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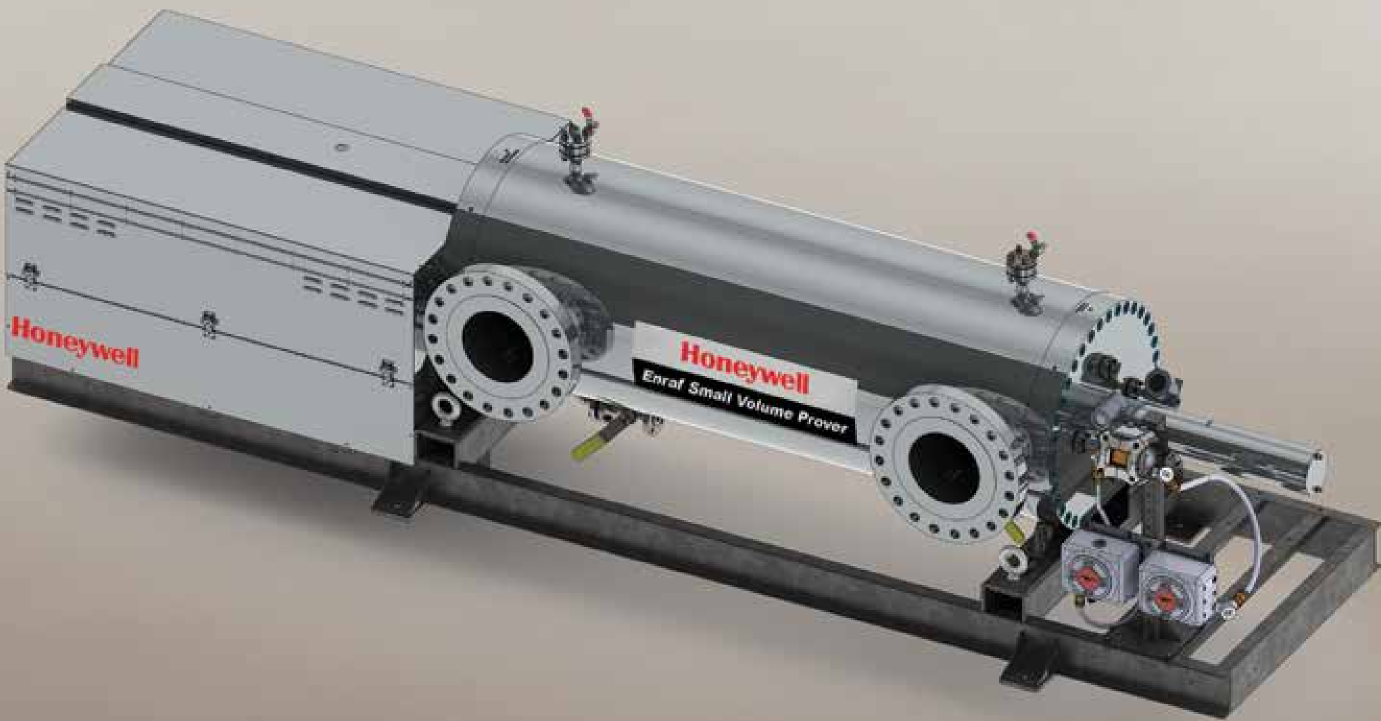

FOR MODEL 35, 50, 85, 120

Honeywell Enraf Small Volume Prover Installation, Operation & Service Manual

HONEYWELL ENRAF

SMALL VOLUME PROVER INSTALLATION, OPERATION & SERVICE MANUAL

FOR

MODEL 35, 50, 85, 120

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Safety instructions for installation, commissioning, operation and maintenance

Preface

The Honeywell Enraf (HE) SVP (Small Volume Prover) is a high precision instrument for verification of calibration of flow metering equipment. The SVP Controller and the Fusion4 Local Access Device (LAD) form the control aspects of the SVP. The LAD is a hand held controller used to interface to the SVP Controller allowing tasks such as the adjustment of parameters, resetting of alarms and calibration. The LAD facilitates two way data communications between the SVP Controller and the LAD, allowing the rapid transfer of transaction data, configuration files and calibration records and even upgrading of firmware in the field. The following warnings apply to all components of the SVP.

Warning

Only use the instrument for its intended purpose.

EC declaration of conformity

Refer to the EC declaration of conformity and ATEX certificate(s), shipped with the instrument.

Installation

The mechanical and electrical installation shall only be carried out by trained personnel with knowledge of the requirements for installation of explosion proof equipment in (potentially) explosive atmospheres.

The entire installation procedure shall be carried out in accordance with national, local and company regulations. The entire electrical installation shall be carried out in accordance with the International Standard EN 60079-14 for electrical equipment to be installed in (potentially) explosive atmospheres.

No specific installation requirements apply to the LAD; the device is factory ready for connection to Fusion4 parent devices (for example the SVP Controller).

Warning – Risk of Explosion

Do not open any of the electronics enclosures when an explosive atmosphere may be present.

Warning – Risk of Explosion

Explosion proof (Ex d) compound cable glands or conduit sealed directly at all cable entries must be used.

Which type depends on local & national requirements and legislation. For the SVP Controller these glands and seals are installed at the factory.

Warning – Risk of Explosion

Unused cable entries must be sealed with an approved metric or NPT threaded stopping ("Stopper") plugs. Take care to select whichever is appropriate and contact Honeywell Enraf in case of doubt. Improper installation of cable glands, conduit or stopping plugs will invalidate the Ex approval.

Warning – Risk of Explosion

Intrinsically safe connections to the SVP are factory wired. No unauthorized changes are allowed as these would invalidate the approval.

The LAD and the SVP Controller are intrinsically safe devices and as such may only be connected to devices with compatible intrinsically safe parameters. Intrinsically safe cabling may only be connected to the outside 5 pin socket of the SVP Controller. Connection of non-intrinsically safe signals will invalidate the approval. The electrical data of the intrinsically safe circuits is to be taken from the ATEX/IECEx certificates (numbers see below) which are shipped with the instruments.

Warning – Risk of Explosion

In order to withstand the explosion pressure the bolts of the SVP Controller lid must be fastened hand-tight (approximately 13.5 to 17.6 Nm [10 to 13 Lbf-Ft]) but don't overtighten so as not to damage the threads.

Warning – Risk of Explosion

For ensuring intrinsic safety, ground connection of one of the internal boards to the enclosure and the box to the local grounding system is crucial. The former is done at the factory but the local grounding is required to ensure compliant installation.

Warning

For information on the dimensions of the flameproof joints, contact Honeywell Enraf.

Warning – Risk of injury

Honeywell Enraf recommends mains power to be shut off, including lockout-tagout at that mains switch to ensure safety during maintenance and related work being performed on the inside of the drive end cover.

Warning – Risk of injury

Ensure that the motor drive end and downstream shaft covers are always in place before operating the device, to guard against human injury.

Warning – Risk of injury

Pressurize system slowly to avoid a hydraulic shock which could result in damage to prover, personnel, and/or piping systems.

Warning – Risk of injury

Ensure that the unit is fully depressurized and drained prior to disassembly or service.

Commissioning

The commissioning of the instrument shall be conducted by qualified engineers, trained by Honeywell Enraf and with knowledge of the (local and national) requirements for electrical equipment in (potentially) explosive atmospheres.

Operation

After commissioning the Honeywell Enraf SVP and its associated SVP Controller can be used for its intended purpose. After connecting to the SVP Controller the LAD can be used for its intended purpose. The memory card can be removed and inserted also in hazardous areas but be aware that the device is then no longer suitably protected against ingress of water.

Maintenance and troubleshooting

In the unlikely event of malfunction, only a qualified service engineer, trained by Honeywell Enraf and with knowledge of safety regulations for working in (potentially) explosive atmospheres is allowed to repair the instrument.

Additional information

If you require additional information, contact Honeywell Enraf or its representative.

Approvals :
Refer to the EC declaration of conformity and ATEX certificate(s), shipped with the instrument (as it may vary per configuration)

CE Directives and approvals:

CE Directive	Certificate number
94/9/EC ATEX electrical	LCIE 05 ATEX 6068X
94/9/EC ATEX mechanical	Honeywell Enraf declared
2006/42/EC Machinery Directive	Honeywell Enraf declared
97/23/EC Pressure Equipment Directive	60330-2009-CE-HOU-DNV

Environmental conditions:

Ambient pressure	:	atmospheric
Relative humidity	:	5 – 95 %
Ingress Protection (IP rating)	:	IP56
Ambient temperature	:	ATEX Approval Standard Temperature: -20°C to +40°C (-4°F to +104°F) Extended Temperature Options: As broad as -40°C to +40°C (-40°F to +104°F) or -20°C to +60°C (-4°F to +140°F) CSA Approval Standard Temperature: -20°C to +40°C (-4°F to +104°F) Extended Temperature Options: As broad as -40°C to +40°C (-40°F to +104°F) IECEx Approval Standard Temperature: -20°C to +40°C (-4°F to +104°F) Extended Temperature Options: As broad as -40°C to +40°C (-40°F to +104°F) or -20°C to +60°C (-4°F to +140°F)
Special Approvals	:	Up to 60°C (140°F)

Additional information specific to the SVP Controller

Approvals :
ATEX: II 2 G Ex d [ia] IIB T6 Gb IECEx: Ex d [ia] IIB T6 Gb

Certificates:

Approval	Certificate number
ATEX	12ATEX0101 X
IECEx	DEK 12.0021X
CSA	11.2370409

Additional information specific to the Fusion4 LAD

Approvals :
II 2 G Ex ia IIB T4 Gb
Ex ia IIB T4 Gb

Certificates:

Approval	Certificate number
ATEX	KEMA 10ATEX0152
IECEx	IECEx KEM 10.0070
CSA	11.2395571

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INSTALLATION PROCEDURE

Warning

Please read this section carefully before installing, using, or maintaining your Honeywell Enraf small volume prover. Failure to follow directions may result in personal injury and/or property damage. Honeywell Enraf is not responsible for injury/damages/losses as a result of deviation from installation procedure.

The Honeywell Enraf small volume prover is fitted with transit seals in both the up & downstream shaft seal retainers upon its shipment from the factory. It is important to replace these seals during the commissioning procedure and prior to the process fluid being introduced into the unit. An additional set of seals are supplied with every Honeywell Enraf small volume prover for this purpose.

1. *Before* performing *any* operations with the Honeywell Enraf small volume prover read this operation manual *completely!* Also read Manual of Petroleum Measurement Standards by American Petroleum Institute 4.8 “Operation of Prover Systems”, Current Edition. If there are any uncertainties please consult your Honeywell Enraf representative or the factory directly.
2. The Honeywell Enraf small volume prover has been designed to meet certain operational conditions. Using the prover outside of these boundaries may cause permanent damage and *will* void warranty (ref. Section 1.3)
3. All provers are designed as per pressure standard ANSI B16.5. For process temperatures above 37.8°C (100°F), pressure must be de-rated, following the above mentioned standard.
4. Each Honeywell Enraf small volume prover is functionally tested at different flow rates starting from the lowest to the maximum flow rates, pressure tested (hydrostatic pressure test) and water draw calibrated at the factory prior to shipment. When the equipment is received, inspect the outside of the packing case(s) for damage. Any visible damage should be reported to the carrier immediately, for the purpose of liability. If anything is missing or incorrect from your shipment, please contact your local Honeywell Enraf sales representative or sales office. Have the serial number and sales order number available to help expedite any assistance needed.
5. The Honeywell Enraf small volume prover has been designed to be used as either a portable or stationary mounted flow prover. The Honeywell Enraf small volume prover may be installed upstream or downstream of the meter under test, as the displaced volumes are equal.

6. The Honeywell Enraf small volume prover should be installed on a flat surface and secured using 4 bolts through the pre-determined anchor points on the prover frame (Refer to Figure 2-4). It is recommended to bolt the prover to the slab/trailer at these *four locations only*. It is *not* recommended to use any other method or type of securing the prover against the movement during operation. Honeywell Enraf will not be responsible for possible damages to the prover or system parts if these recommendations are not followed.
7. It is mandatory to provide enough space around the prover to accommodate any removal of components during maintenance (see Figure 2-3).
8. When installing the Honeywell Enraf small volume prover, follow all recommended procedures regarding positioning of prover in relation to the flow meter. To assure that all flow is passed through the flow prover, double block & bleed diverter valves are recommended.
9. Ensure not to overload prover inlet & outlet nozzles. Maximum allowable loads on prover nozzles are provided in the Table 10. It is the customer's responsibility to design piping systems and maintain nozzle loads within the provers maximum allowable loads. It is also important to provide adequate support of inlet and outlet piping.
10. Prover vent and drain lines must be plumbed to drain/collection sumps. Do not vent directly from the bleed valves as personal injury may occur.

Warning

For proper operation of the SVPs it is mandatory to properly vent the prover and to make sure that fluid vapor is removed from the SVP. SVPs can fully function when proving fluids are in the liquid form only.

11. Install a correctly sized strainer/filter upstream of the prover in order to ensure the flow entering the prover is free from debris and foreign material. Honeywell Enraf's recommendation would be to use strainers with minimum 40 mesh screen.
12. To avoid over-pressuring of the prover and prover components, a correctly sized pressure relief (as per API 520, API 521 and API 526), should be installed on the downstream side of the prover. The option for the installation of the relief valve would be to use one of the spare openings in the downstream end flange or to install the relief valve in the downstream section between the prover outlet flange and the closest discharge valve.
13. Lifting instruction. (Ref. Figure 2-2).

