reserved	Reserved
		7 = Reserved	Reserved
		8 = Reserved	Reserved
		9 = Reserved	Reserved
		10 = Reserved	Reserved
		11 = Reserved	Reserved
		12 = Reserved	Reserved
		13 = Reserved	Reserved
		14 = Reserved	Reserved
		15 = Reserved	Reserved
40214	Read Only	Controller State Timer	Seconds
40215	Read Only	Target Engine Speed from Controller	RPM
40216	Read Only	All Purpose Auto Start Function: (Active Function: Numeral Indicated)	Numerals
		0 = Single Contact	
		1 = Local Start Button	
		2 = Two Contact Maintained	
		3 = Reserved	
		4 = Pressure Transducer	
		5 = Level Transducer	
		6 = Reserved	
40217	Read & Write	Pressure Maintain Deadband (Auto)	kPa
40218	Read & Write	System Level Maintain Deadband (Auto)	Feet
40219	Reserved	Reserved	Reserved
40220	Read & Write	Ambient Temperature Engine Start (Auto)	Celsius
40221	Read & Write	Ambient Temperature Engine Stop (Auto)	Celsius
40222	Reserved	Reserved	Reserved
40223	Reserved	Reserved	Reserved
40224	Read & Write	Minimum Engine Speed Setpoint	RPM
40225	Read Only	Service Reminder - Air Filter Life	Hours
40226	Read Only	Service Reminder - Air Filter Life Remaining	Hours
40227	Read Only	Service Reminder - Battery Life	Hours
40228	Read Only	Service Reminder - Battery Life Remaining	Hours
40229	Read Only	Service Reminder - Belt Life	Hours
40230	Read Only	Service Reminder - Belt Life Remaining	Hours
40231	Read Only	Service Reminder - Fuel Filter Life	Hours
40232	Read Only	Service Reminder - Fuel Filter Life Remaining	Hours
40233	Read Only	Service Reminder - Oil Filter Life	Hours
40234	Read Only	Service Reminder - Oil Filter Life Remaining	Hours
40235	Read Only	Service Reminder - Oil Life	Hours
40236	Read Only	Service Reminder - Oil Life Remaining	Hours
40237	Read Only	Service Reminder - Overhaul Life	Hours
40238	Read Only	Service Reminder - Overhaul Life Remaining	Hours
40239	Read Only	Actual Fuel Level	Percent

40240	Read & Write	Modbus EEPROM Values Save (Save = 1)	(0 or 1)
40241	Read Only	Modbus EEPROM Values Saved Confirmation (Saved = 1)	(0 or 1)
40242	Read Only	Active Warning Status (Active Fault: Bit = 1, Inactive: Bit = 0)	
		0 = Low Fuel Warn	(0 or 1)
		1 = Fuel Leak Warn	(0 or 1)
		2 = Fuel Filter Restriction Warn	(0 or 1)
		3 = Low Lube Level Warn	(0 or 1)
		4 = Coolant Level Warn	(0 or 1)
		5 = Water in Fuel Warn	(0 or 1)
		6 = No Flow Warn	(0 or 1)
		7 = High Engine Oil Temp Warn	(0 or 1)
		8 = Low Oil Pressure Warn	(0 or 1)
		9 = High Engine Temp Warn	(0 or 1)
		10 = High Discharge Pressure Warn	(0 or 1)
		11 = Low Discharge Pressure Warn	(0 or 1)
		12 = High Suction Warn	(0 or 1)
		13 = Low Suction Warn	(0 or 1)
		14 = High Level Warn	(0 or 1)
		15 = Low Level Warn	(0 or 1)
40243	Read Only	Active Warning Status (Active Fault: Bit = 1, Inactive: Bit = 0)	
		0 = High Flow Warn	(0 or 1)
		1 = Low Flow Warn	(0 or 1)
		2 = Reserved	(0 or 1)
		3 = Reserved	(0 or 1)
		4 = Low Gear Box Pressure Warn	(0 or 1)
		5 = High Gear Box Pressure Warn	(0 or 1)
		6 = Reserved	(0 or 1)
		7 = Reserved	(0 or 1)
		8 = Reserved	(0 or 1)
		9 = Low Engine Temp Warn	(0 or 1)
		10 = Reserved	(0 or 1)
		11 = Reserved	(0 or 1)
		12 = Run To Destruct Warn	(0 or 1)
		13 = Battery High Warn	(0 or 1)
		14 = Battery Low Warn	(0 or 1)
		15 = Amber Lamp Status	(0 or 1)
40244	Read Only	Active Warning Status (Active Fault: Bit = 1, Inactive: Bit = 0)	
		0 = Pivot Alignment Warn	(0 or 1)
		1 = Reserved	Reserved
		2 = Reserved	Reserved
		3 = Reserved	Reserved
		4 = Reserved	Reserved
		5 = Reserved	Reserved
		6 = Reserved	Reserved
		7 = Reserved	Reserved
		8 = Reserved	Reserved
		9 = Reserved	Reserved

		10 = Reserved	Reserved
		11 = Reserved	Reserved
		12 = Reserved	Reserved
		13 = Reserved	Reserved
		14 = Reserved	Reserved
		15 = Reserved	Reserved
40245-40246	Read Only	J1939.Aftertreatment 1 Diesel Particulate Filter Time to Next Active Regeneration	Seconds
40247	Read & Write	Remote Alarm Acknowledgement	(0 or 1)

CAN Parameter Map

This feature of the MPC-10 allows an operator to control functions of the controller over CAN (J1939) similar to Modbus over the RS485 serial port. The map below will allow for devices to communicate via CAN in place of RS485 to start, stop, and control features listed in the map by enabling the setting in the Communications menu.
All the parameters shown in the map below have a resolution of one and an offset of zero. The PGNs used are shown in HEX and listed as a proprietary parameters in the J1939 standard.

All PGNs received from the MPC-10 will have identification bytes A3, and AD respectively for the first two bytes. Sending to the MPC-10 the PGN will be the same as the one it is received from, however the first two identification bytes will be changed to be A5, AD. The priority will be 18 (hex), and the source address will be 70 (hex). To save the value in the controller through power cycles, send PGN FFBB bit 16 a value of 1. When the controller receives this command a save occurs. In order to save again, FFBB bit 16 needs to be returned to a 0 before it will allow a 1 again.

Parameter Map updates once per second on the CANbus when enabled.

PGN	LENGTH	Start BIT	Stop BIT	TYPE	DESCRIPTION	UNITS
FF90	2 Bytes	16	31	Read Only	Actual Engine Speed	RPM
	2 Bytes	32	47	Read Only	Target Engine Speed	RPM
FF91	2 Bytes	16	31	Read & Write	Minimum Engine Speed Setpoint	RPM
FF92	2 Bytes	16	31	Read & Write	Maximum Engine Speed Setpoint	RPM
FF93	2 Bytes	16	31	Read Only	System Voltage (12.5 will read 125)	VDC
	2 Bytes	32	47	Read Only	Actual Engine Oil Pressure	kPa
	2 Bytes	48	63	Read Only	Actual Engine Temperature	Celsius
FF94	4 Bytes	16	47	Read Only	Current Engine Hours	Hours
	2 Bytes	48	63	Read Only	Actual Fuel Level	Percent
FF95	1 Byte	16	23	Read Only	Controller State (Active State: Numeral Indicated)	Numerals
					0 = Stabilize	
					1 = Stopped	
					2 = Standby	
					3 = Prestart 1 Delay	
					4 = Check Safe To Start	
					5 = Prestart 2 Delay	
					6 = Crank	
					7 = Crank Rest	

					8 = False Start Check	
					9 = Engine Warmup	
					10 = Line Fill 1	
					11 = Line Fill 2	
					12 = Running Loaded	
					13 = Engine Cooldown	
					14 = Energize to Stop	
					15 = Spindown	
					16 = Wait to Start	
	2 Bytes	24	39	Read Only	Controller State Timer	Seconds
FF96	1 Bit	16	16	Read & Write	Communication Engine Start/Stop Auto Mode Only (Stop = 0, Start = 1)	(0 or 1)
FF97	1 Bit	16	16	Read & Write	Auto/Manual Mode (Manual = 0, Auto = 1)	(0 or 1)
FF98	1 Bit	17	17	Read & Write	Manual Only (Manual Only Active = 1, Auto and Manual = 0)	(0 or 1)
FF99	1 Bit	18	18	Read & Write	Prestart 1 Auto Only (Prestart Auto Only = 1, Prestart Auto & Manual = 0)	(0 or 1)
FF9A	1 Bit	19	19	Read & Write	Prestart 2 Auto Only (Prestart Auto Only = 1, Prestart Auto & Manual = 0)	(0 or 1)
FF9B	2 Bytes	16	31	Read & Write	Running Loaded Speed in Auto Setpoint	RPM
FF9C	2 Bytes	16	31	Read Only	Active Discharge Pressure	kPa
FF9D	2 Bytes	16	31	Read & Write	Pressure Engine Start (Auto)	kPa
FF9E	2 Bytes	16	31	Read & Write	Pressure Engine Stop (Auto)	kPa
FF9F	2 Bytes	16	31	Read & Write	Pressure Maintain Value (Auto)	kPa
FFA0	1 Byte	16	23	Read & Write	Pressure Maintain Deadband (Auto)	kPa
FFA1	2 Bytes	16	31	Read Only	Actual System Level	Feet
FFA2	2 Bytes	16	31	Read & Write	System Level Engine Start (Auto)	Feet
FFA3	2 Bytes	16	31	Read & Write	System Level Engine Stop (Auto)	Feet
FFA4	2 Bytes	16	31	Read & Write	System Level Maintain Value (Auto)	Feet
FFA5	1 Byte	16	23	Read & Write	System Level Deadband (Auto)	Feet
FFA6	2 Bytes	16	31	Reserved	Reserved	Reserved
FFA7	2 Bytes	16	31	Reserved	Reserved	Reserved
FFA8	2 Bytes	16	31	Reserved	Reserved	Reserved
FFA9	2 Bytes	16	31	Reserved	Reserved	Reserved
FFAA	1 Byte	16	23	Reserved	Reserved	Reserved
FFAB	2 Bytes	16	31	Read Only	Actual Ambient Temp	Celsius
FFAC	2 Bytes	16	31	Read & Write	Ambient Temperature Engine Start (Auto)	Celsius
FFAD	2 Bytes	16	31	Read & Write	Ambient Temperature Engine Stop (Auto)	Celsius
FFAE	4 Bytes	16-48		Active Warning Status (Active Fault: Bit = 1, Inactive: Bit = 0)		
		16	16	Read Only	Low Fuel Warn	(0 or 1)
		17	17	Read Only	Fuel Leak Warn	(0 or 1)
		18	18	Read Only	Fuel Filter Restriction Warn	(0 or 1)
		19	19	Read Only	Low Lube Level Warn	(0 or 1)
		20	20	Read Only	Low Coolant Level Warn	(0 or 1)
		21	21	Read Only	Water in Fuel Warn	(0 or 1)
		22	22	Read Only	No Flow Warn	(0 or 1)

		23	23	Read Only	High Engine Oil Temp Warn	(0 or 1)
		24	24	Read Only	Low Oil Pressure Warn	(0 or 1)
		25	25	Read Only	High Engine Temp Warn	(0 or 1)
		26	26	Read Only	High Discharge Pressure Warn	(0 or 1)
		27	27	Read Only	Low Discharge Pressure Warn	(0 or 1)
		28	28	Read Only	High Suction Warn	(0 or 1)
		29	29	Read Only	Low Suction Warn	(0 or 1)
		30	30	Read Only	High Level Warn	(0 or 1)
		31	31	Read Only	Low Level Warn	(0 or 1)
		32	32	Read Only	High Flow Warn	(0 or 1)
		33	33	Read Only	Low Flow Warn	(0 or 1)
		34	34	Reserved	Reserved	Reserved
		35	35	Reserved	Reserved	Reserved
		36	36	Read Only	Low Gear Box Pressure Warn	(0 or 1)
		37	37	Read Only	High Gear Box Pressure Warn	(0 or 1)
		38	38	Reserved	Reserved	Reserved
		39	39	Reserved	Reserved	Reserved
		40	40	Reserved	Reserved	Reserved
		41	41	Read Only	Low Engine Temp Warn	(0 or 1)
		42	42	Reserved	Reserved	Reserved
		43	43	Reserved	Reserved	Reserved
		44	44	Read Only	Run To Destruct Warn	(0 or 1)
		45	45	Read Only	Battery High Warn	(0 or 1)
		46	46	Read Only	Battery Low Warn	(0 or 1)
		47	47	Read Only	Amber Lamp Status	(0 or 1)
		48	48	Read Only	Pivot Alignment Warn	(0 or 1)
FFAF	4 Bytes	16-49		Active Shutdown Status (Active Fault: Bit = 1, Inactive: Bit = 0)		
		16	16	Read Only	Overspeed SD	(0 or 1)
		17	17	Read Only	Underspeed SD	(0 or 1)
		18	18	Read Only	Overcrank SD	(0 or 1)
		19	19	Read Only	Low Oil Pressure SD	(0 or 1)
		20	20	Read Only	High Engine Temp SD	(0 or 1)
		21	21	Read Only	Low Fuel SD	(0 or 1)
		22	22	Read Only	Low Discharge Pressure SD	(0 or 1)
		23	23	Read Only	High Discharge Pressure SD	(0 or 1)
		24	24	Read Only	Speed Signal Lost SD	(0 or 1)
		25	25	Read Only	Low Lube Level SD	(0 or 1)
		26	26	Read Only	Fuel Leak SD	(0 or 1)
		27	27	Read Only	Fuel Filter Restriction SD	(0 or 1)
		28	28	Reserved	Reserved	Reserved
		29	29	Reserved	Reserved	Reserved
		30	30	Reserved	Reserved	Reserved
		31	31	Read Only	Remote Stop SD	(0 or 1)
		32	32	Read Only	Coolant Level SD	(0 or 1)
		33	33	Read Only	High Level SD	(0 or 1)
		34	34	Read Only	Low Level SD	(0 or 1)
		35	35	Read Only	High Flow SD	(0 or 1)
		36	36	Read Only	Low Flow SD	(0 or 1)

		37	37	Reserved	Reserved	Reserved
		38	38	Reserved	Reserved	Reserved
		39	39	Read Only	Water in Fuel SD	(0 or 1)
		40	40	Read Only	Low Suction SD	(0 or 1)
		41	41	Read Only	High Suction SD	(0 or 1)
		42	42	Reserved	Reserved	Reserved
		43	43	Read Only	High Engine Oil Temp SD	(0 or 1)
		44	44	Read Only	Low Gear Box Pressure SD	(0 or 1)
		45	45	Read Only	High Gear Box Pressure SD	(0 or 1)
		46	46	Reserved	Reserved	Reserved
		47	47	Read Only	Red Lamp Status	(0 or 1)
		48	48	Reserved	Reserved	Reserved
		49	49	Read Only	Pivot Alignment SD	(0 or 1)
FFB0	2 Bytes	16	31	Read Only	Service Reminder - Air Filter Life	Hours
	2 Bytes	32	47	Read Only	Service Reminder – Air Filter Life Remaining	Hours
FFB1	2 Bytes	16	31	Read Only	Service Reminder – Battery Life	Hours
	2 Bytes	32	47	Read Only	Service Reminder – Battery Life Remaining	Hours
FFB2	2 Bytes	16	31	Read Only	Service Reminder – Belt Life	Hours
	2 Bytes	32	47	Read Only	Service Reminder – Belt Life Remaining	Hours
FFB3	2 Bytes	16	31	Read Only	Service Reminder – Fuel Filter Life	Hours
	2 Bytes	32	47	Read Only	Service Reminder – Fuel Filter Life Remaining	Hours
FFB4	2 Bytes	16	31	Read Only	Service Reminder – Oil Filter Life	Hours
	2 Bytes	32	47	Read Only	Service Reminder – Oil Filter Life Remaining	Hours
FFB5	2 Bytes	16	31	Read Only	Service Reminder – Oil Life	Hours
	2 Bytes	32	47	Read Only	Service Reminder – Oil Life Remaining	Hours
FFB6	2 Bytes	16	31	Read Only	Service Reminder – Overhaul Life	Hours
	2 Bytes	32	47	Read Only	Service Reminder – Overhaul Life Remaining	Hours
FFB7	1 Byte	16	23	Read Only	All Purpose Autostart Function (Current Function = Numeral Indicated)	Numerals
					0 = Single Contact	
					1 = Local Start Button	
					2 = Two Contact Maintained	
					3 = Reserved	
					4 = Pressure Transducer	
					5 = Level Transducer	
					6 = Reserved	
FFB8	1 Byte	16	23	Read Only	Version.App.1	Numerals
	1 Byte	24	31	Read Only	Version.App.2	Numerals
	2 Bytes	32	47	Read Only	Version.App.3	Numerals
	1 Byte	48	55	Read Only	Version.App.4	Numerals
FFB9	1 Byte	16	23	Read Only	Version.Config.1	Numerals
	1 Byte	24	31	Read Only	Version.Config.2	Numerals
	2 Bytes	32	47	Read Only	Version.Config.3	Numerals
FFBA	4 Bytes	16	47	Read Only	Reserved	Reserved

FFBB	1 Bit	16	16	Read & Write	CAN Map EEPROM Values Save (Save = 1)	(0 or 1)
	1 Bit	17	17	Read Only	CAN Map EEPROM Values Saved Confirmation (Saved = 1)	(0 or 1)
FFBC	1 Bit	16	16	Read & Write	Remote Alarm Acknowledgement	(0 or 1)

Supplementary Information

Passcodes

The MPC-10 & TEC-10 controllers house three levels of passcode protection. This feature allows the OEM, technician or owner to set desired menu parameters to be shown and changed only by selected operators. The three levels are low security, medium security and high security. The default passcodes can easily be changed via the PC Configuration Software (also known as PowerVision for Controllers). Refer to the Glossary section of this manual to know which parameters are set to low, medium and high by default.

Low Security: allows operators to see the lowest security level menus items as set in PowerVision for Controllers. This can be thought to be a user level menu where only particular items such as the warm-up delay times and cool-down delay times are able to be shown and altered. This will keep the user from getting confused in the menu and changing parameters they shouldn't change.

Medium Security: allows operators to see the low and medium security level menus items as set in PowerVision for Controllers. This security can be thought to be a technician level where more access is needed for other critical items in the menu but not necessarily the items like engine manufacturer and Engine Emissions Tier Rating.

High Security: allows operators to see the low, medium and high security level menus items as set in PowerVision for Controllers. This level of security can be thought to be an OEM level where the entire menu is present and is able to be changed. This security level allows the OEM full access to every menu item while setting up the controller for a particular engine and/or application where the OEM may not want the user to have access.

PC Configuration Software

PowerVision for Controllers (PC Configuration Software)

The MPC-10 / TEC-10 controller is released utilizing Enovation Controls' PowerVision Configuration Studio®. PowerVision allows engineering the ability to deliver quicker software updates with the flexibility of a software developer's environment. The addition of PowerVision gives Enovation Controls the ability to provide a free-of-charge basic PC configuration program (PowerVision for Controllers) to all customers for changing default parameters within the controller.

PowerVision for Controllers allows fast changes of default menu settings, customer splash screen, parameters in the 4-up gauges screens, security levels, and text strings within the controller for a ready to load and go setup. PowerVision for Controllers is available via download from our support website.
Login or Register for an Account to Access Downloads

Customers requiring a software developer's environment for changing or adding further functionality into the controller may do so in their own time without waiting or paying non-recurring engineering fees (also referred to as NRE) to make changes. This developer's environment is PowerVision Configuration Studio® and requires purchase of the software license from Enovation Controls. PowerVision Configuration Studio® allows custom software changes to almost all aspects of the controller from languages, screen layouts, text

strings, Modbus communications, CAN communications, IO, faults, state machines, activity diagrams (visual scripting), and menu building to name a few.

MPC-10 Specifications

Interface

Display:
Monochrome HR-TFT, 2.7 in. / 68mm, WQVGA (400 x 240 pixels)
(3) LEDs**:** green (mode), yellow (warning) and red (shutdown)
Operator controls:
(11) Raised silicon keypads, tactile feedback

Power Supply

Operating Voltage: 8-32 VDC, reverse battery polarity and load-dump protected
Cranking Power Holdup: 0 VDC up to 50mS (also good for brownout/blackout instances)
Power Consumption:
18W max without two 1A High-side FETs active,
146W max with two 1A High-side FETs active

Inputs

(5) Digital, configurable (active on High, Low, Open)
(3) Analog, configurable (4-20mA, 0-5V, resistive or digital ground)
(1) Frequency, supporting:
Magnetic Pickup (30 Hz – 10 kHz, 2.0 VAC – 120 VAC) &
Engine Alternator (30 Hz – 10 kHz, 4.5 VRMS – 90 VRMS)

Outputs

(3) Relay, Form C (dry / volt-free), 10A
(2) Low-side FET (-DC), 1A
(2) High-side FET (+DC), 1A
(1) Dedicated Alternator Excitation, +DC, 1A

Communications

(1) CAN: J1939
(1) RS485: Modbus RTU
(1) USB: 2.0B (Supported for quick Programming)

Mating Connectors

12 Position, DT06-12SA PO12 (Gray)
12 Position, DT06-12SB-PO12 (Black)
12 Position, DT06-12SC-PO12 (Green)

Physical / Environmental

Enclosure Material: Polycarbonate / ABS
Dimensions (WxHxD): 9.59 x 7.34 x 5.20 in. (243.48 x 186.5 x 132.23 mm)
Weight: 4 lbs (1.8 kg)
IP Rating: IP69K & IP67 front and back, IP66 panel seal when used with accessory gasket
Operating & Storage Temperature: -40° to +85° C (-40° to +185° F)
Vibration: 7.86 Grms (5-2000 Hz), 3-axis random
Shock: ±50G, 3 axis
Emissions & Immunity: SAE J1113, 2014/30/EU & 2014/35/EU

TEC-10 Specifications

Interface

Display:
- Monochrome HR-TFT, 2.7 in. / 68mm, WQVGA (400 x 240 pixels)
- (3) LEDs**:** green (mode), yellow (warning) and red (shutdown)

Operator controls:
- (11) Raised silicon keypads, tactile feedback
- (1) Keyed Rotary switch, power on/off
- (1) Push-switch (red), engine stop

Power Supply

Operating Voltage: 8-32 VDC, reverse battery polarity and load-dump protected
Cranking Power Holdup: 0 VDC up to 50mS (also good for brownout/blackout instances)
Power Consumption:
- Power on in stopped state; 117 mA at 12 VDC,
- Power on in standby mode; 52 mA at 12 VDC

Inputs

(5) Digital, configurable (active on High, Low, Open)
(3) Analog, configurable (4-20mA, 0-5V, resistive or digital ground)
(1) Frequency, supporting:
- Magnetic Pickup (30 Hz – 10 kHz, 2.0 VAC – 120 VAC) &
- Engine Alternator (30 Hz – 10 kHz, 4.5 VRMS – 90 VRMS)

Outputs

(2) Relay, switched +DC, 10A
(1) Relay, Form C (dry / volt-free), 10A
(2) Low-side FET (-DC), 1A
(2) High-side FET (+DC), 1A
(1) Dedicated Alternator Excitation, +DC, 1A

Communications

(1) CAN: J1939
(1) RS485: Modbus RTU

Mating Connectors

21 Position, Deutsch HDP26-24-21SE,
31 Position, Deutsch HDP26-24-31SE

Physical / Environmental

Enclosure Material: Polycarbonate / ABS
Dimensions (WxHxD): 9.59 x 7.34 x 5.20 in. (243.48 x 186.5 x 132.23 mm)
Weight: 4 lbs (1.8 kg)
IP Rating: IP67
Operating & Storage Temperature: -40° to +85° C (-40° to +185° F)
Vibration: 7.86 Grms (5-2000 Hz), 3-axis random
Shock: ±50G, 3 axis
Emissions & Immunity: SAE J1113, 2014/30/EU & 2014/35/EU

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Software Release: [App: 02.09.10051.00; Config: 2.9.20023; PowerVision Configuration Studio Version: 2.9.23029; BTL: 02.09.10015.00]

ENOVATION CONTROLS CORPORATE HEADQUARTERS
5311 S 122ND EAST AVENUE
TULSA, OK 74146

ENOVATION CONTROLS LTD. – UNITED KINGDOM
CHURCH ROAD LAVERSTOCK
SALISBURY SP1 1QZ UK

SUN MURPHY INTERNATIONAL TRADING (SHANGHAI) CO., LTD
B15 ROOM, 6# BUILDING, 351 SIZHUAN ROAD
SONGJIANG DISTRICT, SHANGHAI 201601, CHINA

ENOVATION CONTROLS INDIA PVT. LTD.
301, 3RD FLOOR, KRSNA CHAMBERS,
11 GALAXY GARDENS, NORTH MAIN ROAD,
KOREGAON PARK, PUNE 411001,
MAHARASHTRA, INDIA

U.S. SALES & SUPPORT

PHONE: 918 317 4100
EMAIL: SALES@ENOVATIONCONTROLS.COM
WWW.ENOVATIONCONTROLS.COM

MURPHY INDUSTRIAL PANEL DIVISION
PHONE: 918 317 4100
EMAIL: IPDSALES@ENOVATIONCONTROLS.COM

INTERNATIONAL SALES & SUPPORT

EUROPE, MIDDLE EAST, AFRICA
PHONE: +44 1722 410055
EMAIL: SALES@ENOVATIONCONTROLS.EU

CHINA
PHONE: +86 21 6237 5885
EMAIL: APSALES@ENOVATIONCONTROLS.COM

INDIA
PHONE: +91 91581 37633
EMAIL: INDIASALES@ENOVATIONCONTROLS.COM

FM 28221 (Tulsa, OK - USA)
FM 29422 (UK)

APPENDIX D

SEAMTERICS FLOWMETER OPERATIONS AND MAINTENANCE MANUAL

iMAG 4700

Municipal/Industrial Magmeter Instructions

Seametrics
Precision Flow Measurement
An ONICON Brand

PROUDLY MADE IN THE USA

ISO 9001

General Information

Installation

Connections

Configuration

Operation

Troubleshooting & Error Messages

Warranty

Note: These instructions cover the iMAG 4700. For details on the iMAG 4700p or 4700r, see the *iMAG 4700p* or *iMAG 4700r Municipal/Industrial Magmeter Instructions*.

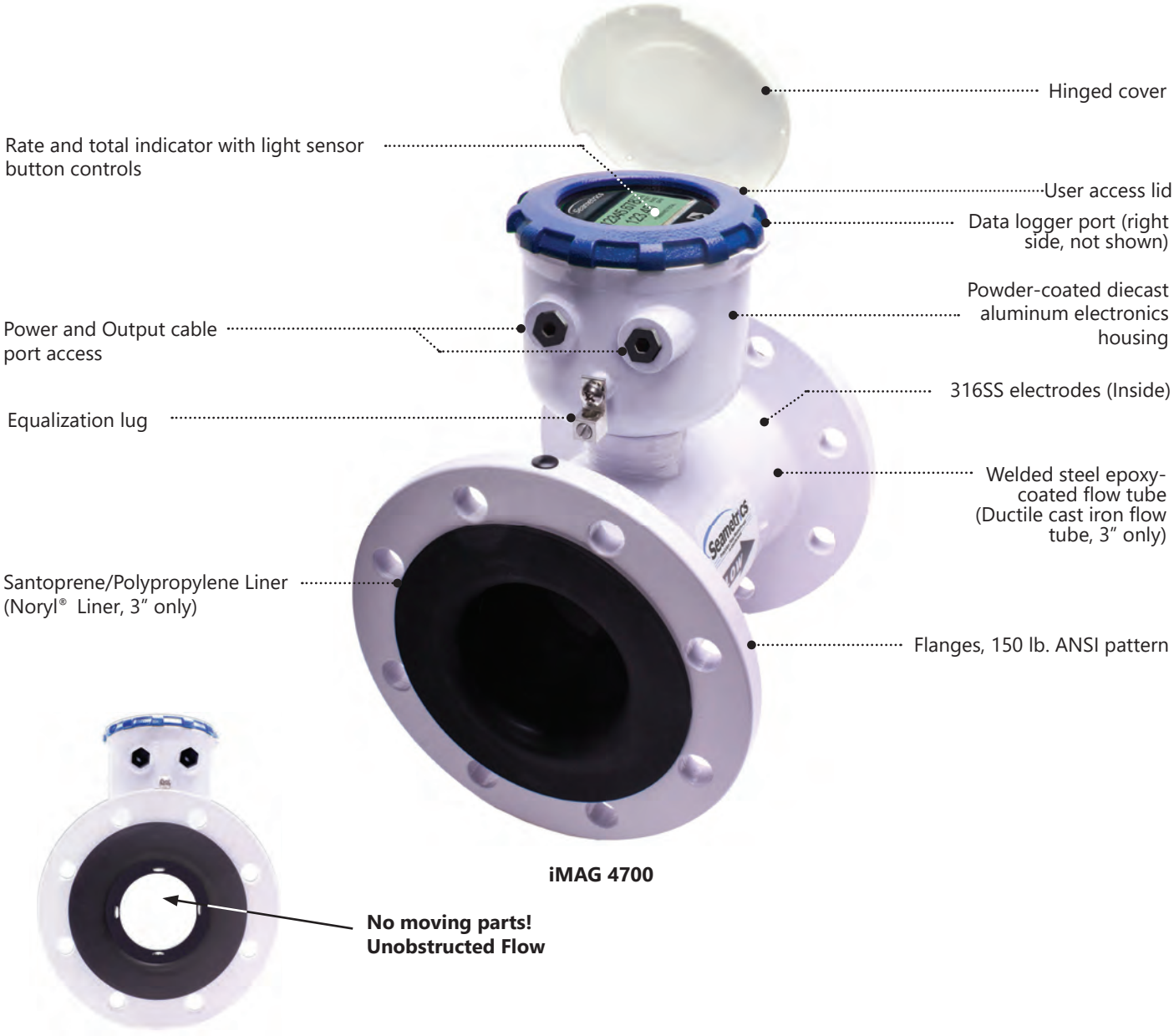
The **iMAG-Series** is the most economical flanged electromagnetic flowmeter on the market. With electrodes designed to discourage fouling, it is available in 3" to 12" pipe in municipal or industrial water, waste and reclaimed water, pump stations, and packaged plant applications. Minimal straight pipe requirements allow iMAG-Series meters to be used in piping configurations where there is little space between the meter and an elbow.

iMAG-Series meters are CE certified, certified to NSF/ANSI standard 61 and are rated IP68 for applications where the meter may be operated under water to a depth of at least 10 feet (3 meters) continuously.