14. When connecting prover to pipeline, be certain that:
    a. Flow direction is correct. Flow must go through the prover in the proper direction. Severe damage may occur if flow direction is not correct!
    b. Bolts, flanges, and piping of sufficient strength are to be used for all pressure retaining connections.
    c. All connection bolts are tightened to correct torque specifications.
    d. No foreign bodies, i.e.: weld slag, will be introduced into the prover.
15. Carry out the removal and replacement of transit seals with the operation seals (as supplied) prior to introducing liquid into the Honeywell Enraf small volume prover.
16. Pressurize system slowly to avoid shock which could result in damage to prover, personnel, and/or lines.
17. Be certain that ALL applicable electrical codes are met when connecting and using the Honeywell Enraf small volume prover, especially in hazardous area locations. The Honeywell Enraf small volume prover is certified by one of the following:

    CSA/US certified for Class 1 Group D T2C

    CSA/US certified for Class 1 Group C T3B

    ATEX certified for II 2 (1) G Ex d [ia Ga] IIB T4 Gb

    IECEx compliant for Ex db [ia Ga] IIB T4 (See Individual Certificates)

    It is the responsibility of the user to satisfy the relevant electrical code requirements on connections made to the Honeywell Enraf small volume prover.
18. Covers must be in place on all explosion-proof electrical enclosures at all times when prover is energized. If it is necessary to troubleshoot electrical components, it must be done in a “safe” area following site procedure.
19. All drive covers *must* be in place during operation or anytime electrical power is applied to the prover to avoid personal injury.
20. Shaft cover located on the downstream side of the flow tube *must* be in place during prover operation to avoid personal injury.
21. Do not alter or modify the Honeywell Enraf small volume prover without prior written consent from the factory. Honeywell Enraf will not be responsible for possible damages, loss, or injury as a result of unauthorized use or modification.
22. Ensure that the unit is fully depressurized and drained prior to disassembly or service.
23. Prover frame must be correctly earth grounded prior to electrical service. Grounding connector is located on the prover frame.

24. Follow all hazardous warning stickers! Pinch and crush points are present on this equipment in addition to electrical shock hazards.

Important Notice to ALL Honeywell Enraf small volume prover users:

It is mandatory that all Honeywell Enraf small volume prover users implement a method of preventing an over pressurization of the flow prover. This task is most readily achieved through the use of a pressure or safety relief valve. The use of a pressure or safety relief valve will reduce, if not eliminate, possible failures due to over pressurization of the prover. Due to the fact that each installation will require a different pressure relief valve (based upon system pressure, fluid properties, flow rate, etc.), the equations provided in API 520, API 521 and API 526 should be used to size the appropriate relief valve.

The pressure rating of the relief valve should be calculated by taking the **maximum operating pressure and adding 10%** for a momentary over pressurization or line surge of the system.

IMPORTANT: WATCH DISCHARGE FROM RELIEVING DEVICES!

Additionally, take extra care when pressuring the flow prover at cold temperatures. All Honeywell Enraf small volume prover tubes are manufactured from stainless steel which experiences a reduction in ductility at reduced and elevated temperatures i.e.: below -29°C (-20°F) or above 37.8°C (100°F). Therefore, pressurization of flow provers in these temperature regions should be done slowly!

Caution: *Evidence has shown pitting in chromed surfaces can be caused by water trapped in piston and shaft seal areas for long periods of time (result of water draws).*

Chrome pitting can also be caused from welding to or near structural components of the prover such as the skid frame or piping (installation, repair or modification work).

CHAPTER 1 INTRODUCTION

1.1 Overview

This manual provides the necessary information and procedures for the proper operation of the Honeywell Enraf small volume prover manufactured by Honeywell Enraf Americas, Inc.

The Honeywell Enraf small volume prover uses a wear and corrosion resistant precisely honed flow tube. Contained within the flow tube is the piston/bypass valve arrangement. Piston/bypass valve arrangement has been designed in such a way that during the proving runs disturbance to the flow is minimal. The free flowing piston has an inherent fail-safe feature that will not cause disruption to the flowing fluid in case that the poppet actuator shaft becomes disconnected or otherwise fails. The poppet valve is coaxially mounted within the free moving piston. At the time a calibration run is initiated by the operator, the piston assembly is moved to the upstream end of the flow tube by a mechanical drive driven by an explosion-proof electric motor. When upstream position has been reached, the poppet valve actuator shaft is released by the return mechanism, allowing the poppet valve to close and the flowing fluid to move the piston through the measurement cylinder.

Slotted precision optical switches are utilized to define volume displaced. These switches are reliable, fast (5 X 10^{-6}s), and precise, showing a maximum deviation of +/- 0.0005 % on repeatability of linear measurement. For maximum fluid compatibility the only seals in contact with the flowing fluid in the Honeywell Enraf small volume prover are filled PTFE. A static leak detector is provided with the prover. This consists of a device to generate a differential pressure across the piston. When filled with fluid, and the blocking valves closed, the operator simply provides a differential pressure gauge or transmitter to monitor any leakage while differential is applied. (Refer to static seal leak test). The latest version of the Honeywell Enraf small volume prover incorporates a hazardous area, intelligent controller, utilizing state-of-the-art microprocessor technology and a display to provide a window to the operation of the prover. When used with its associated Local Access Device (LAD) you are able to view the status of the calibration and perform diagnostics.

The contents of this manual provide general information and operational characteristics for the Honeywell Enraf small volume prover. This manual does not include information regarding auxiliary equipment for unique applications. Consult your factory approved service center for this information.

1.2 General Features

- Field replaceable precision optical volume measurement switches without recalibration
- Flow-through poppet valve piston to minimize flow disturbances
- Patented electromechanical chain drive piston return mechanism
- Operates from a conventional electrical circuit (options include single or 3 phase power in most standard voltages and frequencies)
- 24 Volt DC models available for portable proving applications requiring no outside electrical service. Please note that 24 VDC motors are available for installation on the prover sizes from the model S/O/P05 through S/O/P35 only
- Low consumables design reduces operating cost
- Quick and easy seal change. All seals are serviceable without removing the unit from the pipeline
- Free flowing piston greatly reduces induced line disturbances
- Operates with industry standard flow computers for meter proving capability and double chronometry
- Local display with menus driven by Local Access Device (LAD)
- Direct reading of sweep time (proving time)
- Alarm on/off display for flow computer
- Prover cycle counter
- Diagnostic dashboard
- Adjustable motor off delay which reduces wait time
- Scalable motor time off (system failure safe protection)
- Firmware in-situ upgradeable
- Alarm log records
- Calibration log records

These unique features provide greater confidence and operator convenience while attaining more accurate performance tests of a fluid flow meter in an operational line.

1.3 Honeywell Enraf small volume prover design specifications

Environmental Configuration: Honeywell Enraf small volume prover can be installed and used in different configurations as specified in the Table 1 (see next page).

Standard operating process temperature range: -40°C to +80°C (-40°F to +176°F). Consult factory for higher or lower temperature ranges.

Standard ambient temperature range: -20°C to +40°C (-4°F to +104°F). Extended Temperature Options: ATEX/IECEx range as broad as -40°C to +40°C (-40°F to +104°F) or -20°C to +60°C (-4°F to +140°F)

CSA range as broad as -40°C to +40°C (-40°F to +104°F)

Refer to the name plate for an individual units designed ambient and process temperature ranges.

Local Access Device (LAD)

Operating temperature: -20°C to +65°C (-4°F to +149°F)
Storage temperature: -40°C to +85°C (-40°F to +185°F)

Environmental Configuration (Position 1)	
S	Standard prover for onshore installation
O	Offshore prover: 316 Stainless Steel for wetted parts and for drive end mechanical components (chains, bars, sprockets etc)
P	Portable prover with trailer supplied

Table 1: Environmental Configuration

Operating flow range: The operating flow range depends of the meter type as stated in the Table 2 below. (**Please Note:** Below mentioned maximum flow rates must be de-rated when the fluids with viscosity above 100 cSt are used.)

FLOW RATE (Position 2, 3, 4)				
Model Type	**Displaced Volume (Gallons)**	**Maximum Flow (Barrels per Hour)**	**Maximum Flow (U.S. Gallons per minute)**	**Maximum Flow (cubic meters per hour)**
05	5	715	500	114
15	20	2140	1498	340
25	20	3570	2499	568
35	25	5000	3500	795
50	40	7200	5040	1145
85	75	12500	8750	1987
120	120	17500	12249	2782

Table 2: Prover Flow Range

"Manufactured pulses" Coriolis and Ultrasonic Flow meters : The maximum flow rate usable with these new generation meters depends on its pulse quality, its damping factor and response time. Consult the flow meter manufacturer for information on de-rating.

AISI 316/316L (UNS31600/UNS31603) stainless steel: Honeywell Enraf small volume provers can be supplied with wetted parts from 304 (AISI 304/304L - UNS30400/UNS30403) or 316 (AISI 316/316L - UNS31600/UNS31603) Stainless Steel material as specified in the Table 3 below. (Note: Materials choice should be based on product MSDS and application information supplied by the end user.)

Wetted Parts (Position 5)	
C	304 Stainless Steel flow tube with chrome plated bore. 304SS piston assembly, end flanges & shafts
E	316 Stainless Steel flow tube with chrome plated bore. 316SS piston assembly, flanges, & shafts (Required for ‘O’ Models)

Table 3: Wetted Parts

Operating pressure range: Honeywell Enraf small volume provers comply with ANSI 16.5 regulations depending on the prover flange rating and operating temperature. (Note: Any operating temperature outside the -29°C to +37.8°C (-20°F to +100°C) temperature range requires de-rating of maximum allowable pressure as per ANSI B16.5.

ANSI B16.5 Flange Rating (Position 6)		005	015	025	035	050	085	120
1A	Class 150 RF connection flanges		#	#	#	#	#	#
2B	Class 300 RF connection flanges		#	#	#	#	#	#
3C	Class 600 RF connection flanges	#		*	*	*	*	*
4D	Class 900 RF connection flanges	#		*	*	*	*	
4F	Class 1500 RF connection flanges							
6A	Class 150 RJ connection flanges		*	*	*	*	*	*
7B	Class 300 RJ connection flanges		*	*	*	*	*	*
8C	Class 600 RJ connection flanges	*		*	*	*	*	*
5D	Class 900 RJ connection flanges	*		*	*	*	*	
9F	Class 1500 RJ connection flanges				*			

"*" : available
"#" reduced lead time

Table 4: Pressure Condition Ranges

Inlet and Outlet Configuration: For easy installation and connection to the end user's piping system Honeywell Enraf small volume prover can be configured per Table 5 below.

INLET AND OUTLET CONFIGURATION (Position 8 and 9)	
0	Inlet both sides & Outlet flange left side
1	Inlet & Outlet flanges opposite-inlet right side
2	Inlet & Outlet flanges same side-right side
3	Flanges at 90°, Inlet on right side Outlet on top
4	Inlet & Outlet flanges same side-left side
5	Inlet & Outlet flanges both sides-double set
6	Inlet & Outlet flanges both on top
7	Inlet & Outlet flanges opposite-Inlet left side
8	Inlet flanges both sides & Outlet on top
9	Inlet flange on top & Outlet on left
11	Inlet flange on top & Outlet on right
12	Flanges at 90°, Inlet on right side Outlet on top
13	Inlet on right, Outlet on left, Outlet on top
14	Inlet and Outlet on the Bottom

Table 5: Inlet and Outlet Configuration

Motor Voltage Supply Options: The SVP motor characteristics have been established to satisfy the industry needs globally for most facility needs. Consult factory for other combinations.

Motor Voltage Supply (Position 10)								
	CSA	**005**	**015**	**025**	**035**	**050**	**085**	**120**
D	24 VDC	Y	Y	Y	Y			
A	120 VAC, 60 Hz	Y1	Y1	Y1	Y1	Y1		
B	220 VAC, 60 Hz	Y1	Y1	Y1	Y1	Y1	Y1	
H	220/240 VAC, 60 Hz, 3 phase	Y	Y	Y	Y	Y	Y	Y
E	460/480 VAC, 60 Hz, 3 phase	Y	Y	Y	Y	Y	Y	Y
	Motor Power	0.5 HP	1 HP	1 HP	1 HP	1 HP	2 HP	5 HP

Y from -40°C to +40°C

Y1 only available from -20°C to +40°C

Table 6: Motor Voltage Supply

	ATEX or IECEx	005	015	025	035	050	085	120
D	24 VDC	Z2	Z2	Z2	Z2			
C	220 VAC, 50 Hz	Z	Z	Z	Z	Z		
N	220/240 VAC, 50 Hz, 3 phase	Z1	Z1	Z1	Z1	Z1	Z1	
L	380/400/415 VAC, 50 Hz, 3 phase	Z	Z	Z	Z	Z	Z	Z
E	460/480 VAC, 60 Hz, 3 phase	Z	Z	Z	Z	Z	Z	Z
W	690 VAC, 60 Hz, 3 phase						Z	Z
	Motor Power	0.5 HP	1 HP	1 HP	1 HP	1 HP	2 HP	5 HP

Z Available 20°C to +60°C or -40°C to +40°C
Z1 only available -20°C to +60°C
Z2 only ATEX, no IECEx available

Table 6: Motor Voltage Supply

Electrical Agency Approvals & Certifications: The SVP provers has electrical agency approval for hazardous area classification installation that cover the industry requirements.