Rate and total units and pulse scaling can be set via the front panel touch key pad by the user. Bidirectional flow reading is standard with totals available in forward, reverse, net flow, batch forward flow, and batch reverse flow. Batch totals can be reset.

A power/output cable allows outputs for use with a variety of Seametrics and other displays and controls for remote reading and telemetry applications. Pulse output is standard on all models. In addition, 4-20mA passive current loop, HART protocol, high speed digital, and Modbus® protocol outputs are optional on the externally powered units, depending on model.

Features



iMAG 4700

Specifications*

Pipe Sizes		3", 4", 6", 8", 10", 12"				
Flanges		150 lb. ANSI Pattern				
Pressure		150 psi (10.3 bar) line pressure				
Temperature	**Operating**	10˚ to 140˚ F (-12˚ to 60˚ C)				
	Storage	-40˚ to 158˚ F (-40˚ to 70˚ C)				
Accuracy		±0.75% of reading on iMAG 4700p and 4700r (±1.0% iMAG 4700), ±0.025% of full-scale flow from low flow cutoff to maxi. flow rate of 10 m/sec				
Low Flow Cutoff		0.5% of maximum flow rate				
Material	**Body** *(3" only)*	Ductile cast iron, powder coated				
	Body *(4"-12")*	Welded steel, epoxy-coated				
	Liner *(3" only)*	Noryl®				
	Liner *(4"-12")*	Santoprene flange/Polypropylene liner body				
	Electronics Housing	Powder-coated diecast aluminum				
	Electrodes	316 stainless steel				
	O-ring (3" only)	EPDM				
Display	**Type**	128x64 dot-matrix LCD				
	Digits	5 Digit Rate			8 Digit Total	
	Units *Please Note: All iMAG meters are factory set for gallons per minute (GPM) rate and gallons total. If other units are required, they can be set in the field.*	Rate Volume Units		Rate Time Units	Total Volume Units	
		Gallons Liters Barrels(42 gal) Cubic Feet Cubic Meters	Million Gallons[2] Mega Liters[2] Imperial Gallons Million Imperial Gallons[2]	Second Minute Hour Day	Gallons Gallons x 10 Gallons x 100 Gallons x 1000 Million Gallons Liters Kilo Liters Mega Liters	Barrels (42 gal) Cubic Meters Cubic Meters x 1000 Cubic Feet Cubic Feet x 1000 Second Foot Day Million Cubic Feet	Acre Feet Acre Inches Imperial Gallons Imperial Gallons x 1000 Million Imperial Gallons Fluid Ounces
	Bidirectional[1]	Forward Total, Reverse Total, Net Total, Batch Forward Total, Batch Reverse Total (Batch totals can be reset)				
Power	**DC Power**	9-36 Vdc @ 250 mA max, 30 mA average				
	Battery Backup **(Not for use as primary power)**	DC powered units: Two lithium 3.6V 'D' batteries, replaceable. AC powered units: One 9V alkaline battery, replaceable.				
	AC Power *(iMAG 4700r and 4700p only)*	85-264Vac, 50/60Hz, 0.12A				
	Battery *(iMAG 4700 only)*	One lithium 7.2V 'D' size battery pack, replaceable.				
Scaled Pulse Output	**Signal**	Current sinking pulse, isolated, 36 Vdc at 10 mA max				
	Pulse Rates	User-scalable from 0.1 to 99,999.9 volume units/pulse. Pulse width is one-half of pulse period with minimum pulse width of 2.5 ms, 200 pulses/sec max. For battery option meters, pulse width varies with frequency, 150 pulses/sec max.				
Options	**4-20mA Current Loop**	Isolated, passive, 24Vdc, 650 Ω maximum current loop				
	HART/4-20mA	HART protocol over 4-20mA line				
	High Speed Digital Output *(iMAG 4700 & 4700p only)*	Isolated, open collector, 24 Vdc				
	Serial Communications	Isolated, asynchronous serial RS485 (Reconfigurable for RS232 or 3.3V CMOS), Modbus® RTU protocol (factory selectable)				
Cable	**Power/Output Cable**	20ft (6m) standard length polyurethane jacketed cable—for power and outputs (lengths up to 200' available).				
	Remote Display Cable *(iMAG 4700r)*	20ft (6m) standard length polyurethane jacketed cable—for connection between meter and remote display (lengths up to 200' available).				
Conductivity		>20 microSiemens/cm				
Empty Pipe Detection		Hardware/software, conductivity-based				
Regulatory		CE (EN 61326), 4"-12" certified to NSF/ANSI standard 61 60°C (140°F); 3" certified to NSF/ANSI standard 61 Cold Water 23°C (73.4°F)				
Environmental		NEMA 6P, IP68 (10ft (3m) depth, continuously)				

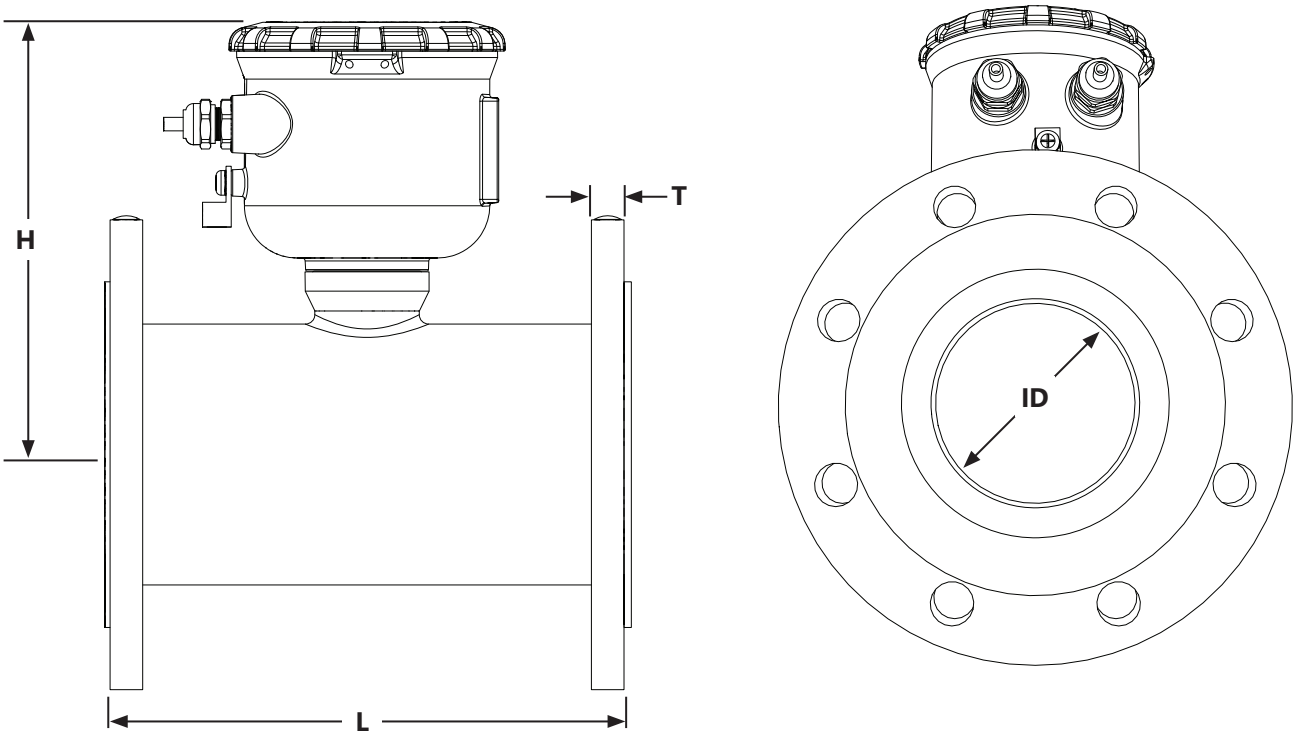
Modbus is a registered trademark of Schneider Electric.

* *Specifications subject to change. Please consult our website for the most current data (www.seametrics.com).*

[1] *If forward and reverse flow data needs to be sent to another device, either the Digital or Modbus output is required.*

[2] *Rate Time Unit is available in Day only.*

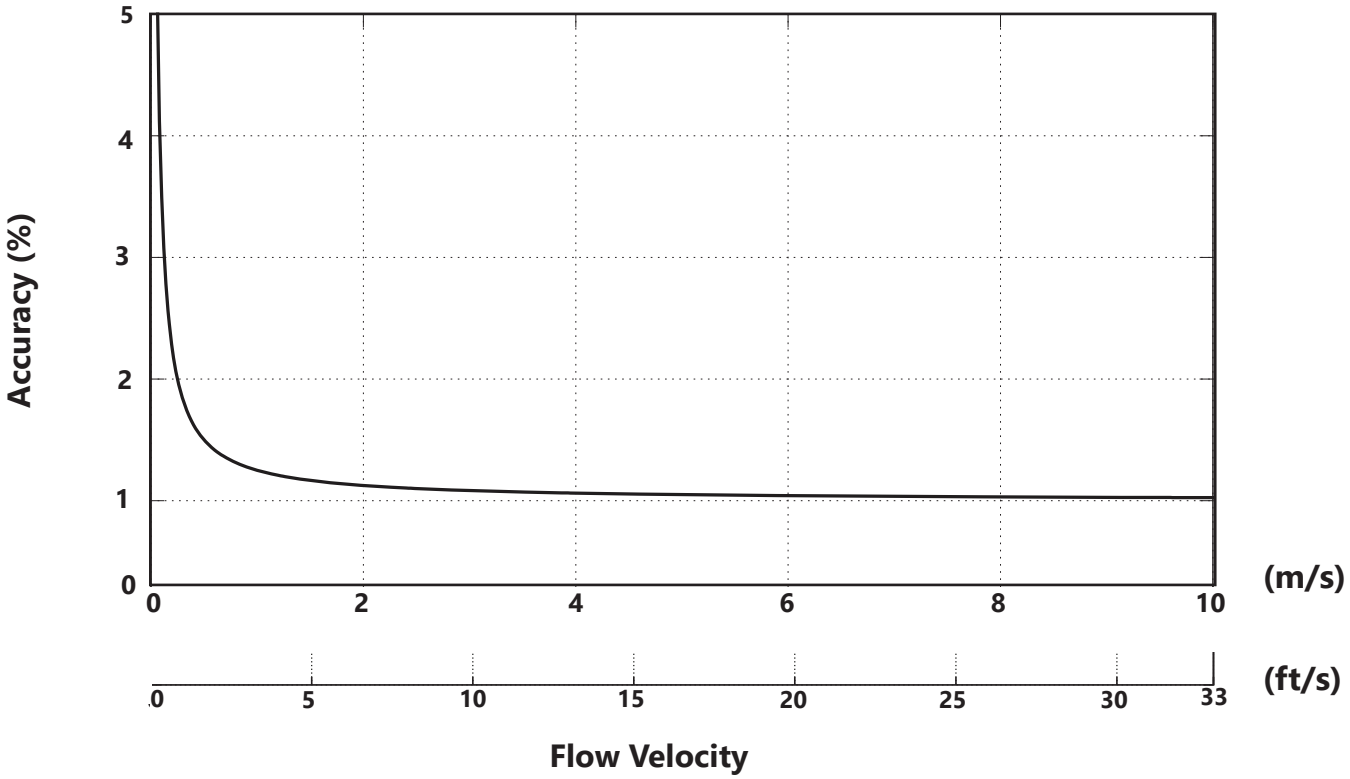
Dimensions



iMAG 4700 Meter Size	L		H		T		ID		Shipping Weight	
	inch	mm	inch	mm	inch	mm	inch	mm	lbs	Kg
3″	12.25	311.15	7.08	179.8	.68	17.25	2.6	66.04	38	17
4″	10.24	260	8.3	211	.62	15.7	3.12	79	33	15
6″	12.27	312	9.1	231	.69	17.5	5.05	128	49	22
8″	14.24	362	10.1	257	.69	17.5	6.44	164	70	32
10″	18.18	462	11.2	284	.69	17.5	8.61	219	130	59
12″	19.68	500	12.2	310	.81	20.6	10.55	268	170	77
Flanges	Standard ANSI 150 lb. drilling								Cable 1 lb.	

Install security seal during installation if regulations require.

iMAG Accuracy



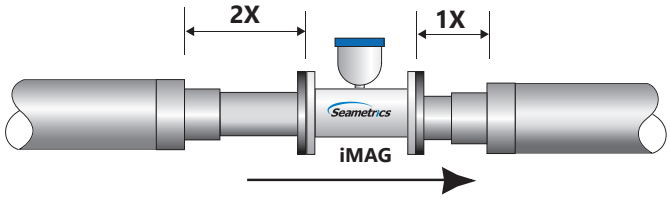
Flow Rate (3″ - 12″)

Pipe Size *(Inches in diameter)*	**3″**	**4″**	**6″**	**8″**	**10″**	**12″**
Max Flow Rate *(Gallons/Minute)*	723	1285	2891	5140	8031	11565
Cut-off (min) Flow Rate *(Gallons/Minute)*	3.62	6.43	14.46	25.70	40.15	57.82
Max Flow Rate *(Liters/Second)*	46	81	182	324	507	730
Cut-off (min) Flow Rate *(Liters/Second)*	0.23	0.41	0.91	1.62	2.54	3.65
Max Flow Velocity *(Meters/Second)*	10	10	10	10	10	10

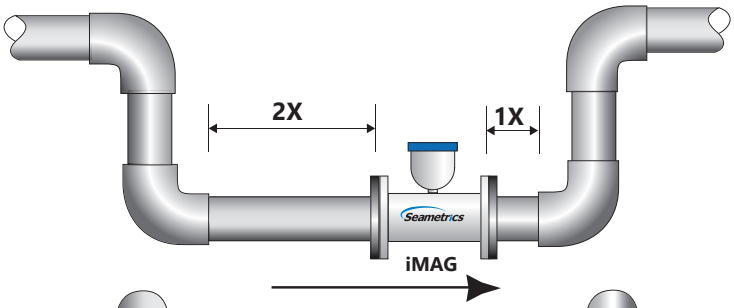
Straight Pipe Recommendations (X = diameter)

NOTE: These configurations are to be used as general guidelines and do not cover every possible installation. A combination of two or more obstructions will require additional straight pipe. If there is any concern about the length of pipe required for a specific application, please contact your local dealer.

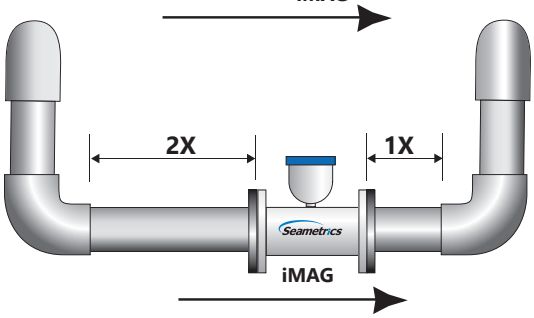
Reduced Pipe



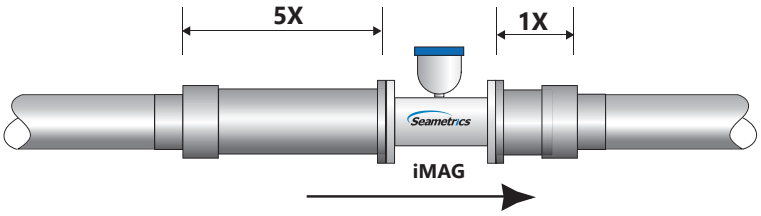
Two Elbows In Plane



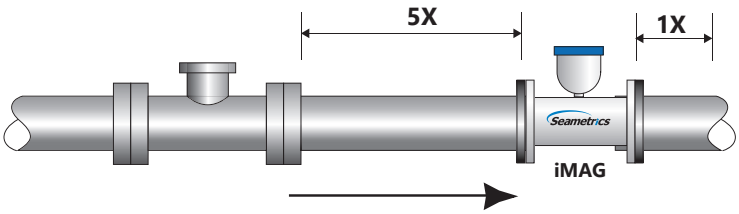
Two Elbows, Out Of Plane



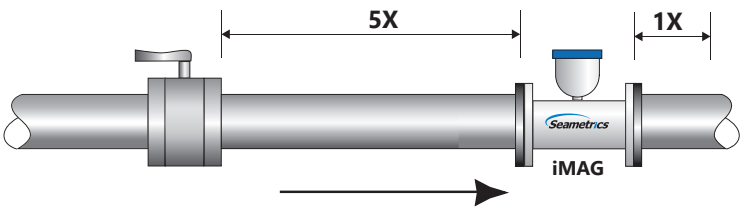
Expanded Pipe



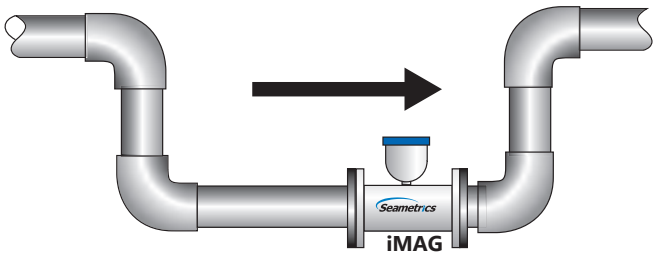
Swirling Flow: Propeller Meter



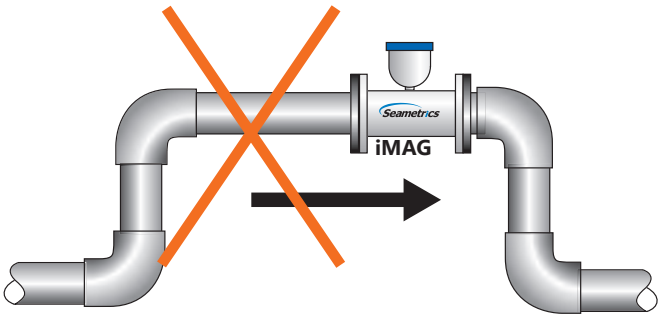
Swirling Flow: Partially Open Butterfly Valve



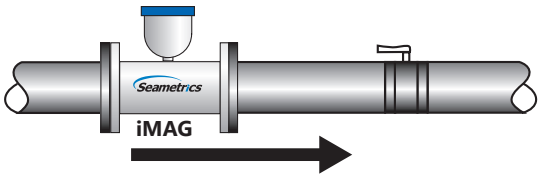
Full Pipe Recommendations



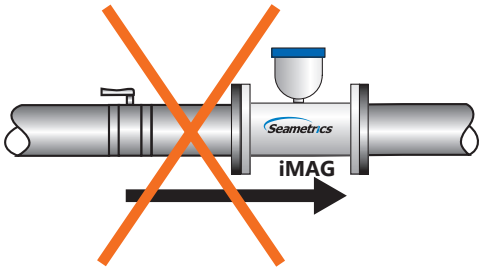
Recommended:
Keep pipe full at meter for accuracy



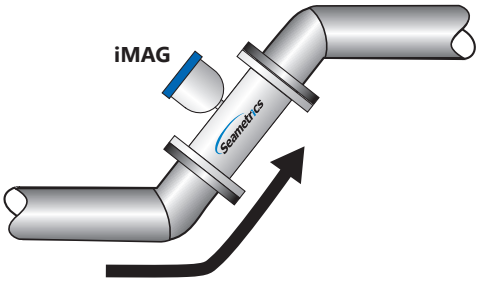
Not Ideal:
Allows air pockets to form at meter



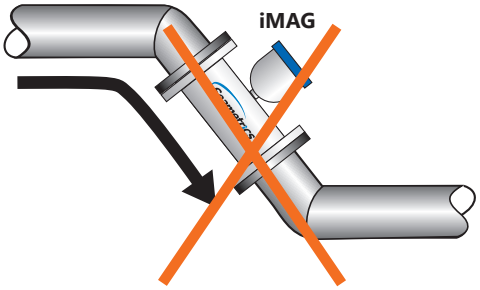
Recommended:
Keeps pipe full at meter for accuracy



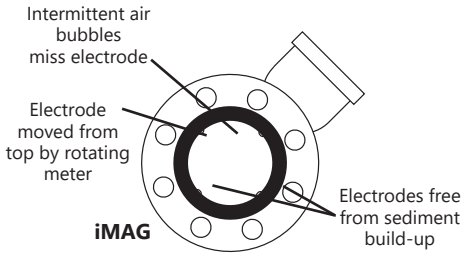
Not Ideal:
Post-valve cavitation can create air pocket



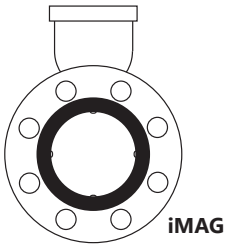
Recommended:
Allows air to bleed off



Not Ideal:
Air can be trapped



Recommended:
Improved accuracy results from unimpeded electrodes



Not Ideal:
Air bubbles and sediment on the electrodes can affect accuracy

Positioning the Meter

CAUTION: These flow sensors are not recommended where installation may expose the flow sensor to boiler pressure and temperature. Maximum recommended operating temperature is 130˚ F.

These meters can be installed horizontally, vertically (with upward flow), or in any radial position. **Using a check valve on the upstream side of the meter, and/or an air vent (vacuum relief valve) in the same, unobstructed run of pipe as the meter, is required in any installation where the meter may be exposed to suction when the system is not in normal operation. Suction can cause damage to the liner. Liner damage caused by suction, without the use of a check valve and/or air vent, may void the warranty.**

Straight Pipe Recommendations. The iMAG requires straight pipe before and after the meter for best accuracy. However, the ability of electromagnetic meters to average the flow across the entire pipe allows for shorter straight pipe recommendations than most mechanical meters (see page 7).

Full Pipe Recommendations. To prevent false readings, this meter is designed to indicate 'EMPTY PIPE' if one or more electrodes is exposed. For highest accuracy, install the meter so that the pipe will be full when there is flow. If air bubbles may be present in the pipe or sludge accumulation is an issue, rotate the meter by one flange hole to position the control housing at a 45˚ angle (see diagrams on page 8).

Fittings. The iMAG has ANSI 150 lb. drilled flanges and will mate with any other ANSI 150 lb. flanges. *See table on page 10 for flange bolt tightening torque specifications.*

Calibration. The iMAG is factory-calibrated before shipping. The frequency of recalibration will depend on the needs of each application and local regulatory policies.

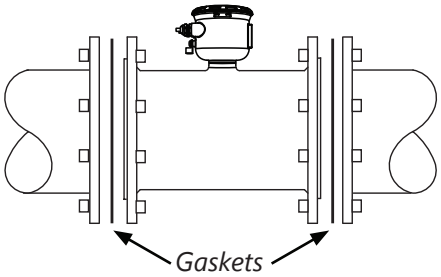
Chemical Injection. When the iMAG is used in a chemical injection application, the chemical injection point must be placed downstream of the magmeter OR far enough upstream for complete mixing to occur before the fluid reaches the meter. When unmixed chemical alternates with water passing through the meter, the rapid changes in conductivity may cause sudden spikes and drops in the meter's reading, resulting in inaccurate measurement. The magmeter will re-stabilize, however, with a steady flow of fluid of uniform conductivity.

CAUTION: In chemical injection applications, install chemical injection point downstream of magmeter, or far enough upstream to allow complete mixing of fluids.

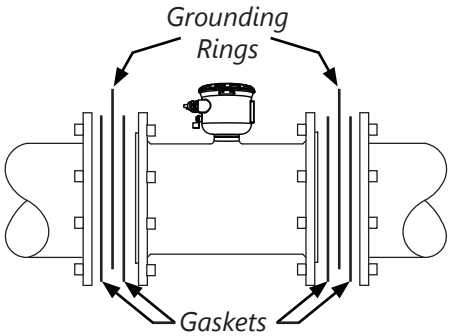
Installing Gaskets

GASKETS
Gaskets are required at all junctions.

1. Be sure all mating surfaces are smooth and free of debris.
2. Install Seametrics provided gaskets, or equivilent, on each end of meter as shown in diagrams below. If using grounding rings, install one gasket on each side of the grounding ring.
3. **Failure to install gaskets will void warranty.**



Installation without grounding rings

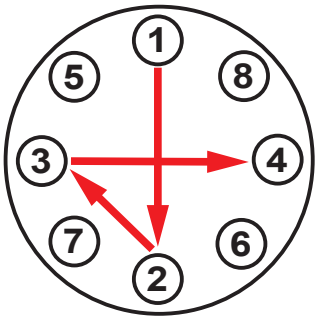


Installation with grounding rings

Tightening Flange Bolts

NOTE: Mating pipe flanges must be ANSI 150# full face (FF) and/or raised face (RF).

1. Tighten flange bolts in an alternating pattern.
   - Tighten left flange bolt-1 to 20% recommended torque.
   - Tighten right flange bolt-1 to 20% of recommended torque.
   - Repeat steps a and b for each bolt in an alternating order, such as shown at right, tightening to 40%, then 60%, then 80%, and then 100%.
2. Test for leaks.
3. If needed, tighten further in 10% increments until leaking stops. **DO NOT over-tighten. Over-tightening can cause serious damage to the flow meter.**
4. Recheck after 24 hours, adjusting if needed.



Suggested Tightening Sequence

Caution: Improper tightening sequence can cause serious damage to the flow meter.
- Do not tighten one side at a time.
- Do not tighten each bolt completely at one time.

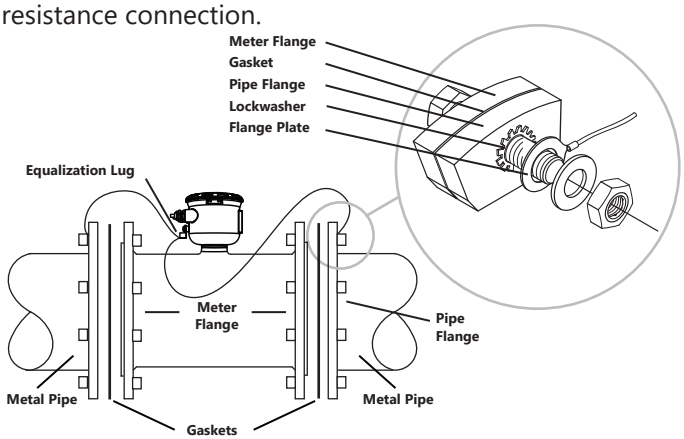
SUGGESTED FLANGE BOLT TORQUE

Pipe Size	Santoprene Liner	
	ft-lb	Nm
3″	25	34
4″	20	27
6″	42	57
8″	65	88
10″	73	99
12″	97	132

Equalization and Grounding

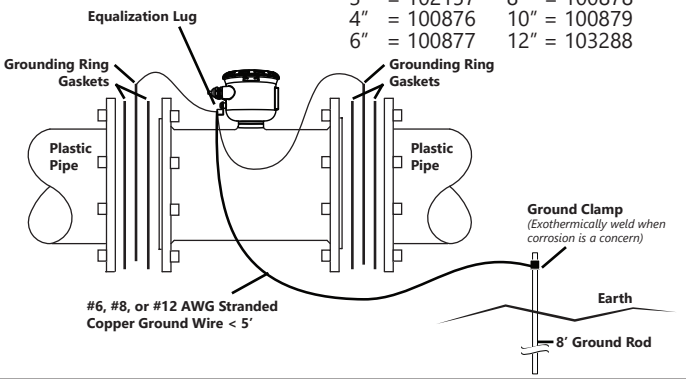
WARNING: ELECTRICAL SHOCK HAZARD
When the iMAG is installed in a plastic piping system, or when externally powered, the piping system must be grounded to meet national and local electrical safety codes. Failure to do so can result in electrocution.