Electrical hazardous classification (Position 11)	
3	CSA/UL Class 1 Division 1 Group D T2C [CSA 70041568]
4	CSA/UL Class 1 Division 1 Group C T3B [CSA 70041568]
5	ATEX certified for II 2 (1) G Ex d [ia Ga] IIB T4 Gb
6	IECEx Ex db [ia Ga] IIB T4 [See Individual Equipment Markings]
X	Special approval (On request)

Table 7: Electrical hazardous classification

Prover Finish: The prover comes standard with a brushed finish to enhance the stainless steel materials. There is also an option for a white paint seal coat for a higher level of environmental protection if required.

Flow Tube finish (Position 12)	
A	Stainless Steel - Brushed
B	Painted (White)

Table 8: Flow Tube Finish

Temperature rating: The SVP is designed to operate continuously and reliably within its domain of temperature. Consult factory for higher or lower temperature ranges.

Ambiant temperature (position 13)	
1	Low Ambient temperature range (-40 °C to +40 °C) (-40°F to +104°F)
2	High Ambient temperature range (-20 °C to +60 °C) (-4°F to +140°F)
3	**Middle temperature range (-20°C to +40°C) (-4°F to +104°F)**

Table 9: Ambient temperature

Process Fluid temperature (position 14)	
A	**Standard (-40°C to +80°C) (-40°F to 176°F)**
B	Extended process temperature

Table 10: Process temperature

Options Extra optical switch: This switch reduces the volume signal to a lower displaced volume to reduce the calibration runtime on low flow rates. The smaller stroke volume is selected via a menu option. Position of the third optical switch depends on the application : Please contact your nearest sales office.

Third optical switch (position 15)	
0	**Without third optical switch**
1	With third optical switch

Table 11: Optical switch

Nitrogen purge system: The purge covers consist of both a cover on the downstream shaft and a cover for the drive end and are needed to prevent icing of the shaft that can occur when the product temperature is below 0 °C (32 °F) when in operation. Covers are made of stainless steel and will have O-ring sealing. The kit includes a pressure relief valve. The drive end will also be purged via a purge control system. Purge system may be manual or automatic, but the automatic purge is not available below -20 °C (-4 °F) ambient temperature.

Nitrogen purge (position 16)	
0	Without Nitrogen purge system
1	Nitrogen purge system, Automatic
2	Nitrogen purge system, Manual

Table 12: Nitrogen purge

Insulation

This option is for applications on process fluid temperatures low or high (above 60 °C - 140°F). It consist of two parts:

1. An insulation plate between the drive unit and flow tube.
2. An insulation jacket for the flow tube. This is model-dependent and not suited for tracing. — For low temperature applications the insulation plate is a minimum requirement to protect the drive end.

Insulation (position 17)	
0	**Without insulation**
1	Insulation plate
2	Insulation jacket and plate

Table 13: Insulation

Pullers: Models 35, 85 or 120 come with one puller as standard on the chain drive pulling system. Adding an additional puller decreases the idle time between runs and increases the frequency of the proving runs.

Additional puller (position 18)	
0	**Standard (Two pullers except models 35, 85, 120)**
1	Additional puller on model 35, 85 or 120

Table 14: Pullers

Seal material: Standard seals are made of Ekonol® filled PTFE. For crude oil applications it is advisable to use carbon-reinforced seals to increase their lifetime.

Reinforced seal (position 19)	
0	Standard Ekonol filled PTFE seal
1	Carbon Fiber Reinforced PTFE seal for crude oil applications

Table 15: Seals

Location and power of controller: On the standard design the controller is facing right, as on the pictures. For constrained spaces it is possible to locate the controller facing left. The SVP controller can be supplied in AC (100-240 VAC, Single Phase) or 24 VDC version. 70 Watts service recommended.

Controller (position 20)	
0	AC voltage, facing right
1	AC voltage, facing left
2	24VDC power supply, facing right
3	24VDC power supply, facing left

Table 16: Controller

Pressure and temperature transmitters: The prover is delivered as standard with Honeywell Smart transmitters ST800 and STT 250. Other brands, or delivery without transmitters, are available on request.

Transmitters (position 21)	
0	Standard Honeywell Transmitters
1	Other transmitters
2	No transmitters

Table 17: Transmitters

Pressure approvals: Testing & material certificates can be provided according to 97/23/EC Directive. Material certificates will be according to ISO EN10204: 2004 3.1 or ISO EN10204: 2004 3.2

Positive material identification on welds and pressurized parts will be performed according API 587 on the parts as these enter the factory in Roswell, GA.

Pressure approvals (position 22)	
0	No approval
1	PED (Pressure Equipment Directive) 97/23/EC
2	PMI (positive material identification) on welds and pressurized parts
3	PMI +PED

Table 18: PED/PMI

NACE and Water Draw: NACE MR-0175 conformity for wetted and pressurized parts (for use in corrosive environments in oil and gas production).

The standard factory test is volumetric water draw by gravimetric calibration (API Chapter 4.9.4). On request the factory can calibrate the prover with volumetric method water draw according to API MPMS 4.9.2

(Position 23)	
0	No NACE, gravimetric water draw
1	NACE MR-0175 (ISO 15156)
2	Volumetric water Draw according to API MPMS 4.9.2
3	NACE and volumetric water draw

Table 19: NACE and water draw

Using the values from Table 1 through 9 allows information of the design of the prover. (EXAMPLE: S25C1A4H4AH)

Maximum allowable flange loads: It is customer's responsibility to design the piping system so that the forces (loads) on the inlet and outlet nozzles of the prover are lower than the maximum allowable loads specified in the Table 10.

S/O/P05 – Inlet/Outlet Nozzle Nominal Diameter: 3 inch							
Top Nozzle	FX =	467 N	105 lb_f	Each Nozzle	Mx =	664 Nm	490 lb_f•ft
	Fy =	747 N	168 lb_f		My =	503 Nm	371 lb_f•ft
	Fz =	623 N	140 lb_f		Mz =	332 Nm	245 lb_f•ft
Side Nozzle	FX =	747 N	168 lb_f				
	Fy =	623 N	140 lb_f	Resultant	Fr =	1993 N	448 lb_f
	Fz =	934 N	210 lb_f		Mr =	1329 Nm	980 lb_f•ft

S/O/P15, S/O/P25 – Inlet/Outlet Nozzle Nominal Diameter: 6 inch							
Top Nozzle	FX =	1090 N	245 lb_f	Each Nozzle	Mx =	1613 Nm	1190 lb_f•ft
	Fy =	1744 N	392 lb_f		My =	1234 Nm	910 lb_f•ft
	Fz =	1432 N	322 lb_f		Mz =	826 Nm	609 lb_f•ft
Side Nozzle	FX =	1744 N	392 lb_f				
	Fy =	1432 N	322 lb_f	Resultant	Fr =	4671 N	1050 lb_f
	Fz =	2180 N	490 lb_f		Mr =	3322 Nm	2450 lb_f•ft

S/O/P35, S/O/P50 – Inlet/Outlet Nozzle Nominal Diameter: 8 inch							
Top Nozzle	FX =	1650 N	371 lb_f	Each Nozzle	Mx =	2468 Nm	1820 lb_f•ft
	Fy =	2647 N	595 lb_f		My =	2577 Nm	1901 lb_f•ft
	Fz =	2180 N	490 lb_f		Mz =	1234 Nm	910 lb_f•ft
Side Nozzle	FX =	2647 N	595 lb_f				
	Fy =	2180 N	490 lb_f	Resultant	Fr =	7162 N	1610 lb_f
	Fz =	3425 N	770 lb_f		Mr =	4935 Nm	3640 lb_f•ft

S/O/P85 – Inlet/Outlet Nozzle Nominal Diameter: 12 inch						
Top Nozzle	FX =	2865 N	644 lb_f	Each Nozzle	Mx =	4271 Nm	3150 lb_f•ft
	Fy =	4671N	1050 lb_f		My =	3227 Nm	2380 lb_f•ft
	Fz =	3737 N	840 lb_f		Mz =	2088 Nm	1540 lb_f•ft
Side Nozzle	FX =	4671 N	1050 lb_f				
	Fy =	3737 N	840 lb_f	Resultant	Fr =	9030 N	2030 lb_f
	Fz =	5605 N	1260 lb_f		Mr =	7782 Nm	5740 lb_f•ft

S/O/P120 – Inlet/Outlet Nozzle Nominal Diameter: 16 inch							
Top Nozzle	FX =	3737 N	840 lb_f	Each Nozzle	Mx =	5125 Nm	3780 lb_f•ft
	Fy =	5916 N	1330 lb_f		My =	3796 Nm	2800 lb_f•ft
	Fz =	4671 N	1050 lb_f		Mz =	2562 Nm	1890 lb_f•ft
Side Nozzle	FX =	5916 N	1330 lb_f				
	Fy =	4671 N	1050 lb_f	Resultant	Fr =	11521 N	2590 lb_f
	Fz =	7162 N	1610 lb_f		Mr =	10535 Nm	7770 lb_f•ft

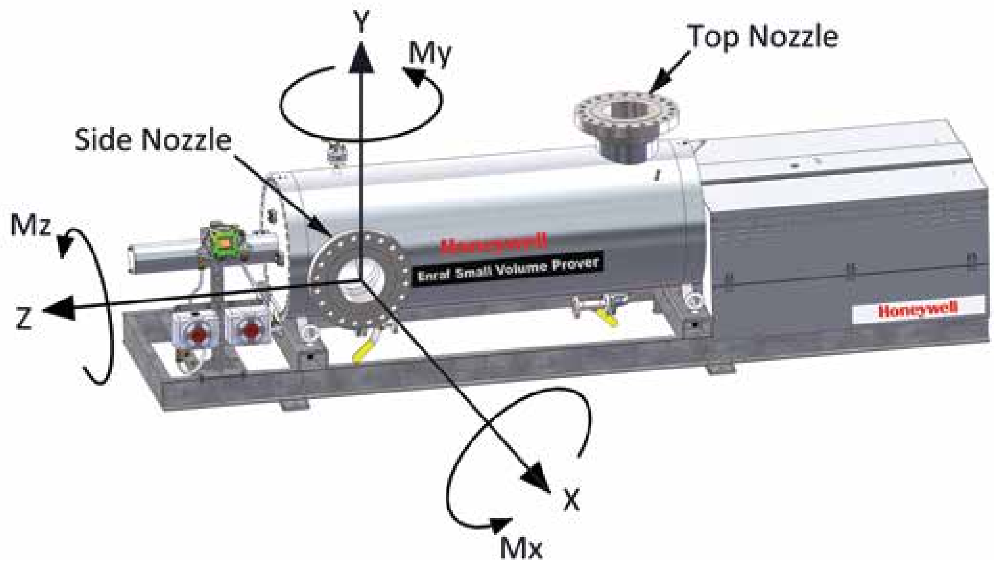
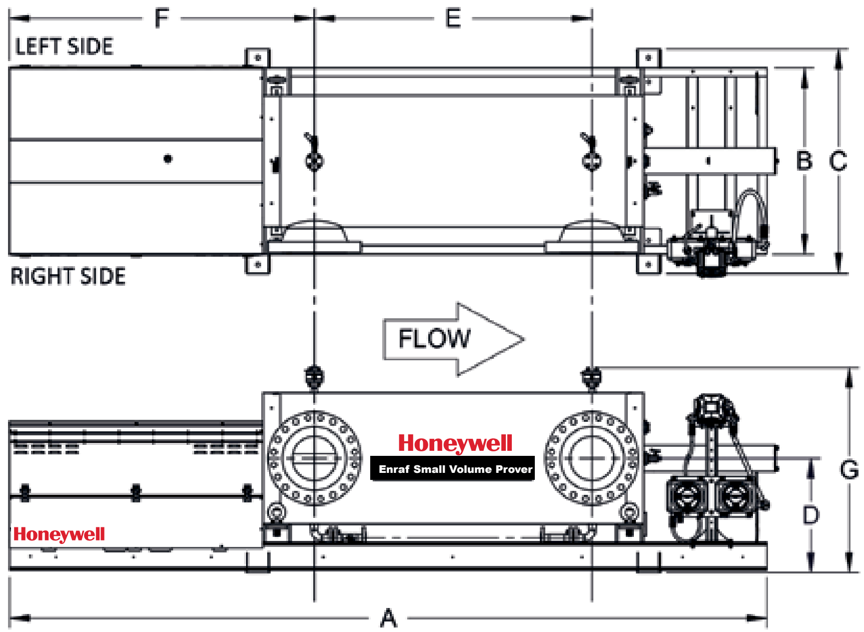


Table 20: Maximum allowable inlet and outlet flange loads

Prover critical dimensions: See prover's critical dimensions provided below.