Metal Pipe Installations. To equalize the electrical potential of the fluid, the iMAG meter, and the surrounding pipe, secure the flange plates (factory-installed on the equalization wire) to both pipe flanges at one of the bolt holes, as shown below. Be sure the lock washer fits between the pipe flange and the flange plate. For the best electrical bonding, remove rust and paint to expose clean, bare metal where the equalization flange plate lock washer contacts the pipe flange. Connection must be inspected periodically for corrosion to maintain the necessary low resistance connection.



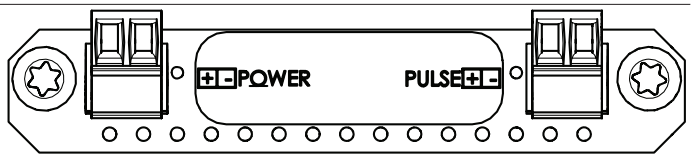
Plastic Pipe and Electronically Noisy Installations. When the iMAG 4700 is installed in plastic pipe or in an electrically noisy system (near a VFD etc.), grounding rings are recommended. As shown in the diagram below, the equalization wires should be solidly connected to the grounding ring tabs instead of the flange bolts as in metal piping installations. Where lightning is a threat, or in severe electrical environments, an optional connection to a nearby equipment ground or ground rod may be advisable.

Grounding Ring Part Numbers:
3″ = 102157 8″ = 100878
4″ = 100876 10″ = 100879
6″ = 100877 12″ = 103288

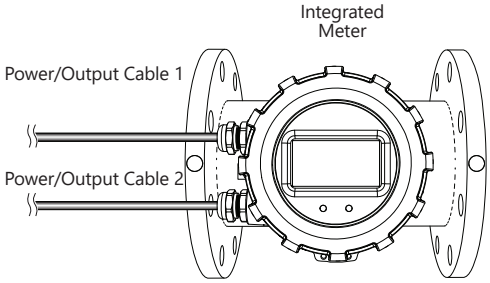


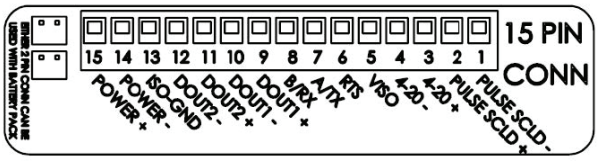
General Cable Information

In the iMAG 4700 meter, there are a maximum of two Power/Output cables that can be installed. These cables contain the wires for DC power and for any output (scaled pulse, 4-20mA, Modbus®, HART, and high speed digital). (See Sample Cable Wiring Diagrams and Cable Wiring Table.) It is up to the user to decide how to best organize the wiring for the application.



Two 2-pin Connectors for iMAG 4700 Battery Version

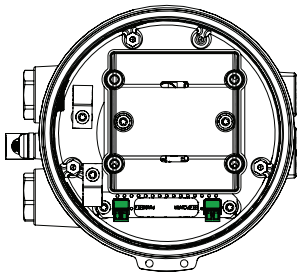




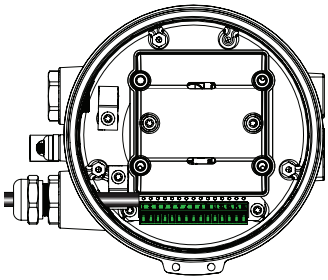
15 Pin Connector for iMAG 4700 DC Versions

The iMAG 4700 is available in either Battery or external DC versions.

Note that when viewing the connectors from the front of the meter, the labels will be upside down with numbering going from left to right.



Battery version with two 2-pin connectors

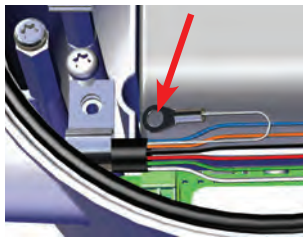


DC version with a 15-pin connector. (Your meter may have one or two cable glands, depending on configuration.)

Cable Gland Opening and Sealing

WARNING: Improper sealing of glands or cables (or direct connection with conduit to meter) will invalidate any warranty. If plugs or cable glands are removed, reinstall using Teflon pipe sealant, or tape, to ensure maximum moisture protection.

Remove plug & o-ring. Insert cable gland/strain relief. Feed cable through cable gland.



Clamp cable with strain relief clips. Attach drain wire lug to bracket post.

CRITICAL!
Torque cable gland sealing nut to 22 in-lbs.

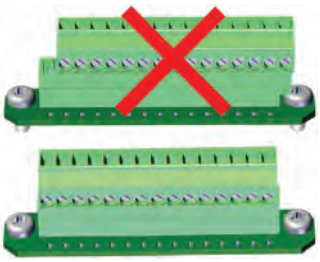
Cable Installation

DC Version or Battery Only Version with external pulse output.

1. Unscrew the display lid and remove it.
2. The display assembly is held in with 3 fasteners. If those fasteners are steel screws (silver) remove them with a T-15 Torx driver and lift the diplay out of the meter. If the fasteners are white Nylon tabs with exposed straight slots, simply grasp the two finger recesses in the display, then pop the diplay up and out of the housing. This will expose the internal connectors. Be sure **NOT** to undo any connections to the display assembly as you remove it.
3. The DC version comes with a 15 pin screw connector. Remove this from its bag. (On the battery version, there are two 2-pin connectors already installed.)
4. Remove the plug and o-ring from the cable port(s) where you want to insert the cable(s).
5. Install cable gland(s) using Teflon pipe sealant, or tape, and insert cable end(s).
6. Strip cable jacket and conductors and install the wires into the connectors in their respective locations for your options, Modbus®, pulse, HART, etc. (See Cable Wiring Table for details.)
7. If using the 15 pin screw connector, plug it into its socket. **Be sure all pins align properly and that the connector has not slipped to one side.**

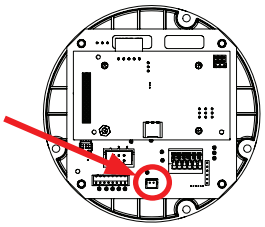
Improper alignment

Proper alignment



8. **Plug the backup battery cable into the circuit board, as shown.** *(DC Version only - Battery version has battery already connected.)*

Battery connection



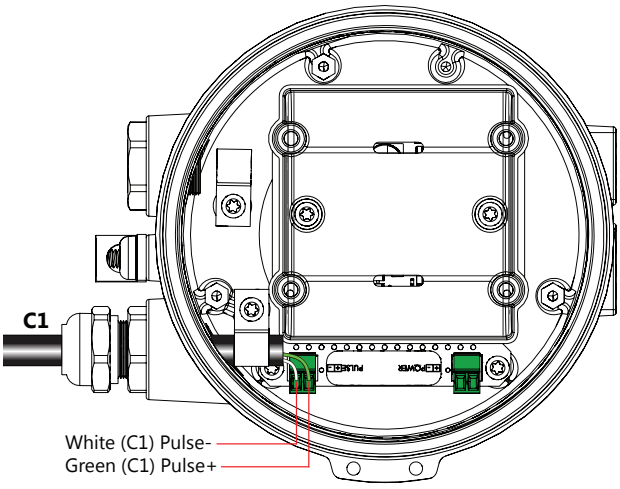
9. Secure the cables inside the internal strain relief clip and tighten the cable gland sealing nut securely. (torque nut to 22 in-lbs.). A loose nut could cause moisture ingress and compromise the meter head's IP68 rating, voiding the warranty.
10. Remount the display assembly, being careful to not pinch any wires, and install the display assembly screws.
11. Reinstall the display lid, being sure to avoid cross-threading the lid.

Battery Only Version with <u>no</u> external pulse output

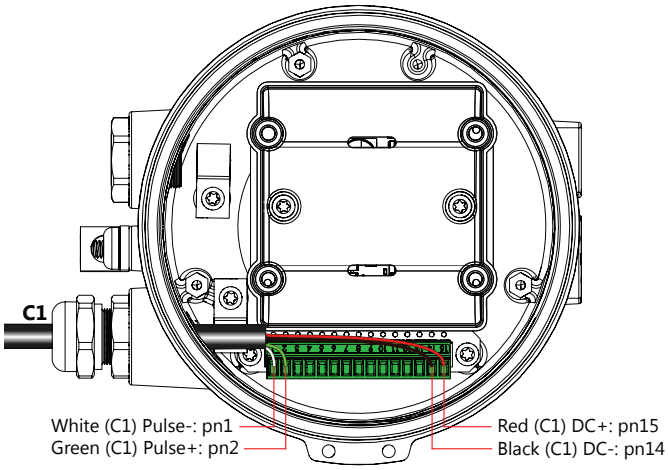
No wiring is needed.

Wiring Diagrams

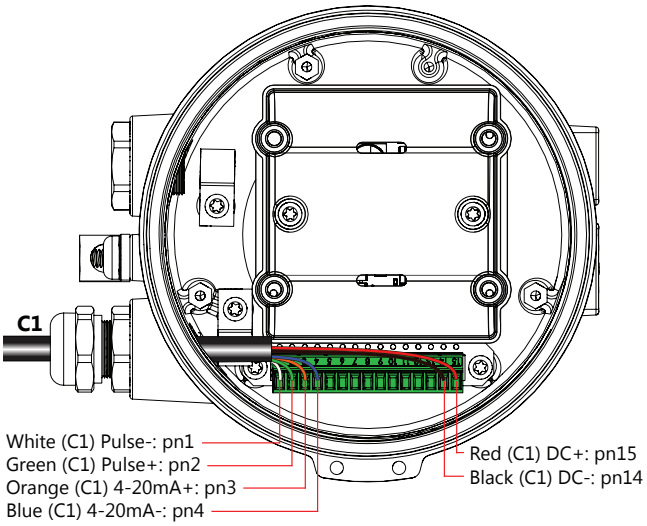
Unscrew the display lid and remove it. The display assembly is held in with 3 fasteners. If those fasteners are steel screws (silver) remove them with a T-15 Torx driver and lift the diplay out of the meter. If the fasteners are white Nylon tabs with exposed straight slots, simply grasp the two finger recesses in the display, then pop the diplay up and out of the housing. Remove the 15 pin screw connector from its bag. Install the wires through the cable glands into the 15 pin screw connector in their respective locations. Plug the 15 pin screw connector into its socket **Be sure all pins align properly and that the connector has not slipped to one side.** *(C1 = power/output cable, C2 = power/output cable 2)*



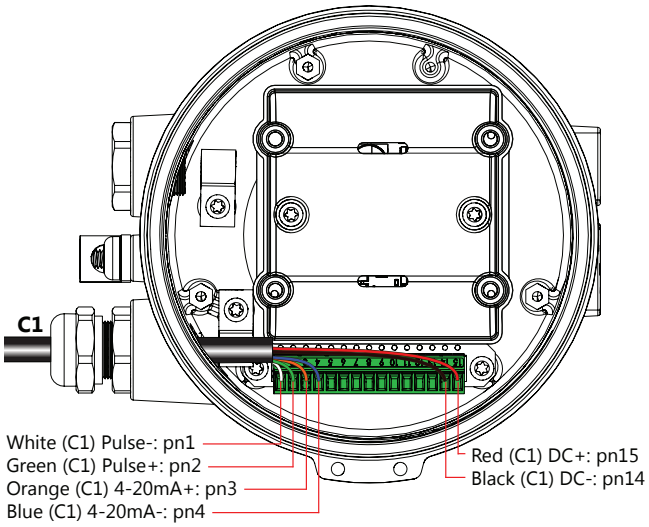
Battery Power with Pulse (BXX)



DC Power with Pulse (D1X/D2X)



DC Power with Pulse and 4-20mA (D1L/D2L)

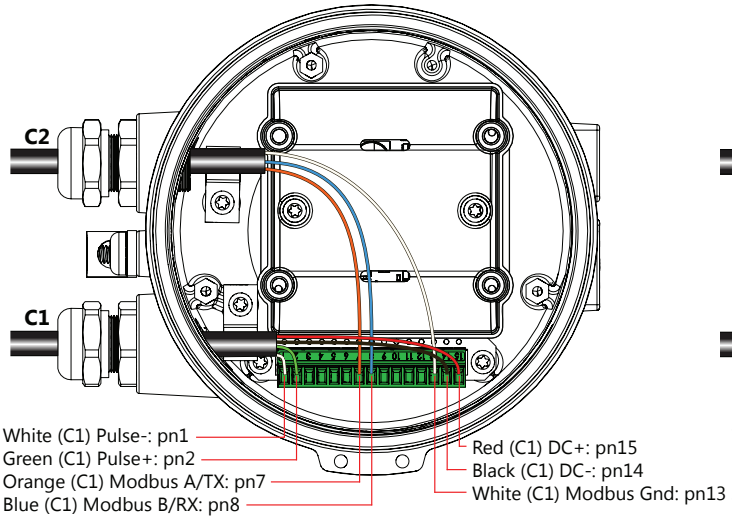


DC Power with Pulse and HART/4-20mA (D1H/D2H)

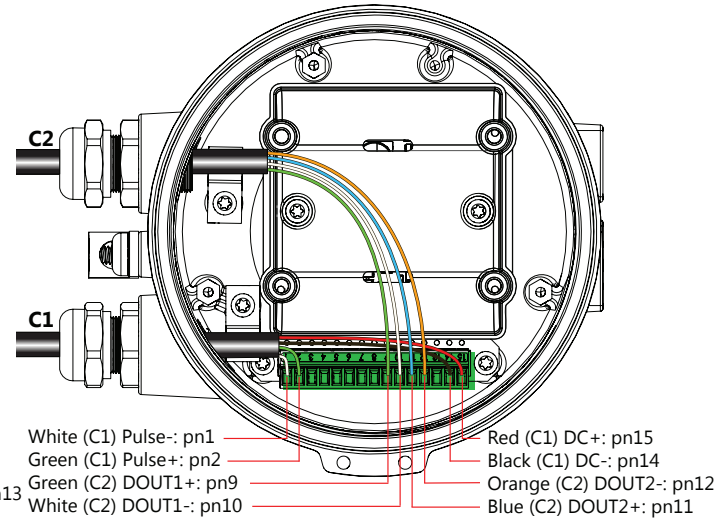
Wiring Diagrams (continued)

Unscrew the display lid and remove it. The display assembly is held in with 3 fasteners. If those fasteners are steel screws (silver) remove them with a T-15 Torx driver and lift the diplay out of the meter. If the fasteners are white Nylon tabs with exposed straight slots, simply grasp the two finger recesses in the display, then pop the diplay up and out of the housing.

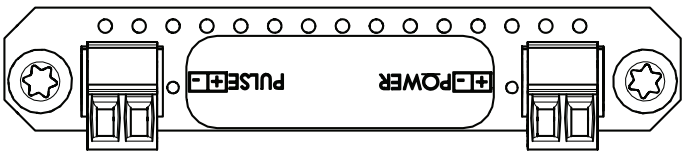
Remove the 15 pin screw connector from its bag. Install the wires through the cable glands into the 15 pin screw connector in their respective locations. Plug the 15 pin screw connector into its socket. *(C1 = power/output cable, C2 = power/output cable 2)*



DC Power with Pulse and Modbus® (D1S/D2S)

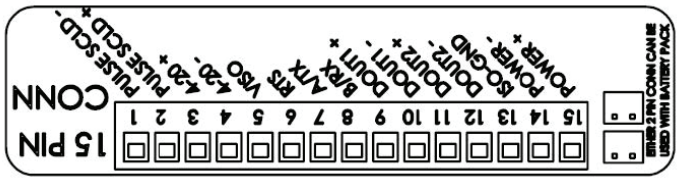


DC Power with Pulse and Digital (D1G/D2G)



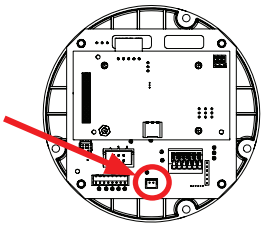
Two 2-pin Connectors for iMAG 4700 Battery Version

Note that when viewing the connectors from the front of the meter, the labels will be upside down, as shown here, with numbering going from left to right.



15 Pin Connector for iMAG 4700 DC Versions

Plug the backup battery cable into the circuit board



WARNING: BACKUP BATTERIES ARE NOT INTENDED AS A PRIMARY POWER SOURCE OF A MAINS (DC or AC) CONFIGURED METER.

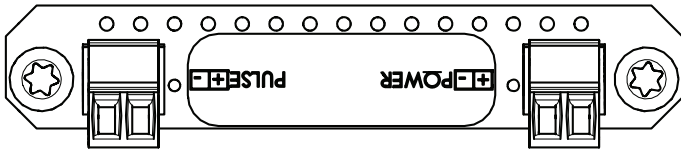
Cable Wiring Table

PIN	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
O ID	**PWR+**	**PWR-**	**ISO-GND**	**DOUT 2-**	**DOUT 2+**	**DOUT 1-**	**DOUT 1+**	**B/RX**	**A/TX**	**RTS**	**VISO**	**4-20 -**	**4-20 +**	**PULSE SCLD+**	**PULSE SCLD-**
BXX														GREEN C1	WHITE C1
D1X/ D2X	RED C1	BLACK C1												GREEN C1	WHITE C1
D1L/ D2L	RED C1	BLACK C1										BLUE C1	ORNG C1	GREEN C1	WHITE C1
D1H/ D2H	RED C1	BLACK C1										BLUE C1	ORNG C1	GREEN C1	WHITE C1
D1S/ D2S	RED C1	BLACK C1	WHITE C2					BLUE C2	ORNG C2					GREEN C1	WHITE C1
D1G/ D2G	RED C1	BLACK C1		ORNG C2	BLUE C2	WHITE C2	GREEN C2							GREEN C1	WHITE C1

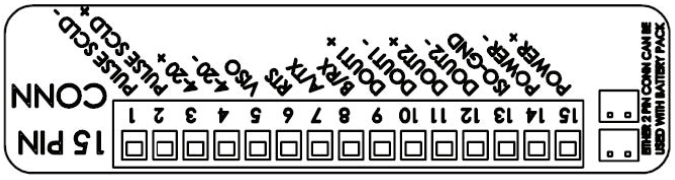
(C1 = power/output cable 1 C2 = power/output cable 2)

Option IDs

O ID		POWER SOURCE / OUTPUT(S)
BXX	=	BATTERY POWER / PULSE SCALED
D1X/D2X	=	DC POWER / PULSE SCALED
D1L/D2L	=	DC POWER / PULSE SCALED AND 4-20mA
D1H/D2H	=	DC POWER / PULSE SCALED AND HART/4-20mA
D1S/D2S	=	DC POWER / PULSE SCALED AND MODBUS®
D1G/D2G	=	DC POWER / PULSE SCALED AND DIGITAL



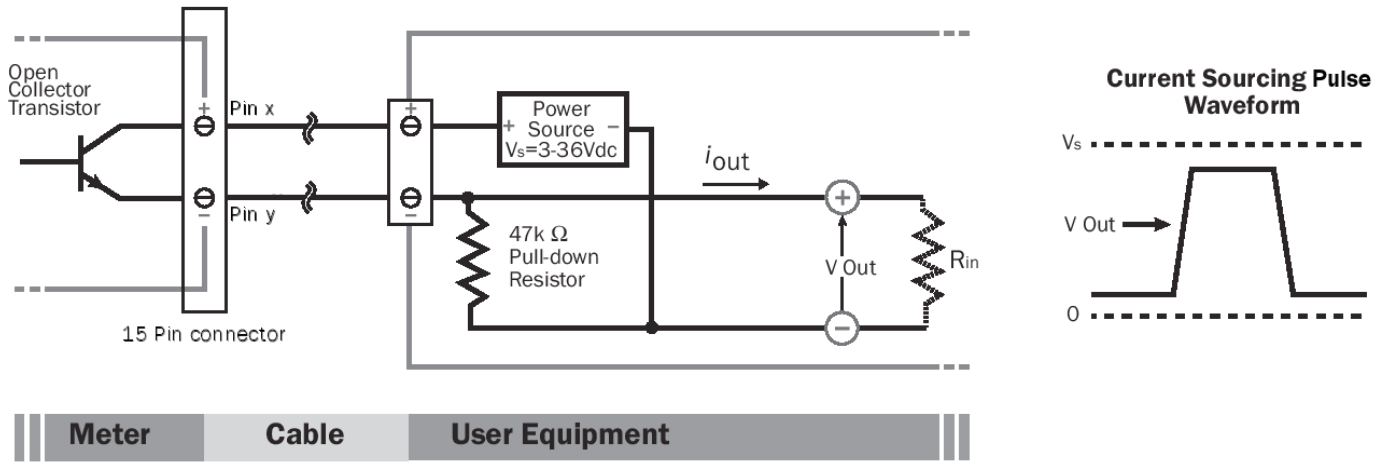
Two 2-pin Connectors for iMAG 4700 Battery Version



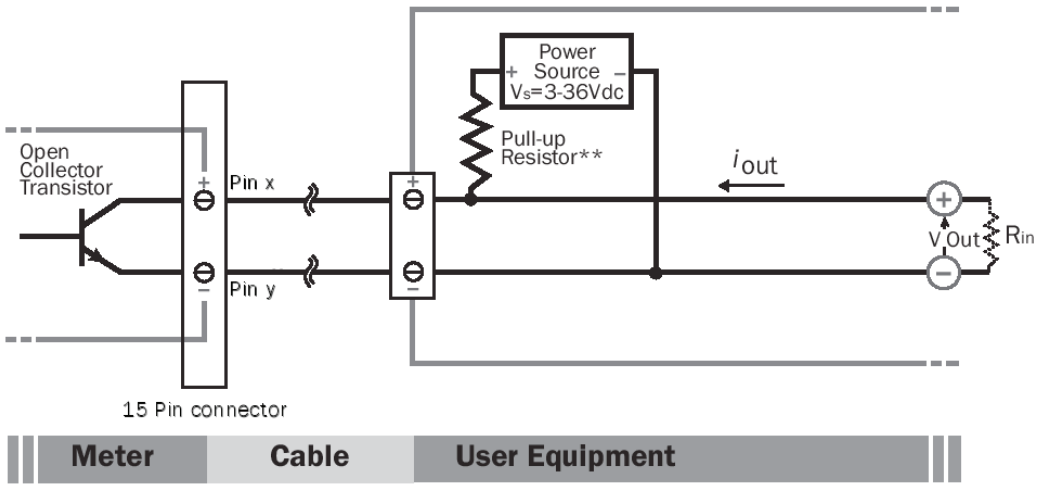
15 Pin Connector for iMAG 4700 DC Versions

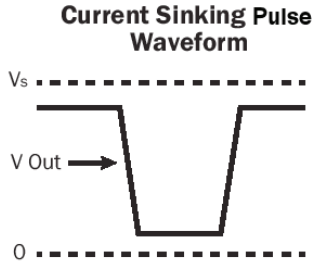
Note that when viewing the connectors from the front of the meter, the labels will be upside down, as shown above, with numbering going from left to right.

Pulse or Digital Output Application - Sourcing Mode (Recommended for Rin < 30kΩ)

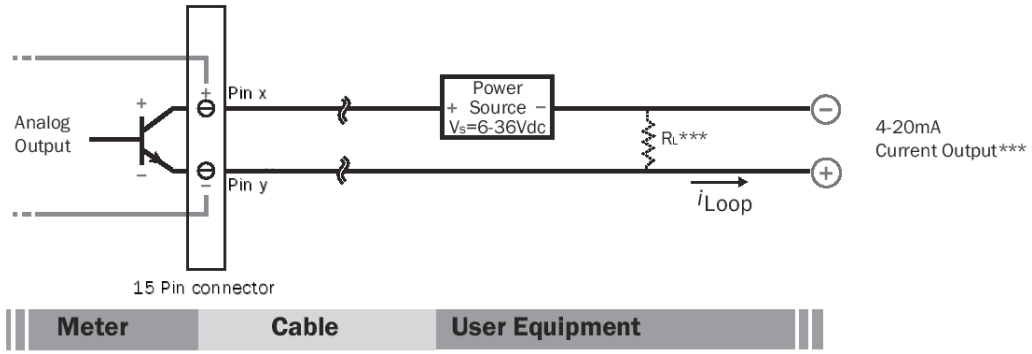


Pulse or Digital Output Application - Sinking Mode (Recommended for Rin > 30kΩ)





Analog (4-20mA Current Loop) Output Application



*** Minimum resistor value is (100 x Vs) ohms. Higher resistances maybe used depending on frequency and cable length. Longer cables and high frequencies require lower resistance.*
**** Resistor RL converts 4-20mA current to voltage for voltage input only devices.*

Cable Shield. In general, the cable shield and its bare drain wire should be left unconnected at the user equipment end of the cable to minimize "ground loop" problems.

Pulse Output Configuration. A pulse output is standard on all models. Since this is an isolated output, the external equipment must include a DC power source to regenerate the pulse from the open-collector output (transistor equivalent of a contact closure). A pull-up or pull-down resistor may be needed if not included in the user equipment as shown in the diagrams. Both the power source and resistor may be supplied internally in some types of control and monitoring devices. If not, as for most PLC discrete input modules, they must be added externally at the module input terminals. The pulse output rate in volume units/pulse can be set by the user via the SETP tab on the meter's setup menus.

Because the pulse output of an iMAG 4700 meter is set by the user, care must be taken to assure the output pulses do not exceed the maximum frequency of the meter while also ensuring a reasonable resolution.

K-factor: Remember that SETP is expressed in units totaled per output pulse (G/P if using gallons) while K-factors are expressed in pulses per gallon (P/G.) To determine K-factor from SETP, divide 1 by SETP (if SETP is expressed in gallons.) Conversely, 1 divided by the K-factor equals SETP

iMAG 4700 meters that were initially configured as battery powered units have a maximum output frequency of 150 Hz. Those that were initially configured as powered units have a maximum output frequency of 200 Hz.

Because all pulse outputs (SETP) are configured in (rate) units totaled per pulse, all sizes of meters can be configured with the same SETP values

For example, if your rate is chosen as gallons per minute (GPM) the table below applies. If your rate is different, simply use your rate label in place of (GPM.) The numerical values will remain the same.

Pulse Units. The units of measure of SETP are independently selectable and are not tied to rate or total. Upon change of the SETP unit, the pulse output may take up to 10 seconds, or the duration of one pulse (whichever is longer) to take effect.

If Pulse Output is Inconsistent. The PDAMP filter may need to be increased.

Pulse Width Timing. The unit and value of SETP must be chosen to keep the duration between meter pulse outputs to less than 500 seconds.

Pulse Timing in Battery Powered Units. The output pulse width in battery powered units is short and varies with pulse frequency. (See table)

SETP	Flow Rate at 1 Hz (GPM)	Flow Rate at 200 Hz (GPM) *Powered Meters*	Flow Rate at 150 Hz (GPM) *Battery Powered Meters*
0.1	6	1200	900
0.2	12	2400	1800
0.3	18	3600	2700
0.4	24	4800	3600
0.5	30	6000	4500
0.6	36	7200	5400
0.7	42	8400	6300
0.8	48	9600	7200
0.9	54	10800	8100
1.0	60	12000	9000

Lower frequency output pulses (1 pulse for some particular number of gallons) can also be set.

Any output frequency can be determined by:

Rate (units/minute) ÷ SETP (units/pulse) = pulse/minute
Hz = pulse/minute ÷ 60 seconds / minutes

For reference/comparison only

K-factors and the equivalent SETP values for old style WMX units are shown below.