Dimension Description mm [inches]	MODEL	005 ANSI 600	015 & 025 ANSI 150	035 ANSI 150	050 ANSI 150	085 ANSI 150	120 ANSI 150
Length	A	2756 [108.5'']	4089 [161.0'']	4089 [161.0'']	4572 [180.0'']	5258 [207.0'']	5576 [219.5'']
Width at Frame	B	813 [32.0'']	986 [38.8'']	1092 [43.0'']	1245 [49.0'']	1448 [57.0'']	1549 [61.0'']
Width at Feet	C	947 [37.3'']	1118 [44.0'']	1227 [48.3'']	1378 [54.3'']	1588 [62.5'']	1702 [67.0'']
Inlet & Outlet Height**	D	424 [16.7'']	513 [20.2'']	565 [22.3'']	673 [26.5'']	756 [29.8'']	840 [33.1'']
Inlet & Outlet Separation**	E	780 [30.7'']	1369 [53.9'']	1299 [51.2'']	1473 [58.0'']	1930 [76.0'']	2045 [80.5'']
Inlet Distance from End**	F	955 [37.6'']	1499 [59.0'']	1534 [60.4'']	1873 [73.7'']	2106 [82.9'']	2244 [88.4'']
Highest Point**	G	1207 [47.5'']*	1257 [49.5'']*	1257 [49.5'']*	1308 [51.5'']*	1316 [51.8'']	1481 [58.3'']
Inlet & Outlet Flange Size		3 Inch	6 Inch	8 Inch	8 Inch	12 Inch	16 Inch

NOTES:
1. All dimensions are in mm (inches)
2. Dimensions 'D', 'E', 'F' and 'G' may vary according to model type/ configuration
3. All dimensions vary according to pressure rating
4. All dimensions are subject to change
5. *Highest Point is SVP Controller. Offshore Provers are 2" (51mm) taller.
6. **All values may vary due to selected options. These dimensions are particularly affected by pressure rating, . Consult General Arrangment Drawings for specific values.

Table 21: Prover Dimensions

Pressure drop: Pressure drop measured between inlet and outlet of the prover is specified in the Table 12 (see below). The drop is obtained at maximum flow rate using water as a fluid.

Honeywell Enraf SVP MODEL	FLOW RATE (BPH)	PRESSURE DROP
S05	785	69 kPa (10.0 psig)
S15	2,140	28 kPa (4.0 psig)
S25	3,570	52 kPa (7.5 psig)
S35	5,000	69 kPa (10.0 psig)
S50	8,000	69 kPa (10.0 psig)
S85	12,500	69 kPa (10.0 psig)
S120	17,500	55 kPa (8.0 psig)

Table 22: Maximum pressure drop per prover size

1.4 Tests and Certifications

The Honeywell Enraf small volume provers are factory tested on the following before shipment:

I. **Electrical Tests:** Dielectric strength and ground bond test.

II. **Hydrostatic Pressure Test:** Hydrostatic pressure test is done per ASME, Section 8, Pressure Vessel Code. Prover wetted parts are pressurized for four hours and the pressure has been recorded.

III. **Water Draw Calibration Test:** Water Draw calibration using NIST traceable test equipment on an NMI certified test stand. The water draw is performed by the gravimetric method using the Honeywell Enraf dual-valve assembly in conjunction with an electronic scale. Base volume on the certificate of calibration is corrected to 0 psig and 60°F (or to meet alternate standard conditions specified by customer). If requested, the water draw calibration can be completed using volumetric method.

IV. **Piston Seal Leak Test:** During the execution of the piston seal leak test the differential pressure will be maintained across the piston assembly for at least 20 minutes.

V. **Function Test:** As a final stage of the testing procedure the Honeywell Enraf small volume provers are functionally tested on water test loop. Each prover is operated at all flow rates including minimum and maximum flow rates.

1.5 Principle of Operation

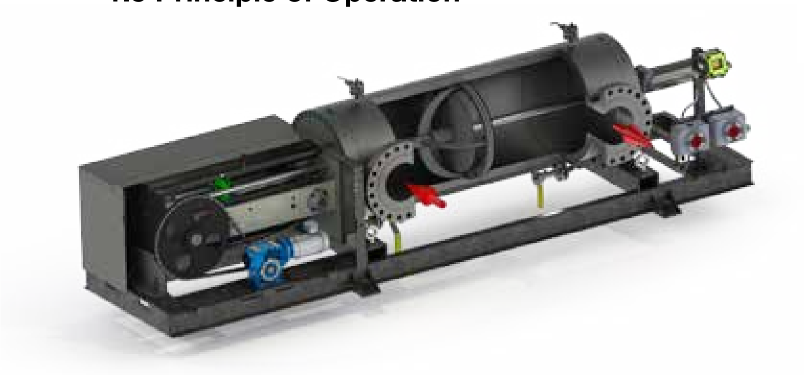


Figure 1-1: Prover in Stand-By Mode

In the stand-by mode the piston is down-stream and stationary, see Figure 1-1. The piston's inner *flow-thru* poppet valve is open allowing free flow of the fluid through the measurement cylinder with minimal pressure drop.

When the operator initiates a proving run sequence, the flow computer signals the return drive motor to pull the piston to the up-stream position. The piston then mechanically disconnects from the chain drive return mechanism. When the piston is released, the flow-thru poppet valve closes by spring tension as seen in Figure 1-2. The piston is now free to follow the fluid flow with the least possible effect on the flow stream. The piston velocity is now **synchronized** with the fluid velocity.

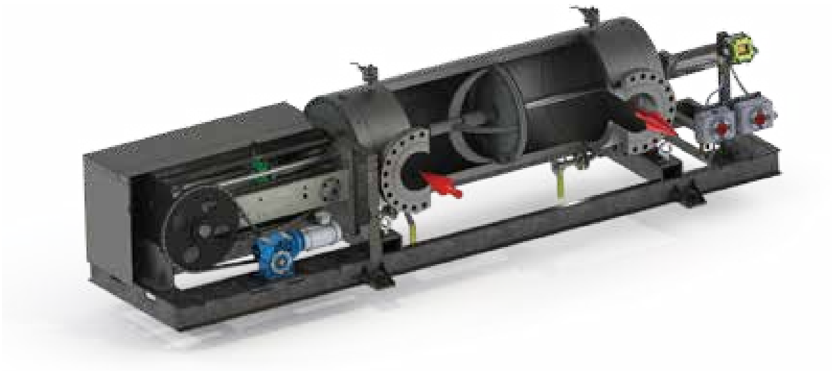


Figure 1-2: Prover During Prove Run - Mid-Run

After the piston has been released and synchronized with the fluid flow, the precision optical start of volume switch is actuated, which sends a signal to the flow computer to start the timing sequence. The piston continues downstream with the flow. Upon reaching the end of volume switch, a signal is sent to the flow computer to stop the timing sequence. After passing the end of volume switch, the piston shaft is stopped mechanically. The fluid pressure in the prover pushes the perimeter of the piston further downstream, opening the flow-thru poppet valve, allowing the flow to continue with little to no pulsation or surge in line pressure. The return drive motor is started electronically to pull the piston back upstream if the flow computer requires more passes and the above sequence is repeated.

2.1 Receipt of Equipment

The Honeywell Enraf small volume prover is pressure and function tested and water draw calibrated at the factory prior to shipment. When the equipment is received, inspect the outside of the packing case or cases to see if the case has been damaged. If there has been any damage to the case, the carrier should be notified immediately concerning their liability for damage to the equipment.

If anything is missing or incorrect from your shipment, please contact your local Honeywell Enraf sales representative or sales office. Have the serial number and sales order number of your order available to help expedite any needed assistance.

2.2 Return Shipment

Before any attempt is made to return the shipment, in part or whole, contact a Honeywell representative. The Honeywell Global Technical Support group (HFS-TAC) should be contacted for all requests or inquiries relating to service, operation, repair and/or replacement.

By telephone: 1-800-423-9883

By email: HFS-TAC-Support@Honeywell.com

2.3 Mechanical Installation

The Honeywell Enraf small volume prover has been designed to be used as a portable or as a stationary mounted flow prover. The Honeywell Enraf small volume prover may be installed upstream or downstream of the meter under test as the displaced volumes are equal.

When installing the Honeywell Enraf small volume prover, follow all recommended procedures regarding placement of the prover in relation to the flow meter. To assure that all the flow goes through the prover, use double block and bleed type diverter valves.

Refer to the system overview in the Figure 2-1 (Process Connections and General Arrangement) for connecting the Honeywell Enraf small volume prover to the process line. Before connecting the prover, be certain that all piping and connections are clean and unobstructed. Also, ensure that no debris, i.e.: weld slag; will be introduced into the system. Check all drain and vent valves on the prover to make certain that they are closed.

Please Note: It is an advantage to provide sufficient back pressure on the down-stream side of the flow prover in order to achieve satisfactory repeatability results.

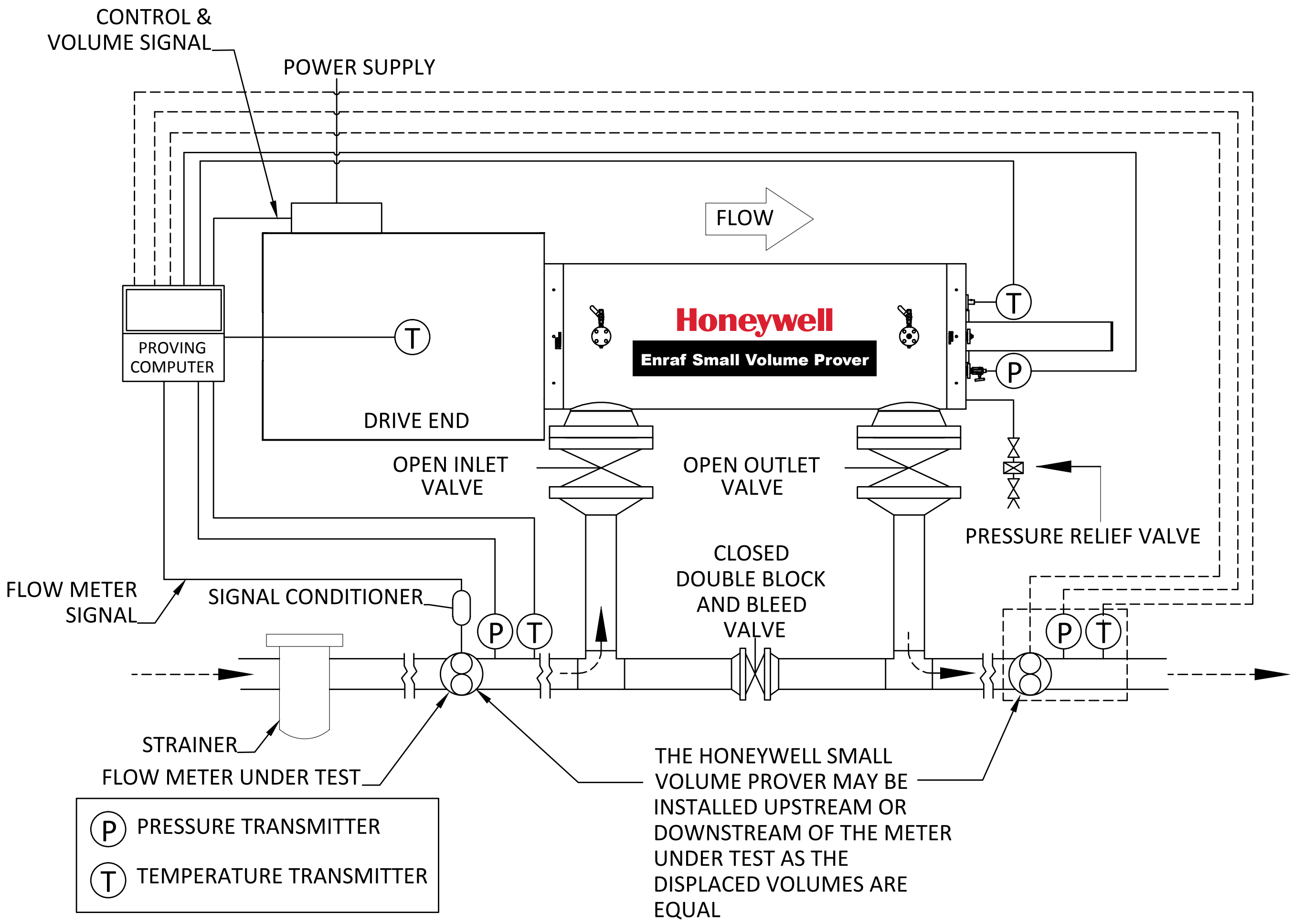


Figure 2-1: Process Connections and General Arrangement

Warning

Do not exceed the maximum working pressure of the prover as detailed on the nameplates.

It is the customer's responsibility to install the prover in a system that is protected by correctly sized over-pressure protection.

Process lines should be cleaned thoroughly by flushing before installation, to eliminate potentially damaging foreign material from entering the prover.

A correctly specified strainer should be installed upstream of the prover to protect it from the introduction of foreign material.

Caution: *Be certain that all flanges, bolts, dry break couplers, hammerlock fittings, hoses/loading arms, and pressure containing components have sufficient pressure rating. Also be absolutely certain that the flow direction through the prover is correct!*

The Honeywell Enraf small volume prover is equipped with integral lifting points. Figure 5 shows the location of these points along with an approximate weight distribution of the prover. Please use these lifting points for all movement of the prover to avoid damage to the unit.