WMX	4"	6"	8"	10"	12"
K-Factor	16.36	6.31	3.34	2.15	1.53
SETP	0.06*	0.16	0.30	0.47	0.65

**Note that on the iMAG 4700 you would need to choose a SETP value of 0.1 for the 4".*

Output Pulse Width of Battery Powered Units		
Output Pulse Frequency	Output Pulse Width as a Percentage of the Pulse Period (Pulse period = 1000 milliseconds/frequency)	
Zero to 1 Hz	Multiply the pulse period by 0.01	= Output Pulse Width (ms)
1 to 20 Hz	Multiply the pulse period by 0.05	= Output Pulse Width (ms)
20 to 100 Hz	Multiply the pulse period by 0.1	= Output Pulse Width (ms)
100 to 150 Hz	Multiply the pulse period by 0.15	= Output Pulse Width (ms)

Example: If frequency = 20 Hz then the pulse period = 50 milliseconds and pulse width = (.05 x 50 milliseconds) = 2.5 ms

Analog Output (4-20mA) Configuration. *(Not available on battery only units.)* Since the meter's analog output is isolated and passive, loop power must be supplied externally as shown previously. (In addition, an external resistor R_L will be needed to convert the loop current to voltage for voltage-only input devices.) The meter's loop transmitter minimum voltage drop is 6Vdc (8Vdc with HART) which, with wiring resistance and loop power supply voltage, will determine the maximum resistance for R_L. The flow rates corresponding to 4 and 20mA can be set by the user via the SET 4 and SET20 tabs on the meter's setup menus.

Note: As configured by the factory, any alarm state will force 22.8mA on the loop. This can be changed to 3.2mA - see Technical Bulletin, 'iMAG4700/AG3000: Changing the 4-20mA Alarm'.

HART Configuration. *(Not available on battery only units.)* The HART protocol, rev.7.5, allows for a Polling address between 0 and 63. The default value in the iMAG is 0. To change the Polling address, use iMAG menu HPOLL to set the Polling address.

To get to this menu, move to the EXIT tab and tap the left button 4 times. This will bring up the SUBMENU page. Navigate to the HPOLL tab. Use the left button to select the Polling address.

To enter SUBMENU

To select address

(See Changing Flow Meter Settings later in these instructions for details in using the menu system.)

A minimum of 250 ohms of loop resistance must be present in order for the HART modem to correctly and reliably demodulate FSK voltage. With this in mind, the maximum loop resistance* for the iMAG HART interface cannot be exceeded in order to assure correct operation.

The iMAG HART interface is HART compatible. All the commands have been implemented in accordance with the HART Protocol Specification published by HART Foundation. A HART Communicator can be used with the iMAG, even in the absence of DD files, by taking advantage of the Generic Online Menu capability of a Communicator. This means that a generic menu is automatically available when DD files are not present.

The following information from the iMAG HART can be displayed on the Communicator using the generic menu:

PV	Flowrate in units selected for iMAG
PV Loop Current	Loop current in mA
PV LRV	Lower range value of PV in units selected for iMAG
PV URV	Upper range of PV in units selected for iMAG

**4-20 mA loop has maximum loop resistance of 650ohms and requires a 24Vdc power supply.*

Modbus® Serial Communication Configuration (factory configured). *(Not available on battery only units.)* These connections provide a half-duplex, isolated, RS485 serial communications port using the Modbus messaging protocol. The port is reconfigurable by internal jumper settings to full-duplex RS232 or 3.3V CMOS (See Seametrics Modbus Interface Description manual for instructions). The TXD connection is the transmitted data output from the meter and RXD is the received data input to the meter. See Seametric's Modbus Interface Description, LT-103393 (available at www.seametrics.com) for supported Modbus message protocol and electrical interface specifications.

Digital Output (High Frequency) Configuration. *(Not available on battery only units.)* These outputs are electrically similar to the Pulse Output described above except they are capable of output frequencies up to 10kHz. The frequency output scaling can be set by the user via the SETF tab on the meter's setup menus. Selections are: 500Hz and 1, 2, 5 and 10 KHz at maximum flow rate.

DOUT1 Pulses in forward direction

DOUT2 Pulses in reverse direction

K-Factors for High Speed Digital Output (High Frequency)

	SETF (Hz)				
Size	**500**	**1K**	**2K**	**5K**	**10K**
3"	41.55	83.10	166.2	415.51	831.02
4"	23.35	46.69	93.39	233.5	466.9
6"	10.38	20.75	41.51	103.8	207.5
8"	5.837	11.67	23.35	58.37	116.7
10"	3.736	7.471	14.94	37.36	74.71
12"	2.594	5.188	10.38	25.94	51.88

Changing Flow Meter Settings

Home Screen and General Navigation

The HOME Screen displays flow volume, direction of the flow total and flow RATE along with status conditions such as Empty Pipe. Two buttons below the LCD display are used to access menu screens for viewing and changing meter setup parameters.

These two buttons are light sensors which can detect when a finger is covering them and activate upon release. Only three button touch actions are needed to control navigation through the menus, settings changes and back to the home screen.

HORIZONTAL SCROLLING:
Tap right button to scroll horizontally through menu tabs or move horizontally within a tab dialog when applicable.

SELECT:
Tap left button to change a highlighted item within a tab dialog.

ENTER/EXIT:
Hold left button while tapping right button once to enter or exit a tab dialog or to navigate between the HOME and other menu screens.

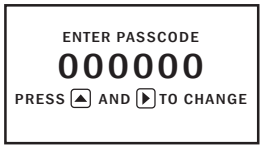
Changing Total Direction/Resetting Batch Totalizers

On the Main screen, hold ▶ and tap ▲ 5 times to scroll through the total direction options. Release ▶ to select a total direction.

Once BATCH FORWARD or BATCH REVERSE is selcted, tap ▶ four times to reset batch totalizer.

Entering Menu System

To enter the Menu System perform the hold and tap sequence. The Passcode entry screen will display. The default passcode is 000000. If a different passcode has previously been set, use the ▲ and ▶ to enter that passcode. In either case, hold and tap again to move into the menu system. (*If you enter the wrong passcode, hold and tap again to return to the previous screen. See page 21 for information on how to change a passcode.)*

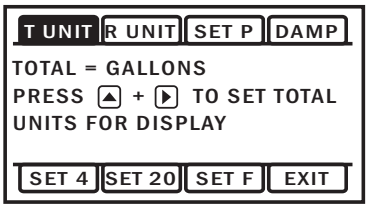


Making Selections

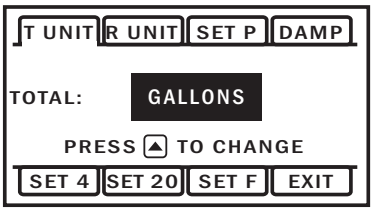
Once in the Menu System, move from tab to tab by tapping the right button. (See the next page for details on the various available tabs.)

Select the parameter. In the screen for the highlighted tab you will see the current parameter value for that tab. Tapping the right button, move to the tab for the parameter you want to change.

In this example, the first line indicates that the current unit for the TOTAL is GALLONS. The next two lines tell you what to do next.



If you would like to change the TOTAL units, just perform the hold and tap sequence to bring up a screen to change the setting.



Select a new setting. Select the new setting by scrolling through a list of selections as in the screen illustration below by tapping the left button to find a different TOTAL unit.

Accept changes. To accept any changes you have made, perform the hold and tap sequence.

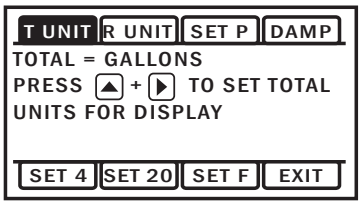
When finished making changes. When you are finished making changes, move to the EXIT tab using the right button.

To return to the HOME screen, perform the hold and tap sequence.

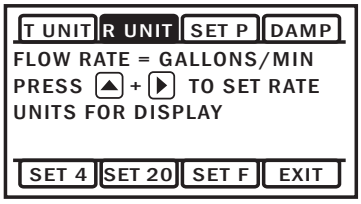
Standard Menu Options

Note: Available options will depend on specific meter configuration. Not all options are available on all meters. **Options not ordered with your meter will not appear on the meter menu.**

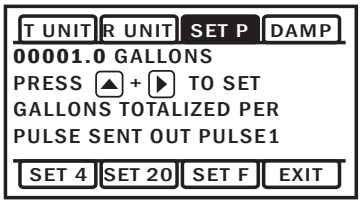
T UNIT
View or change TOTAL volume units



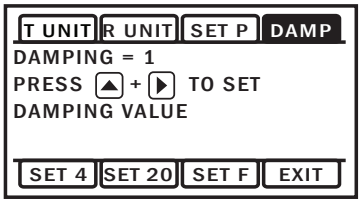
R UNIT
View or change flow RATE units



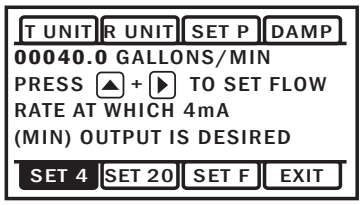
SET P
View or change pulse output scaling



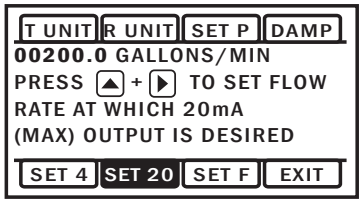
DAMP
View or change # of samples for rolling average.*



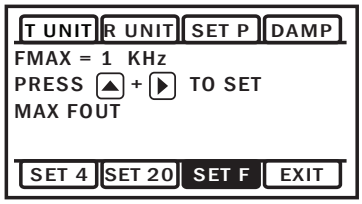
SET 4
View or change flow rate corresponding to 4mA. *(Externally powered units only)*



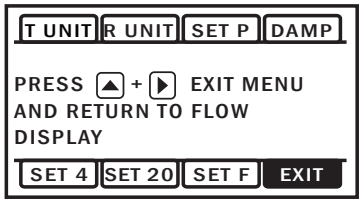
SET 20
View or change flow rate corresponding to 20mA. *(Externally powered units only)*



SET F
View or change high frequency output scaling. *(Externally powered units only)*



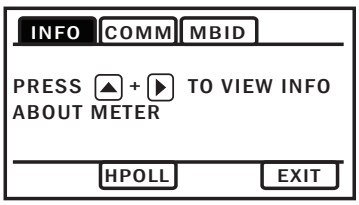
EXIT
Return to HOME SCREEN or enter SUBMENU



Special SUBMENU for Further Options

The EXIT tab in the MAIN MENU has a second function. If, instead of using the hold and tap sequence to return to the HOME screen, you tap ▲ five times, you will be redirected to a SUBMENU screen from which you can access several more options.

Navigation in this SUBMENU is the same as for the MAIN MENU. Whenever you wish, go to the EXIT tab in the SUBMENU and perform the hold and tap sequence to return to the MAIN MENU.



Sub-Menu

INFO: Meter model number, serial number, and firmware version.

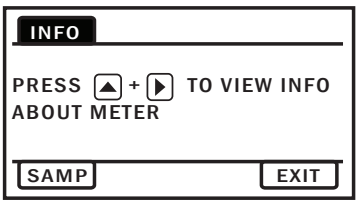
COMM: Modbus® baud rate and parity. *(Not available on battery only units.)*

MBID: Modbus® address *(Not available on battery only units.)*

SAMP: Sample rate *(Battery powered version only.)*

HPOLL: HART Address *(Not available on battery only units.)*

EXIT: Return to MAIN MENU.



Sub-Menu - Battery Only Version

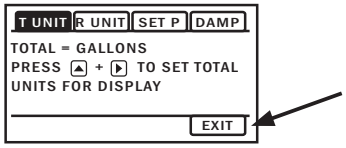
To Change a Passcode and Decimal Places

The iMAG4700 has a passcode system for restricting access to the menus. The iMAG comes from the factory with the passcode set to 000000. When a user attempts to enter the menu system (see details on page 20), the passcode entry screen will be displayed.

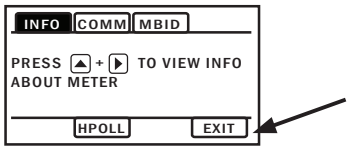
The default passcode is 000000. If a different passcode has previously been set, then the user must enter that passcode at this time. After entering the passcode, or leaving it at 000000 if using the default passcode, the user does the tap and hold sequence to move into the menu system.

To change the passcode, you must use the THIRD MENU screen. Access the THIRD MENU screen as follows:

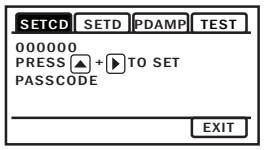
- Enter the main menu system, as described above.



- On the main menu, tab over to the EXIT tab and tap the ▲ five times. A SUBMENU screen will display.



- On the SUBMENU screen tab over to the EXIT tab and tap the ▲ five times. The THIRD MENU screen will display.



- To set the passcode, hold and tap and then use the ▲ and ▶ to enter the new code.
- Hold and tap again to return to the THIRD MENU screen
- Tab to EXIT, and then hold and tap to return to the SUBMENU.

To change the number of decimal places in the total

- To set the decimal point, hold and tap on SETD and then use the ▶ to move the decimal point.
- Hold and tap again to return to the THIRD MENU screen.
- Tab to EXIT, and then hold and tap to return to the SUBMENU.

PDAMP

PDAMP is used to view or change the number of samples for rolling average of pulse output.

TEST

TEST allows the user to initiate a fully functional, artificial flow rate for the purpose of testing other connected equipment. When TEST is applied, all features of the meter will function at the stated flow rate (in gallons per second).

For TEST to function, the meter must be filled (not EMPTY PIPE).

To enter a value into the TEST feature, navigate to the TEST tab and enter a flow rate value in the VAL screen (in gallons per second only,) then ▶ to the VAL box and ▲ to the ON screen. This will initiate the TEST feature. The next ▲ would bring you to the OFF screen, but you can 'hold and tap' the arrows to return you to the sub menu while the feature operates.

After use, the TEST feature must be turned OFF. If the TEST feature is not turned OFF, the stated static flow rate (in gallons per second) will be shown any time the meter is full or in a flowing condition. Flow values recorded by the meter while the TEST feature is operating are permanently recorded in the displayed TOTAL. It may be useful to note that these values are only written to permanent memory every 15 minutes and cycling all power within this 15 minute time frame will return the meter to its previous total.

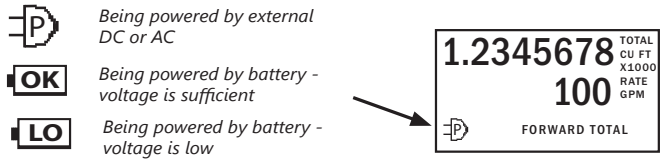
Power Indicators

A power indicator is displayed in the lower left of the main display window.

Any meter powered from an external power source will display a power plug icon when running on external power. If the connection to external power is lost, the meter will switch to the backup battery and the power icon will switch to a battery symbol.

OK on the battery indicator means battery voltage is above 6.4 volts.

LO on the battery indicator means the battery is low and should be replaced soon.



If display reads, 'BATT END' replace battery immediately.