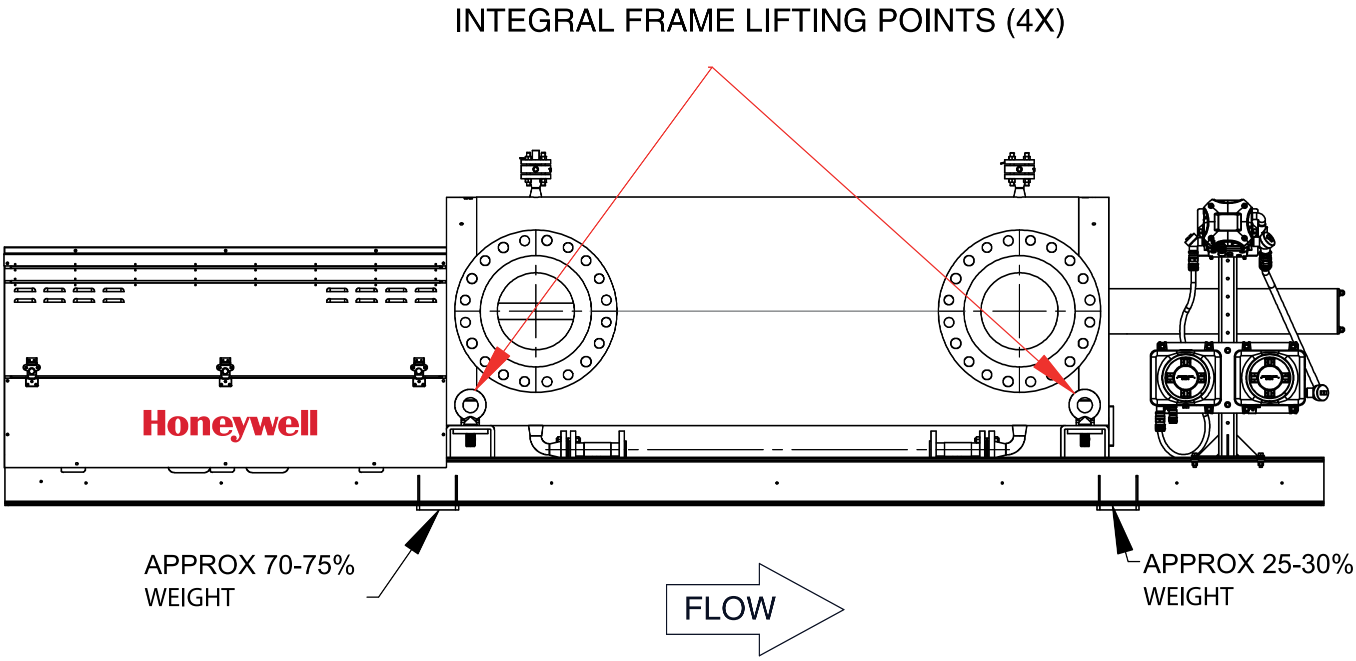
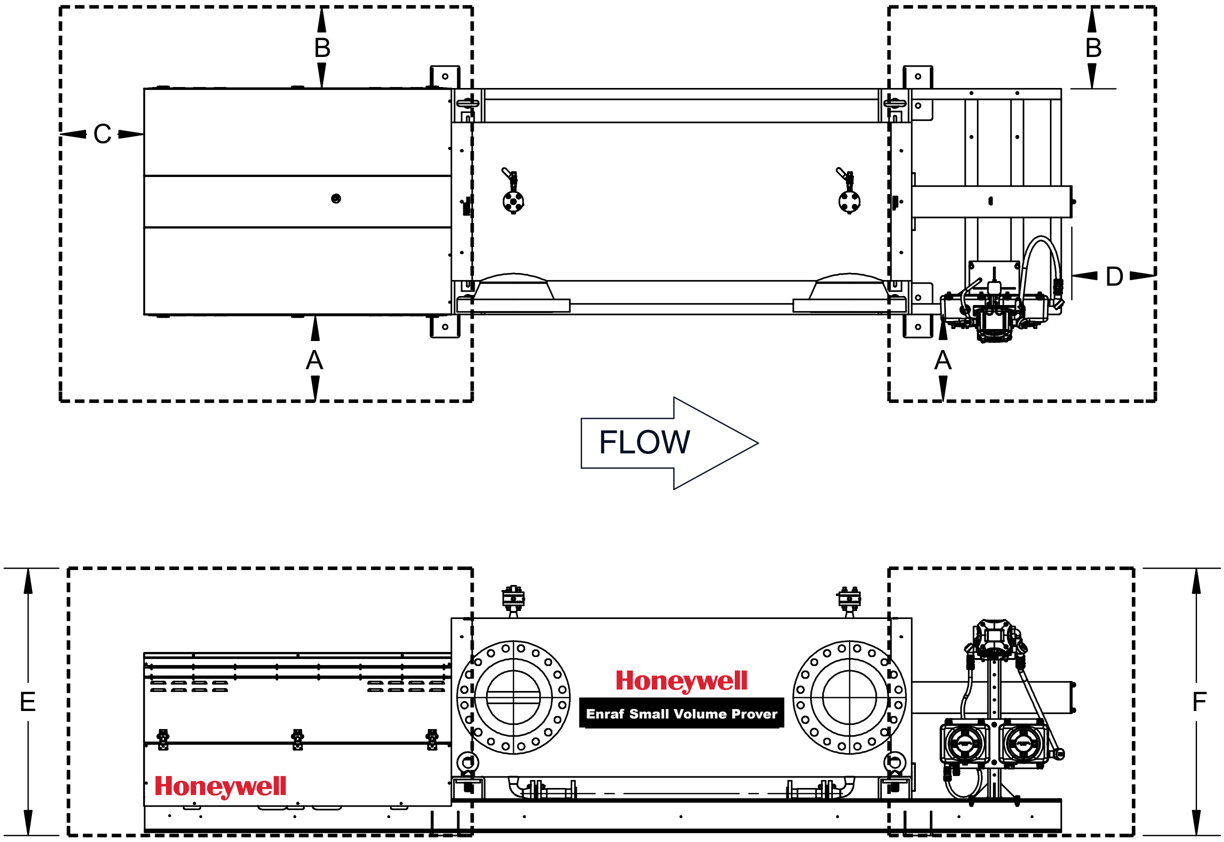


Figure 2-2: Prover Lifting Diagram

As with all pressure containing equipment, it is essential to protect your Honeywell Enraf small volume prover from any possible route of suffering the impact of a foreign body. This especially applies to provers located in high vehicular traffic areas and portable units. Permanent vehicle barricades or pylons are highly recommended around the perimeter of the unit and again at the inlet/outlet connections.

Extra inspection should be given to portable units after transport operations to ensure that no foreign body impacts have been encountered that would sacrifice pressure containing components.

Please remember to place permanent structures of any type outside the required Service Clearance area detailed in Figure 2-3.



MODEL	A	B	C	D	E	F
05	610 (2)	610 (2)	610 (2)	1220 (4)	1520 (5)	1520 (5)
15	610 (2)	610 (2)	610 (2)	2140 (7)	1520 (5)	1830 (6)
25	610 (2)	610 (2)	610 (2)	2140 (7)	1520 (5)	1830 (6)
35	610 (2)	610 (2)	610 (2)	2140 (7)	1520 (5)	1830 (6)
50	920 (3)	920 (3)	920 (3)	2750 (9)	1830 (6)	2140 (7)
85	920 (3)	920 (3)	920 (3)	3050 (10)	2140 (7)	2140 (7)
120	1220 (4)	1220 (4)	1220 (4)	3360 (11)	2440 (8)	2440 (8)

NOTES:

1. The lettered dims represent a minimum recommended service clerance around the prover
2. All dimensions are in mm (ft)
3. Clearance must be provided by customer

Figure 2-3: Prover Service Clearance Diagram

The Honeywell Enraf small volume prover should be installed on a flat surface and secured using 4 bolts through the pre-determined anchor points on the prover frame (see Figure 2-4). It is recommended to bolt the prover to the slab/trailer at these four locations only. It is not recommended to use any other method or type of securing the prover against the movement during operation. Honeywell Enraf will not be responsible for possible damages to the prover or system parts if these recommendations are not followed.

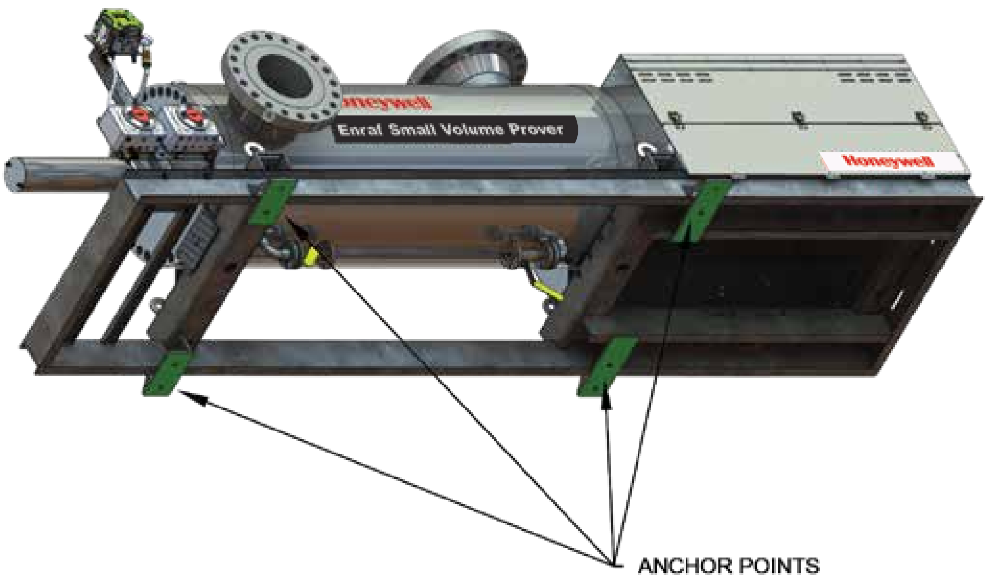


Figure 2-4: Designated anchor points (plates) located on the bottom side of the prover frame.

The Honeywell Enraf small volume prover is fitted with transit seals in both the up & downstream shaft seal retainers upon its shipment from the factory. It is important to replace these seals during the commissioning procedure and prior to the process fluid being introduced into the unit. An additional set of seals are supplied with every prover for this purpose.

2.4 Electrical Connection

The Honeywell Enraf small volume prover can be certified as compliant with one of the following:

CSA/US certified for Class 1 Group D T2C

CSA/US certified for Class 1 Group C T3B

ATEX certified for II 2 (1) G Ex d [ia Ga] IIB T4 Gb

IECEx compliant for Ex db [ia Ga] IIB T4 (See Individual Certificates)

Be certain to conform to all applicable national and local electrical codes when making electrical connections to the Honeywell Enraf small volume prover to maintain electrical safety ratings.

Refer to Section 7 of this manual for connection to several brands of flow computers. The proving computer used for the operation of the provers **must** be equipped with the double chronometry function. For brands not detailed, consult Honeywell Enraf and the flow computer manufacturer.

If equipped with CONDAT® or Prove-It prover control systems, refer to the operators' manual for instructions for installation and operation.

The Honeywell Enraf small volume prover must be correctly earth grounded prior to electrical service connection.

2.4.1 Field wiring

The installation of this device must be carried out in accordance with all appropriate international, national and local standards and site regulations for intrinsically safe apparatus.

2.4.2 Breaker

A readily accessible disconnecting/breaker device shall be incorporated external to the equipment.

2.4.3 Enclosures

The picture below shows the three electrical enclosures mounted on the Small Volume Prover. The connections to the SVP Controller Box are made at the factory and must not be modified. All of your connections are to be made in the Power Box and the Customer Connection Box.

Figure 2-5: Electrical Enclosures

2.4.3.1 Customer Connection Box

The picture below shows the Customer Connection Box where you can connect your flow computer and other signals to the SVP.

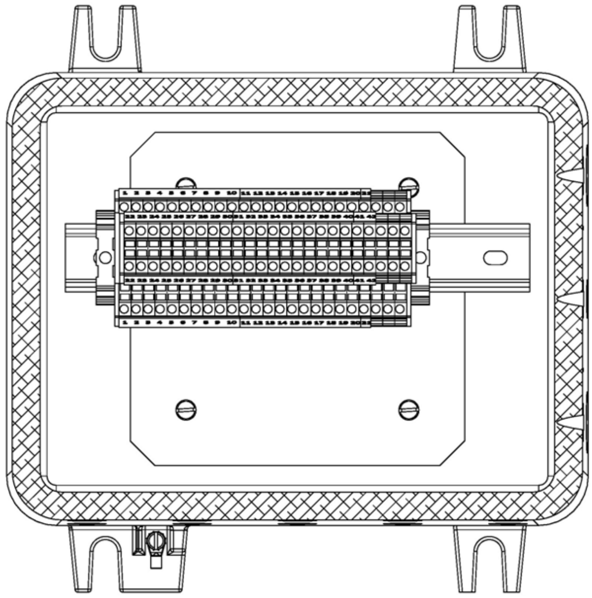


Figure 2-6: Customer Connection Box

2.4.3.2 Power Box

The picture below shows the Power Box with two separate power connections: one for the motor which generates electrical noise during operation and one for clean or instrument power.

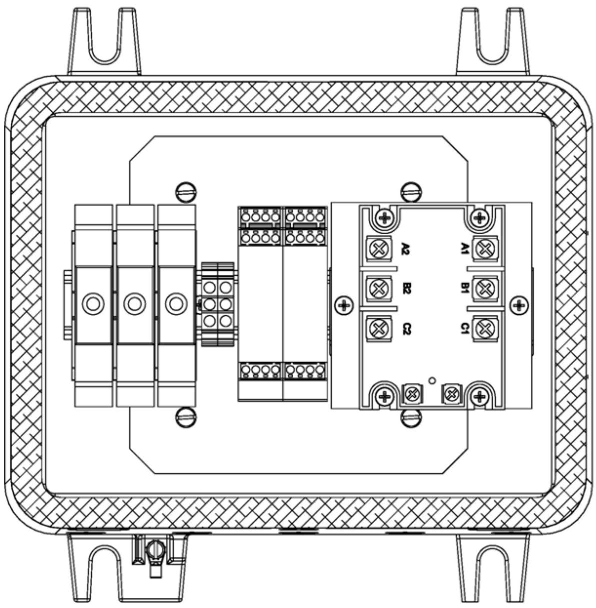


Figure 2-7: Power Box

2.4.3.3 SVP Controller Box

Connection of the LAD is as shown below.

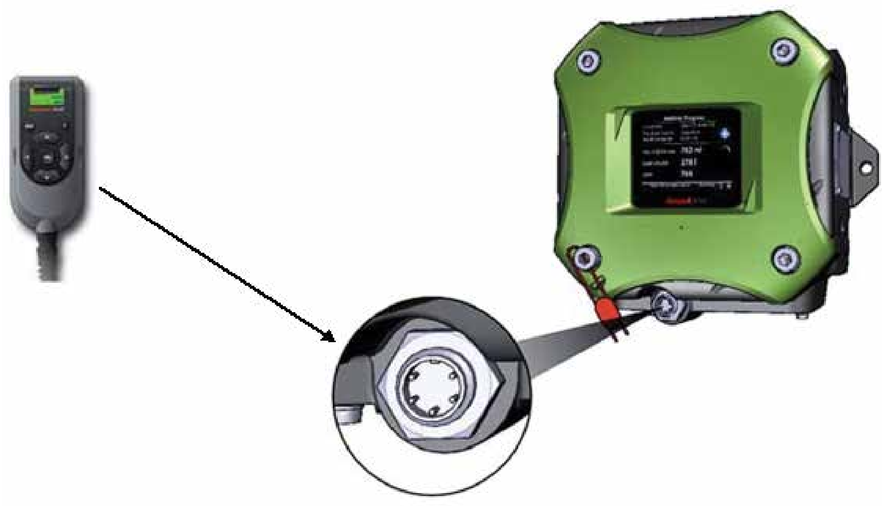


Figure 2-8: SVP Controller Box with LAD

CHAPTER 3 CONTROLLER INFORMATION

3.1 Initial Power up

Upon initial power up of the SVP Controller the Prover Status screen will be displayed showing the operating mode of the prover (Meter Calibration, Prover Calibration, or Prover Test) and the following information:

- Piston status or position
- Motor status
- Error status
- Number of cycles
- Stop time
- Sweep time

An example of a Prover Status screen is shown below.

Prover Status · Meter Calibration	
Piston	Parked Position
Motor	Idle
Error Status	No Error
Cycle	776
Stop Time	10-31-12 11:29:32 AM
Sweep Time	00:00:01:102

Press OK to enter menu	Stop	

3.2 Navigating the SVP Controller Menus Using the LAD

Pressing the OK button on the Local Access Device (LAD) will result in the Main Menu screen being displayed on the SVP Controller.

3.2.1 Text Conventions

In the following sections of this document the entity and entity related text are shown in a distinctive format as shown below.

All [Entity] and <entity-related> text is recognizably formatted.

3.2.2 General

The SVP Controller can be configured through the wired Ex i interface with a Local Access Device (LAD).

The LAD (Local Access Device) is a hand held controller used to interface with the Fusion4 product family, allowing tasks such as parameter adjustment, alarm resetting, and calibration. The device facilitates two-way data communications between the SVP Controller and the LAD, allowing the rapid transfer of transaction data, configuration files and calibration records, and even firmware upgrading while in the field.

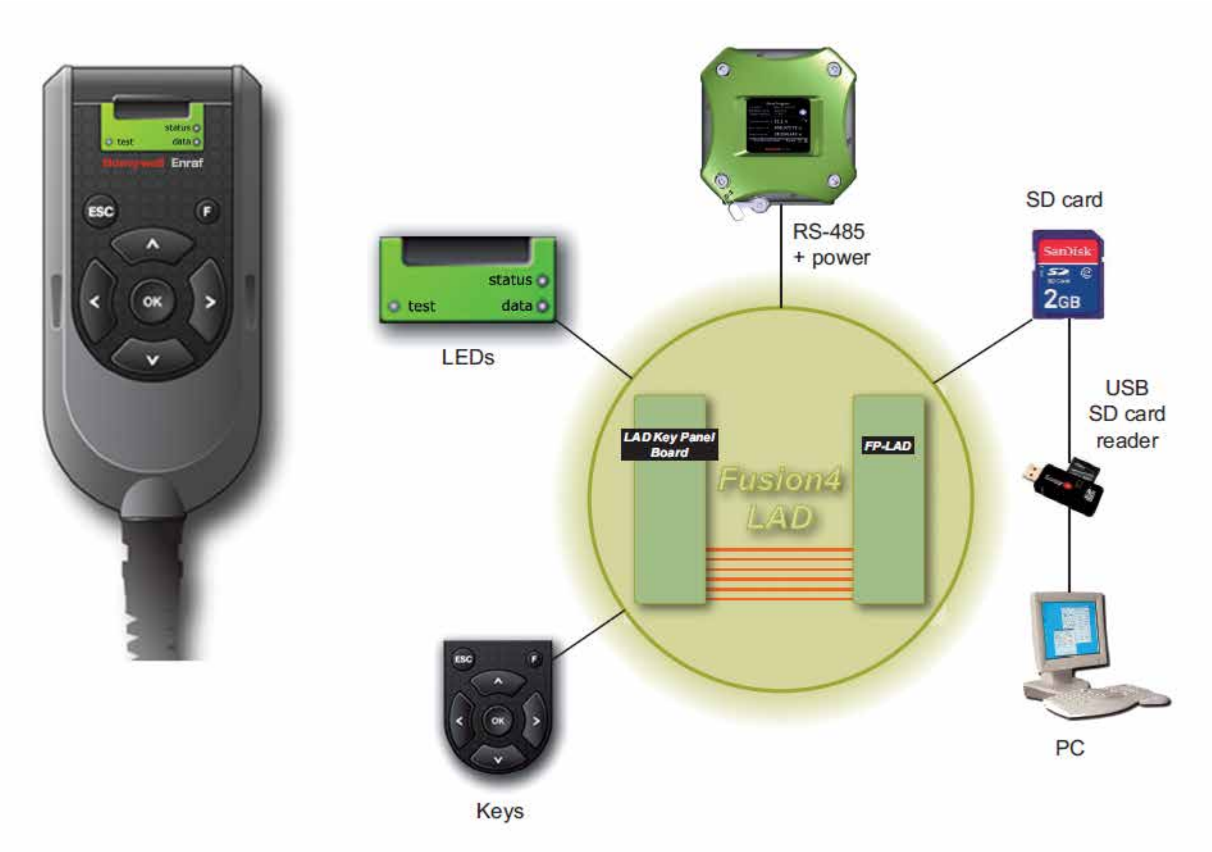


Figure 3-1: The Local Access Device (LAD) and its system overview

3.2.3 Commissioning

The LAD is used to commission the SVP Controller by configuring entities (or parameters) to the desired specific values. This is done by using the LAD to navigate through the Menu functions of the SVP Controller (See 3.3.4).

3.3 Menus and Navigation

3.3.1 General

An intuitive and informative Human Machine Interface (HMI) is available to the user to operate, configure, and service the SVP Controller. This menu-based user interface is as clear and accessible as possible, using easily understandable colored icons for the Main Menu and logically structured sub-menus.

3.3.1.1 Key benefits

- Clean, intuitive, and informative user interface
- No need to memorize parameter codes, enumeration value
- Diagnostic screens
- Record-based approach to transactions and calibrations make re-use possible
- Interoperable with the Local Access Device (LAD)
- Provides a graphical user interface to the LAD

3.3.2 Main Menu

Figure 3-2: Main Menu

3.3.3 Screen Input Fields

3.3.3.1 Text Input Screen

Figure 3-3: Text Input Screen

3.3.3.2 Numeric Input Screen

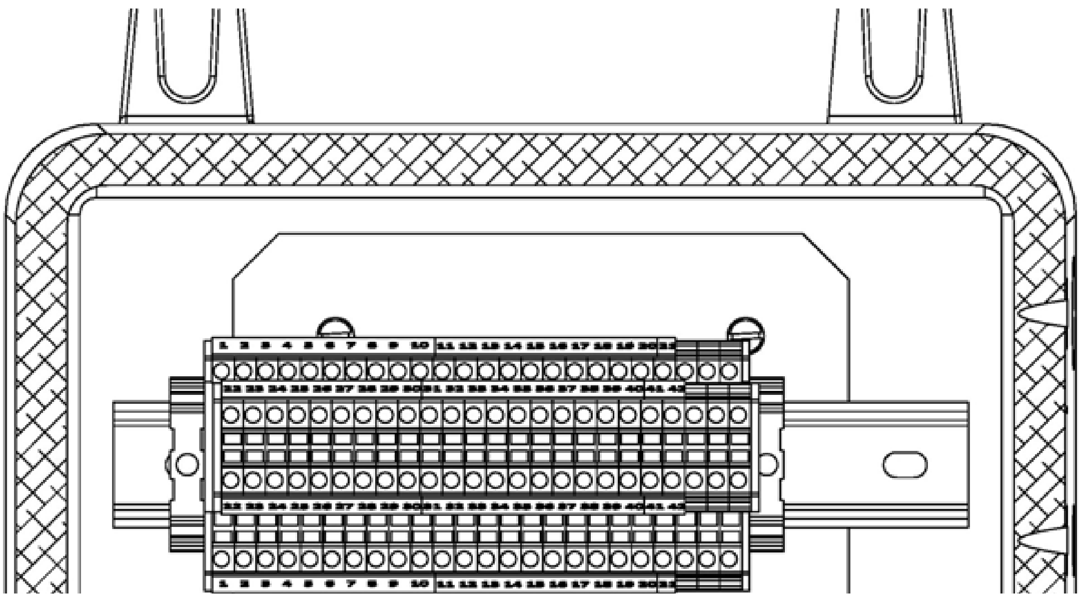


Figure 3-4: Numeric Input Screen

3.3.3.3 Enumeration Input Screen

Figure 3-5: Enumeration Input Screen

3.3.3.4 Status Bar

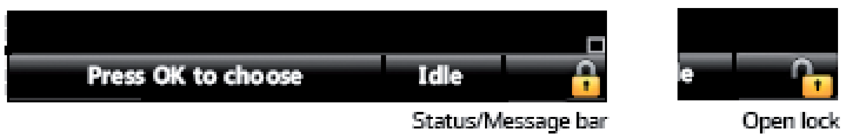


Figure 3-6: Status Bar

- Always visible on all screens
- Contains the following information:
  - Context-specific information/directions to user
  - Status of the transactions (e.g., Idle, Running, Error)
  - Device Locking Icon

3.3.4 Menu Structure

For a high level overview of the entities and parameters, see the following diagram (Figure 3-7).

For a detailed view of all menu items, see the individual section.