Battery Powered Units

To 'wake up' a battery powered meter, you may need to hold the up arrow for 5 seconds and release. If the meter does not wake up on the first attempt, repeat the 5 second hold.

The iMAG 4700 meter can come configured with one lithium 7.2V 'D' size battery pack. In this configuration, the only option/output is the scaled pulse output which comes standard. The scaled output for the battery powered option has a maximum pulse rate of 150 pulses/second. Be sure to set your P value such that the meter will function properly over the flow range in your application. The sample rate of the meter is user selectable through the SAMP tab in the meter's sub-menu. Sample periods of 1/5, 1/3, 1, 3, 5, 15, 30, and 60 seconds can be selected. (A sample period of 5 seconds—5 year battery life—is the default.)

Larger sample periods will yield longer battery life but slower response time. Care must be taken to select a sample period that is suitable for your application. See the table to the right for the expected battery life as a function of sample period.

DAMP Settings for Battery Units

If SAMP (sample period) is set to less than one second, the DAMP value represents the number of seconds (plus one) used in the rolling average for the display. For example, if DAMP is set to four, then when the meter begins to show a flow rate, the rate displayed is the average of all the readings taken in seconds one through five (4 plus 1).

If SAMP (sample period) is set to one second or longer, the DAMP value represents the number of sample periods (plus one) used in the rolling average for the display. For example, if SAMP is set at three seconds and DAMP is set to four, then when the meter begins to show a flow rate, the rate displayed is the average of samples one through five (4 plus 1). Note that depending on the settings selected, it may take up to a minute for the displayed rate to take full advantage of the DAMP filter. When when starting with an EMPTY PIPE it may take at least 30 seconds to register any flow.

Battery Life/Sample Period

Sensor sample period(s) (Seconds)	Expected battery life*
1/5 (0.2)	7 months
1/3 (0.33)	1 year
1	2.25 years
3	4 years
5	5 years
15	6 years
30	6.25 years
60	6.5 years

**Based on 75% battery capacity at room temperature with no option cards installed.*

NOTE: If a large percentage of the meter's life will be spent below 0.5 meters/second and above cutoff, battery life will be reduced.

Troubleshooting

Problem	Probable Causes	Things to try...
Blank Display	Faulty wiring from power source to meter	Check for incorrect wiring. Measure voltage with DMM where red and black wires connect to terminal block TB1 on back side of display. Verify correct polarity and confirm that voltage is steady and between 9Vdc and 32Vdc
	Backup battery has not been plugged in	Plug in the battery
	Dead backup battery	Replace battery
Flow rate reading fluctuates excessively when flow is unchanging	Excessively turbulent or unsteady flow due to partially closed valves or other flow obstructions	Eliminate or minimize causes of flow disturbances or increase meter damping
	Pipe not full	Provide back pressure or other means to ensure pipe is filled
	Pulsing flow due to combining multiple upstream flow sources	Move connection point further upstream
	Insufficient mixing of upstream chemicals	Move chemical injection downstream from meter
	Low fluid conductivity < 20 µS/cm	Replace with different type of meter
	Noisy electrical environment	Improve grounding at meter and nearby potentially noisy electrical equipment. Increase distance between meter and electrical noise sources.
	Defective or noisy AC switching power supply	Replace power supply
Flow Rate appears correct but pulse/ frequency output is low, erratic or absent	Wiring incorrect	Compare wiring with appropriate wiring recommendations
	External device input impedance too low	Use sourcing rather than sinking interface connection
	Cable too long	Reduce interface pull-up resistance
Flow Rate appears correct but pulse/frequency output is erratic and/or too high	Electrical noise sources interfering with pulse frequency signal	Isolate, remove or reduce noise sources. Move meter control cable away from noise sources. Increase pulse damp setting (PDAMP)
	Wrong type of cable	Use only twisted pair cable and ensure both signal wires are on same twisted pair
	Grounding problem	Improve or try different grounding method

Error Messages

Under certain conditions an error message may be displayed.

Message	Description	Notes
INIT	Initialization is occurring during power up.	
EMPTY PIPE	Fluid is not detected between the sensing electrodes.	Loop output = 22.8mA
LO in battery icon	Battery is getting low, replace soon. Meter still functions.	Above 6.4V, OK appears in icon
BATT END	Battery is very low (approx. 6.1V). Totalizer stops updating.	Loop output = 4mA
LOW VOLT	Incoming external power is very low and backup battery is dead or not connected	Loop output = 4mA
COIL FAIL	Coil current too high or too low (short or open).	Loop output = 22.8mA
COMM FAIL	Communication between transmitter and sensor board fails.	Loop output = 22.8mA
OVER RANGE	Rate exceeds number of digits that can be displayed. Adjust units.	Loop output = 4mA

The limited warranty set forth below is given by Seametrics, with respect to Seametrics and INW brand products purchased in the United States of America.

Seametrics warrants that products manufactured by Seametrics, when delivered to you in new condition in their original containers and properly installed, shall be free from defects in material and workmanship. **Seametrics products are warranted against defects for a period of two (2) years from date of installation, with proof of install date. If no proof of install date can be provided, warranty period will be two (2) years from date of shipment from Seametrics, as defined on Seametrics' invoice.** Seametrics' obligation under this warranty shall be limited to replacing or repairing the part or parts, or, at Seametrics' option, the products, which prove defective in material or workmanship. The following are the terms of Seametrics' limited warranty:

a. Buyer must give Seametrics prompt notice of any defect or failure and satisfactory proof thereof.
b. Any defective part or parts must be returned to Seametrics' factory or to an authorized service center for inspection.
c. Buyer will prepay all freight charges to return any products to Seametrics' factory, or another repair facility. as designated by Seametrics.
d. Defective products, or parts thereof, which are returned to Seametrics and proved to be defective upon inspection, will be repaired to factory specifications.
e. Seametrics will deliver repaired products or replacements for defective products to the buyer (ground freight prepaid) to the destination provided in the original order.
f. Products returned to Seametrics for which Seametrics provides replacement under this warranty shall become the property of Seametrics.
g. This limited warranty covers all defects encountered in normal use of Seametrics products, and does not apply to the following cases:
    i. Loss of or damage to Seametrics product due to abuse, mishandling, or improper packaging by buyer
    ii. Failure to follow operating, maintenance, or environmental instructions prescribed in Seametrics' instruction manual
    iii. Products not used for their intended purpose
    iv. Alterations to the product, purposeful or accidental
    v. Electrical current fluctuations
    vi. Corrosion due to aggressive materials not approved for your specific product
    vii. Mishandling, or misapplication of Seametrics products
    viii. Products or parts that are typically consumed during normal operation
    ix. Use of parts or supplies (other than those sold by Seametrics) which cause damage to the products, or cause abnormally frequent service calls or service problems
h. A new warranty period will be established for repaired products, or products replaced during the original warranty period.
i. In the event that equipment is altered or repaired by the buyer without prior written approval by Seametrics, all warranties are void. Damage caused by equipment or accessories not manufactured by Seametrics may void the product's warranty.
j. SOFTWARE: The Seller grants the user a non-exclusive license to use Seametrics' software, according to the following limitations and conditions:
    i. The user may install the software on one or more desktop or laptop computers.
    ii. All title and intellectual rights to the software are owned by Seametrics.
    iii. No copies may be made or distributed except as described above.
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SOME STATES DO NOT ALLOW LIMITATIONS ON THE DURATION OF AN IMPLIED WARRANTY, SO THE ABOVE LIMITATIONS MAY NOT APPLY TO YOU. SIMILARLY, SOME STATES DO NOT ALLOW THE EXCLUSION OR LIMITATIONS OF CONSEQUENTIAL DAMAGE, SO THE ABOVE LIMITATION OR EXCLUSION MAY NOT APPLY TO YOU. THIS LIMITED WARRANTY GIVES YOU SPECIFIC LEGAL RIGHTS; HOWEVER, YOU MAY ALSO HAVE OTHER RIGHTS WHICH MAY VARY FROM STATE TO STATE.

APPENDIX E

CLA-VAL AIR RELEASE VALVE OPERATIONS AND MAINTENANCE MANUAL

CLA-VAL®

— MODEL — 33A
High Performance Combination Air Release & Vacuum Valve

Threaded

Flanged

INTRODUCTION

Cla-Val Combination Air Valves have been designed with stainless steel trim to give years of trouble-free service. Combination Air Valves are typically installed at high points of a water piping system. They perform both functions of air release valve and air/vacuum valve in one body.

Combination Air Valves automatically vent pockets of air from high points while the system is pressurized. The valve will also vent and admit large volumes of air while or draining the system or during emergency power failure conditions. Both air release and air/vacuum functions are essential to maintain pipeline efficiency and protection from adverse pressure conditions.

RECEIVING AND STORAGE

Inspect valves for damage upon receipt. Valves should remain boxed and stored in doors until installed to prevent weather related damage

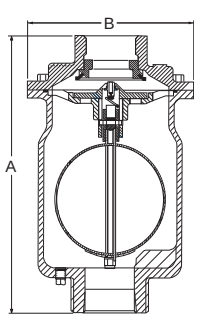
DESCRIPTION OF OPERATION

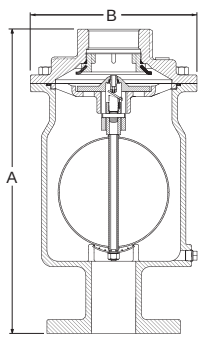
Combination Air Valves are fully automatic and designed to continuously remove pockets of air from high points in a piping system. They also vent and admit large volumes of air during filing or draining of the pipeline or tank. These are a normally open air valves that function in three ways:

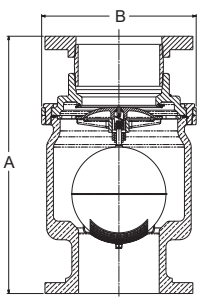
1. During System start-up, the large open orifice exhausts large volumes of air until fluid enters the valve. Then the float rises to shut both the large orifice seat and the small orifice seat. Pressure within the valve will force the float tightly against both the seat orifices.

2. As air accumulates at the high points of the piping system, (where the valve is installed) air displacing the fluid, the float lowers with the fluid and breaks contact with the small orifice seat. Accumulated air in the valve, is then vented through the small orifice. As air is vented, the floats raise again and closes the small orifice. This sequence repeats automatically as air accumulates in the air valve.

	33A Pressure Class 300 Lb Threaded X Threaded				33A Pressure Class 150 Lb Threaded X Flanged				33A Pressure Class 150 Lb Flanged X Flanged
Valve Size	1"	2"	3"	4"	2"	3"	4"	6"	6"
A	9.10	12.44	12.75	12.75	13.88	15.56	15.75	16.38	19.14
B	6.25	7.50	9.00	9.00	7.50	9.25	9.25	11.00	11.00
C	—	—	—	—	.62	.75	.94	1.00	1.06
Inlet (ANSI)	1" NPT	2" NPT	3" NPT	4" NPT	2"	3"	4"	6"	6"
Outlet (NPT)	1" NPT	2" NPT	3" NPT	4" NPT	2" NPT	3" NPT	4" NPT	6" NPT	6"
Number of Holes	—	—	—	—	4	4	8	8	8"
Diameter of Bolts	—	—	—	—	.63	.63	.75	.75	.75
Shipping Wt. (Lb.)	25	29	38	40	39	48	50	70	75







SPECIFICATIONS

MODEL 33A - 1",2",3",4" and 6" SIZES
Single Body Combination Air Vacuum Air Release Valve

Pressure Ratings	Materials
500 psi Ductile Iron Body and Cover	Body and Cover: Ductile Iron ASTM A536 65-45-12
500 psi Stainless Steel Body and Cover	Body and Cover Stainless Steel T303
600 psi Cast Steel Body and Cover	Body and Cover Cast Steel ASTM A 216 WCB

Note:
Readily available for seawater service and other corrosive fluids applications Made of:
Monel - Bronze's - Stainless Steel

Standard Internals
Float: Stainless Steel T304
Balance internals parts Stainless Steel and Delrin
Seals Nitrile Rubber or Viton (extra cost)
Temperature Range
Water to 180° F

Optional:
1. Fusion epoxy lined and coated at extra cost
2. For Well Service Install Throttling Device on the Outlet

PROBLEMS / SOLUTIONS

1. **Leakage at Inlet Connection**:
   Tighten valve threaded connection. If leaks persist, remove valve and seals threads with pipe sealant or tape.

2. **Leakage at Cover/Body joint**:
   Tighten bolts per Table 2, replace gasket.

3. **Small or Large Orifice Leakage**:
   Flush valve to remove debris. Disassemble and inspect both seat, orifices and float for wear or damage. Replace as needed with a float kit or seat kit

4. **Small Orifice not Releasing Air Under Pressure**:
   Check that operating pressure does not exceed Working Pressure on nameplate. Perform inspection step 3 and disassemble valve if problem persists.

DISASSEMBLY
The valve can be disassembled without removing it from the pipeline, or it may be removed from the line. All work on the valve should be performed by a skilled mechanic. Special tools are NOT required.

CAUTION: Drain the vale and de-pressurized before removing the cover or pressure may causing injury.

1. Close inlet shut-off valve. Slowly open drain valve or remove drain plug. Remove the covers bolts slowly.
2. Pry cover loose and lift off valve body.
3. Remove entire seat & float assemblies inspect for damage or wear
4. Clean and inspect parts. Note: Shake float & if water inside float replace it and worn parts as necessary.

NOTE: Float Kit & Seat Kit includes cover gasket

REASSEMBLY
1. All parts must be cleaned and gaskets surfaces cleaned with a stiff wire brush in the direction of the serration or machine marks. Worn parts, gaskets and seal should be replaced during reassembly.

2. Apply Loctite or similar Compound to threaded Connections

3. Stand valve body vertically. Insert entire delrin frame, seat & float assembly into register. Move float up/down to insure concentricity and no binding.

4. Lay new cover gasket on clean surface and apply a gasket compound such as Permatex #80065 to both surfaces. Assemble gasket and cover over bolt holes in body.

5. Insert lubricated bolts and tighten to the torques listed in Table 2.
6. Place valve back in service. Refer to the installation instruction. Slowly open inlet isolation valve.

TABLE 2. VALVE COVER BOLT TORQUES

BOLT SIZE	TORQUE (FT. LBS.)
1/4"-20	6
5/16"-18	11
3/8"-24	19
7/16"-32	30

PARTS AND SERVICE
Parts and service are available from your local representative or the factory. Make note of the valve Model No. and Working Pressure located on the valve nameplate.