Continued on next page

Continued from previous page

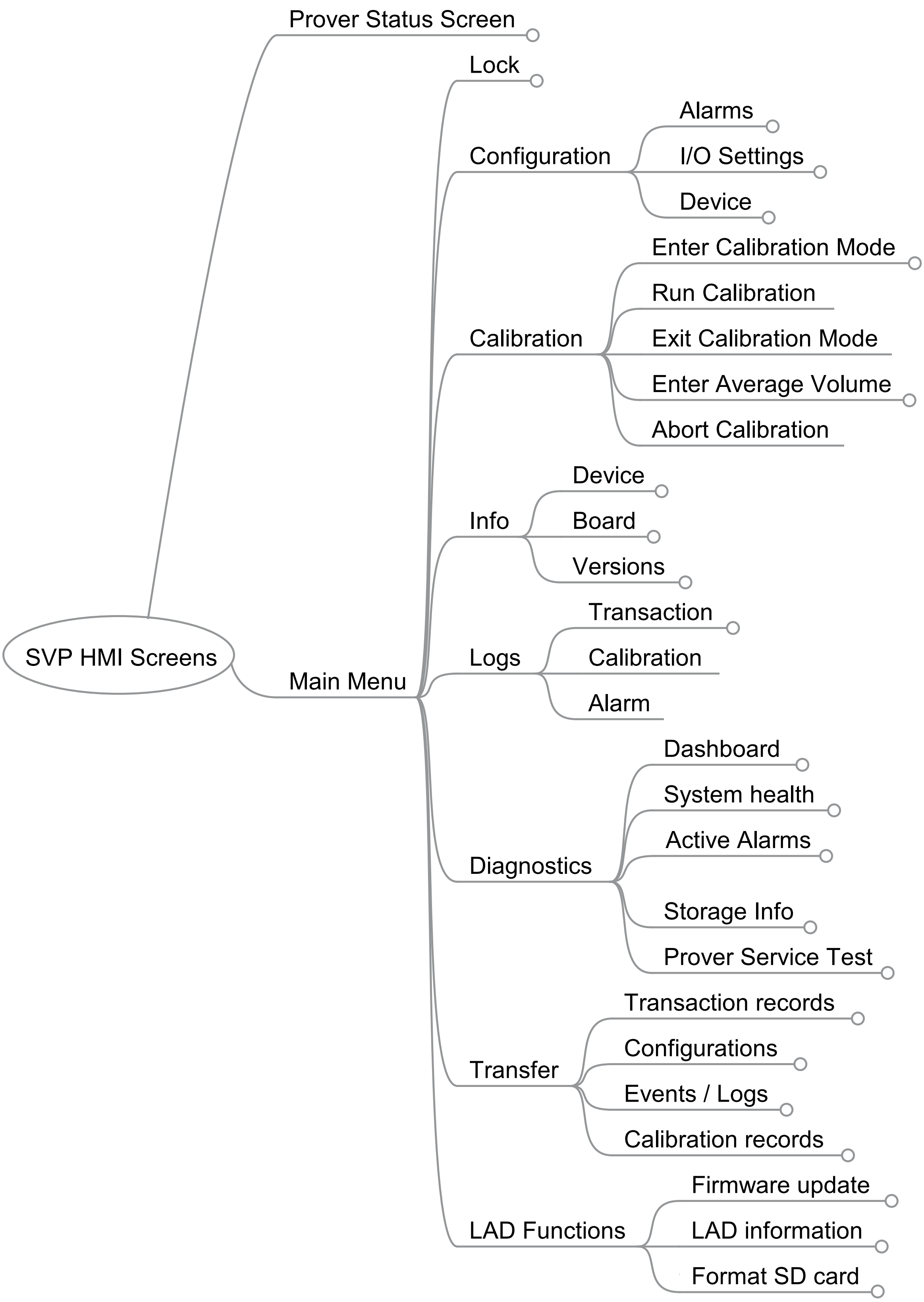


Figure 3-7: Menu Structure

3.3.5 Device Locking Menu 

Within this screen, the user can lock and unlock the SVP Controller.

- A single password is used to lock the controller from further configuration via HMI.
- Password is alphanumeric
  - Only capital letters
  - A-Z, 0-9, _, and '.'
  - No spaces
  - Maximum of 6 characters
- Device remains unlocked until explicitly locked again

The "lock status" is shown at the status bar in the bottom right corner (padlock) as seen in the following screen.

Figure 3-8: Device Locking Menu

To lock the device, the user must enter a password.

Figure 3-9: Password Input Screen

To unlock the controller, the user must enter the password as entered during the locking of the controller. The password will be stored in non-volatile memory.

Note that the locking feature is not infallible as the password is visible to any user with a LAD connected to the controller. It is intended to keep the uninformed user from accidentally changing configuration settings. Changing the configuration parameters will not affect the performance of the prover although caution must be used if changing the Motor parameters or the Sensor Pair. Changing of the Sensor Pair is only applicable if you have the optional third optical switch installed.

Changing of the Motor parameters should only be done after consultation with Honeywell Enraf experts as damage to the drive end could occur; the Motor parameters are set at the factory for the specific model of your prover.

When the device is locked, the following configuration parameters cannot be changed via the LAD menu until the user unlocks the controller again.

>>Device

1. Identification
   - Site Name
   - Device Name
2. Units
   - Units of volume
3. Display
   - Display brightness
   - Display Contrast
   - Session time out value
4. Time
   - Date display format
   - Time display format
   - Date
   - Time
5. Motor
   - Motor switch timeout
   - Motor off delay
6. Sensor Pair
7. Volume
   - Total volume
   - Upstream volume
   - Downstream volume

>> I/O Setting

1. Output
   - Alarm Relay output

>> Alarm

1. Service due reminder
   - Alarm action
2. Machine Fault
   - Alarm action
3. Cycle count Threshold
   - Cycle count

>> Cannot apply configuration (path is Transfer/Configuration/ Apply Configuration).

>> Cannot see and acknowledge or reset alarms (path is Diagnostics/ Active Alarm or Diagnostics/Prover Service Test/Clear Task).

>> Cannot upgrade any firmware (path is LAD Functions/ Firmware update).

The following tasks can be performed even if the controller is locked:

1. Navigate to Calibration and Enter, Run, Exit, Enter Average Volume, and Abort Calibration
2. Navigate and see System Info
3. Navigate to Logs and see and retrieve Transaction, Calibration and Alarm logs
4. Retrieve configuration (path is Transfer/Configuration/ Retrieve Configuration)
5. Navigate and view Diagnostics/Dashboard menu and activate or deactivate alarm output
6. Navigate and view storage info (path is Diagnostics/Storage Info)
7. Navigate to Diagnostics/Prover Service Test/Run Prover Service Test to activate the prover test
8. Navigate to LAD Function and view LAD information
9. Navigate to LAD Function and Format SD card

3.3.6 Configuration 

3.3.6.1 Using the Configuration Menu

Figure 3-10: Configuration Menu

- Via the Configuration menu, you can access the device configuration parameters
- The diagram below (Figure 3-11) allows you to locate all of the configuration parameters
- Always the current device configuration values are shown
- All configuration values are edited one at a time in type-specific data entry window

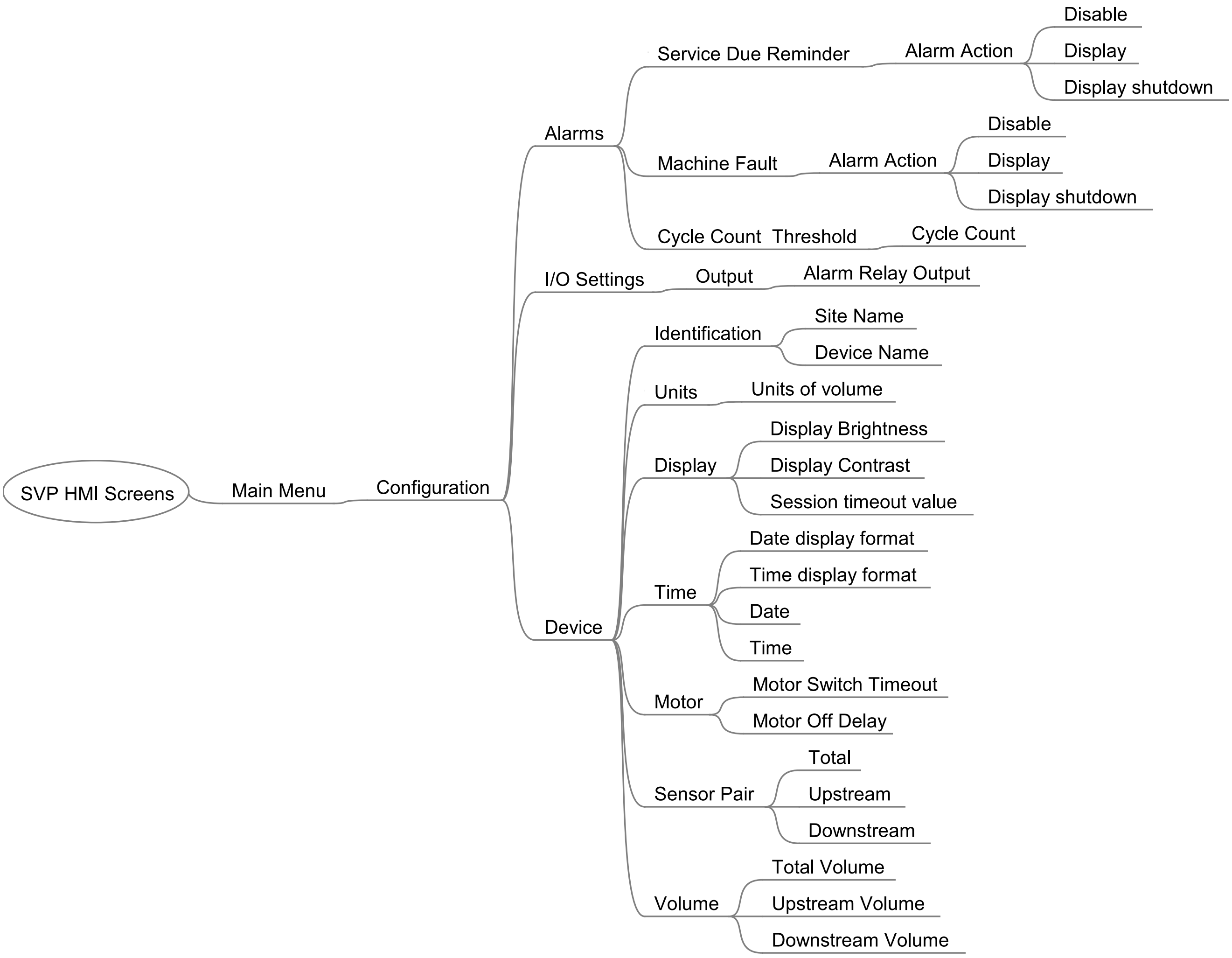


Figure 3-11: Configuration Menu Tree

3.3.6.2 Device

3.3.6.2.1 Identification

Entity	Description	Value range
[Site name]	The name of the site at which the SVP is located	Can be a text string of maximum 20 characters
[Device name]	The name of the SVP itself. In order to have a unique identification of the device by a text string Will be shown in the running screens.	Can be a text string of maximum 20 characters

3.3.6.2.2 Units

Entity	Description	Name	Unit
[Units of volume]	With this entity the user can select the engineering units for volume	Liter Cubic meter Cubic centimeter Cubic decimeter US Gallons UK Gallons Barrel	L m3 cm3 dm3 US gal UK gal bbls

3.3.6.2.3 Display

Entity	Description	Value range
[Display brightness]	With this entity the user can select the brightness of the display. The brightness is controlled by the backlight of the display	0% (low) - 100% (high)
[Display contrast]	With this entity the user can select the contrast of the display	0% (low) - 100% (high)
[Session timeout value]	This value selects the time in seconds between last key press on LAD and the moment the display will switch back to one of the running screens	
[User display language]	This entity selects the display language for the running screens	• English US • List may expand as additional languages are supported

3.3.6.2.4 Time

Entity	Description	Value range
[Date display format]	This entity selects the format of the date	• DD-MM-YY • MM-DD-YY • YY-MM-DD • DD-MM-YYYY • MM-DD-YYYY ***Note:*** *Only the first 3 selections will be completely visible on the SVP screen*
[Time display format]	This entity selects the format of the time	• 24 hours • 12 hours ***Note:*** *When setting the clock, first set the controller to 24-hour mode, then set the time. This will allow the proper AM or PM to be displayed when 12-hour mode is selected.*
[Date]	This entity selects the actual date and will be used for time stamping of transactions, calibrations, and alarms	
[Time]	This entity selects the actual time and will be used for time stamping of transactions, calibrations, and alarms	

3.3.6.2.5 Motor

These parameters are set at the factory and must not be changed without consulting Honeywell Enraf experts or damage to the prover may occur.

Entity	Description	Value range
[Motor switch timeout]	Configurable time interval by which piston puller must have reached motor stop switch before detection of a motor timeout error. Covers retraction of piston from parked position to motor stop switch. Units are in seconds	Configurable range is from 5 seconds to 120 seconds; factory recommended settings per model are shown below. S05 16 | S35 38 | S120 62 S15 14 | S50 26 S25 22 | S85 58
[Motor off delay]	Configurable delay which controls when motor turns off after piston puller has retracted to motor stop switch. Can be adjusted to affect optimal positioning of puller in preparation for next retraction sequence. Units are in seconds	Configurable range is from 0 to 60 seconds; factory recommended settings per model are shown below. S05 0 | S35 2 | S120 2 S15 0 | S50 2 S25 1 | S85 2

3.3.6.2.6 Sensor Pair

Standard provers have an Upstream optical sensor and a Downstream optical sensor. An option is available for a third optical switch. The configuration entities are as shown below.

Entity	Description	Sensor used as “high sensor”	Sensor used as “low sensor”
[Total]	Selects the Upstream Sensor to be used as the “high” volume gate and the Downstream Sensor to be used as the “low” volume gate. This is the default configuration	Upstream Sensor	Downstream Sensor
[Upstream]	Selects the Upstream Sensor to be used as the “high” volume gate and the Midstream Sensor to be used as the “low” volume gate	Upstream Sensor	Midstream Sensor
[Downstream]	Selects the Midstream Sensor to be used as the “high” volume gate and the Downstream Sensor to be used as the “low” volume gate	Midstream Sensor	Downstream Sensor

3.3.6.3 I/O Settings

3.3.6.3.1 Alarm Relay Output

The Alarm Relay Output can be configured to be Energized (normally closed) or De-energized (normally open).

3.3.6.4 Alarms

The following alarm entity applies to Service Due Reminder and Machine Fault.

Entity	Description	Value range
[Alarm action]	With this entity the user can configure the alarm behavior in case this particular alarm will occur	• <Disabled>: The alarm is ignored • <Display>: - Alarm shown on the display - Alarm-indication output set to ON - Next prover cycle will be allowed • <Shutdown>: - Alarm shown on the display - Alarm-indication output set to ON - Operation of further machine run cycles are disabled until the alarm is cleared - Still able to perform diagnostics via RunProver Test or via Dashboard screen from LAD

The Service Due Reminder alarm is activated when the cycle count reaches the threshold value programmed by the user at the Cycle Count Threshold menu. The default setting for the Cycle Count Threshold is 1000.

3.3.7 Prover Calibration 

The menu screens for Prover Calibration are shown in the diagram below (Figure 3-12). See Chapter 5 for detailed calibration procedures.

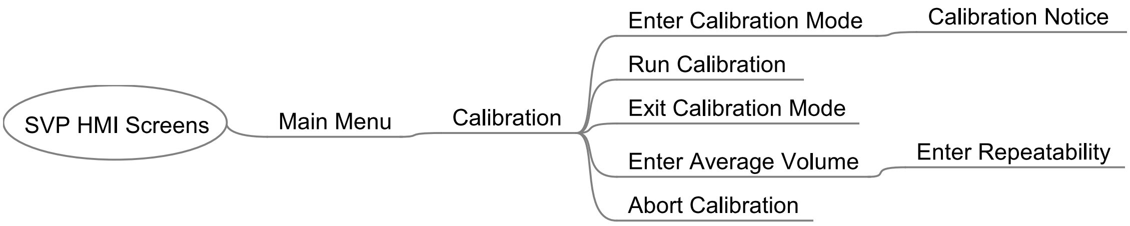


Figure 3-12: Prover Calibration

3.3.8 System Information 

The SVP Controller “About” box is showing important information about:

- The Device (SVP Controller)
- The individual boards (HMI, SVP and Option)
- The firmware versions

Figure 3-13: System Information

Within this screen identification information is shown of the following device components:

- Device serial number
- Production date
- Serial number of each FlexConn board
- Hardware version of each FlexConn board
- Application firmware version of each FlexConn board
- Build information of the firmware of each FlexConn board
- Boot firmware information of the firmware of each FlexConn board
- FlexConn stack firmware version of each FlexConn board
- Build information of the FlexConn stack firmware of each FlexConn board

The menu tree below shows how the information menus are accessed.

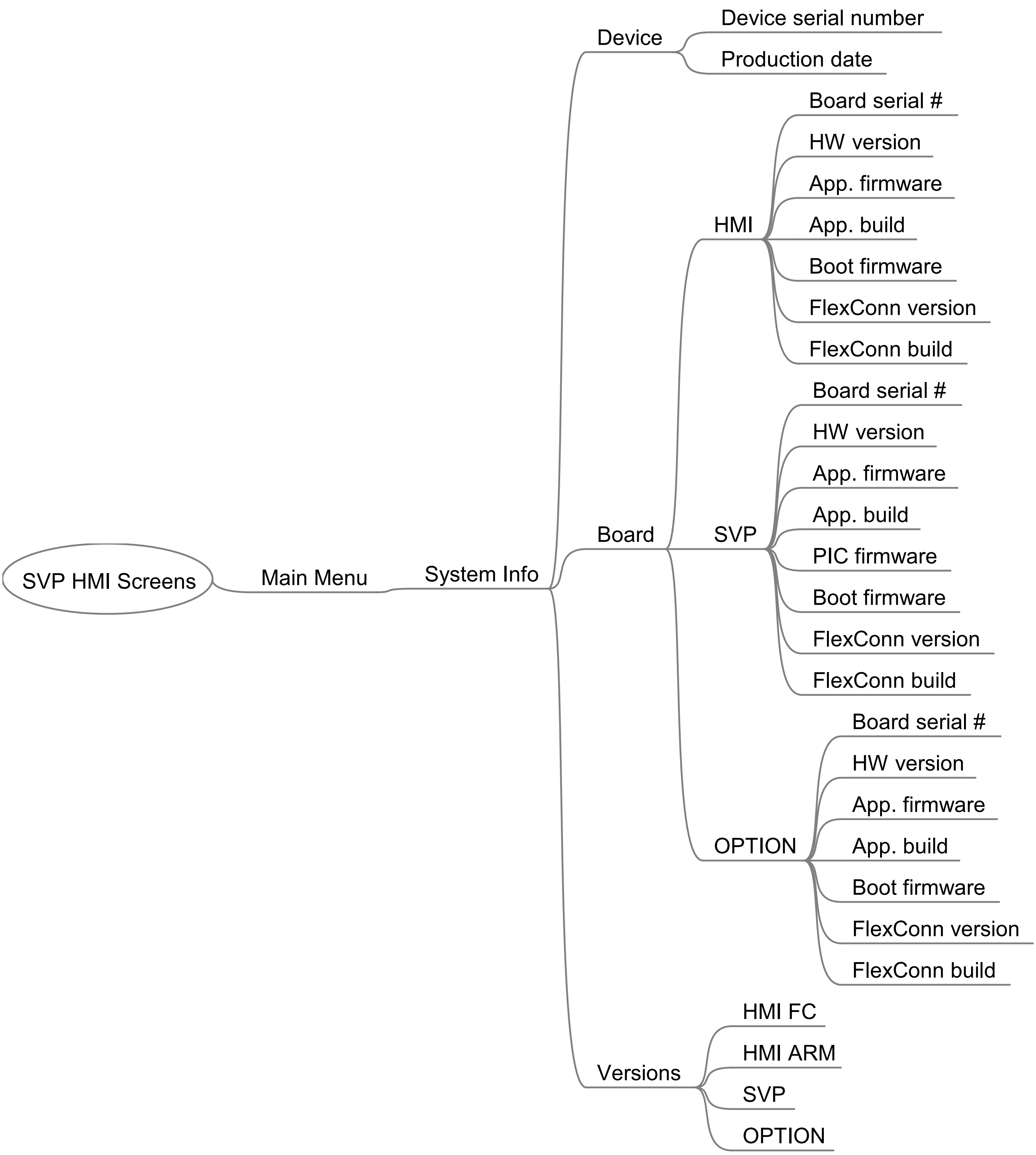


Figure 3-14: System Information Menu Tree

3.3.9 Logs 

This is the user interface to various logs maintained in non-volatile memory including:

- Transaction logs: complete information for each transaction
- Calibration log: shows the sequence of SVP calibrations over time
- Alarm Log: a chronological list on when alarms occurred and what type of alarms they were

Figure 3-15: Logs

The log memory will be a rolling memory file with the oldest data being overwritten first when the memory is full. Note that the log will be simply overwritten without issuing a warning message.

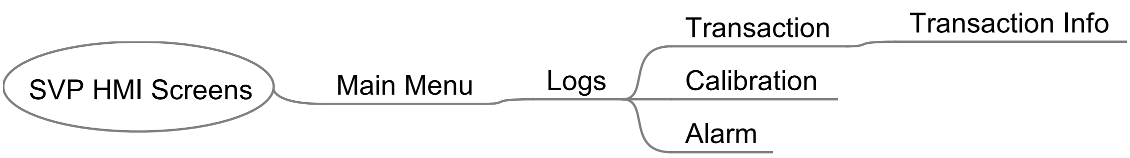


Figure 3-16: Logs Menu Tree

3.3.9.1 Transaction Logs

The transaction log will contain the following data for each Prover run:

- Date and time
- Sweep time in seconds
- Number of prover cycles

3.3.9.1.1 Transaction information

The details of any transaction can be viewed by going to that transaction and pressing OK. After every prover run cycle in calibration of meter mode the following parameters will be logged after completing the prover run

- Transaction ID
- Stop Transaction date and time
- Cycle count
- Sweep time
- Alarm information
- Sensor Pair
- Device Serial Number
- Transaction record version

3.3.9.2 Calibration Logs

The details of any transaction can be viewed by going to that transaction and pressing OK. After every prover run cycle in prover calibration mode the following parameters will be logged after completing the prover run. The calibration log contains the following information:

- Date and time
- Sweep time in seconds
- Average volume
- Repeatability

There are no units displayed for the average volume as they will be known by the user and to avoid complications if the units specified in the Configuration/Device/Units menu are changed.

3.3.9.3 Alarm Logs

The Alarm log forms a permanent record of the same information that can be viewed while an alarm is active from the Diagnostics/Active Alarms screen. This information consists of the date and time stamp and descriptive text.

3.3.10 Diagnostics 

This menu provides the following features:

- High-level view of all device I/O functions showing their state as “High”/“Low”
- Each output function can be tested by selecting and activating it
- Internal memory usage overview
- System health overview
- Active alarms overview
- Clear alarms
- Activate the Run Prover Test mode

Figure 3-17: Diagnostics

Within this screen, the user can view the diagnostics about the following subjects:

- Overview of all I/O (Dashboard)
- Overview of system health
- Overview of all active alarms
- Overview of device tasks such as clearing tasks, clearing alarms, and running prover test task
- Overview of available memory storage space for data logs and total number of available logs

The diagram below shows all of the information available to you. Note that the parameters marked with an * are not relevant for the first release of the SVP Controller. They are reserved for future use or for internal testing.

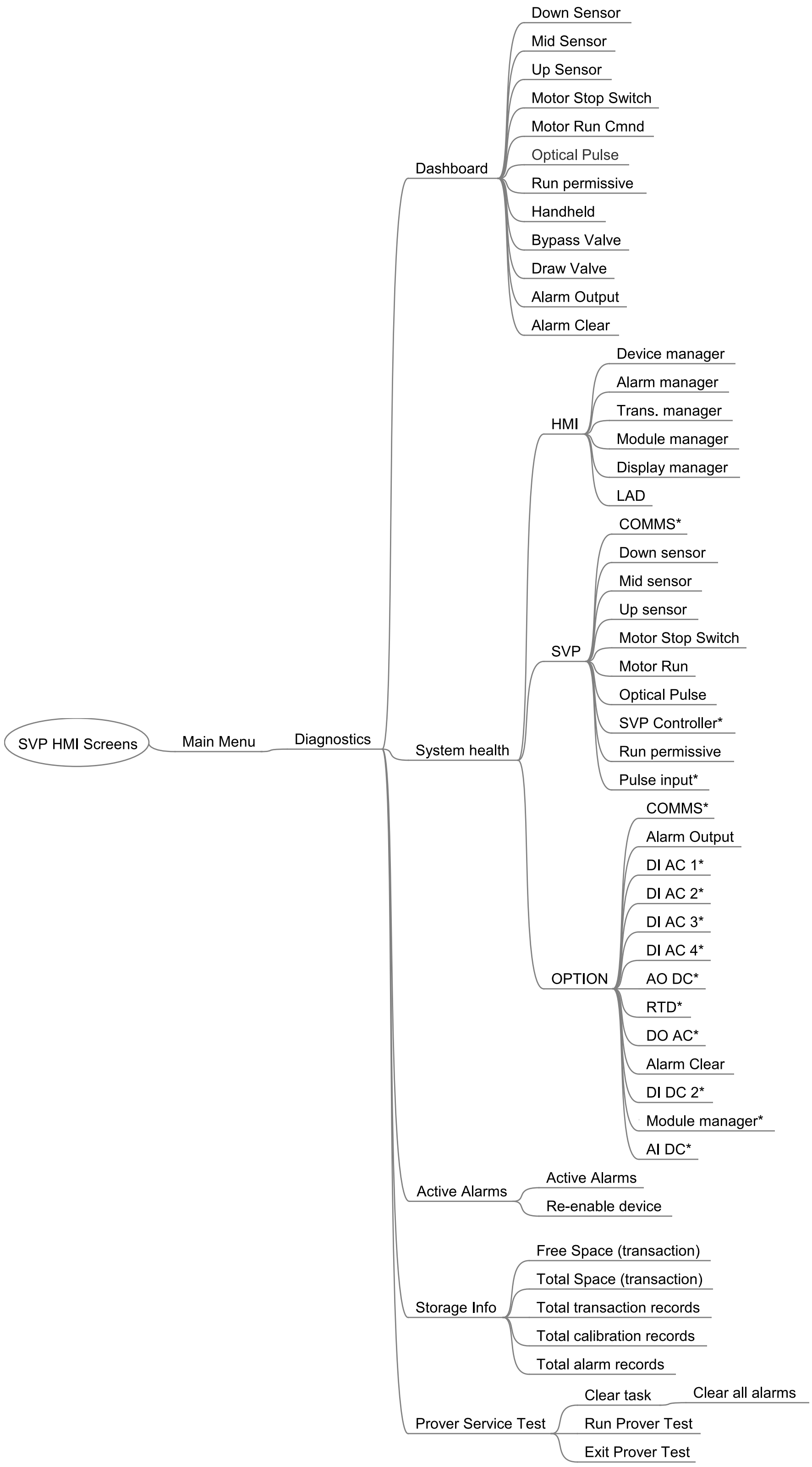


Figure 3-18: Diagnostics Menu Tree

3.3.11 Transfer 

Note: Only when the LAD is connected!

Via this user's interface, the following type of records can be transferred between the SVP Controller and the LAD:

- Transaction records
- Configurations
- Events/logs (alarms)
- Calibration records

Figure 3-19: Transfer

The diagram below shows all of the information available to you.

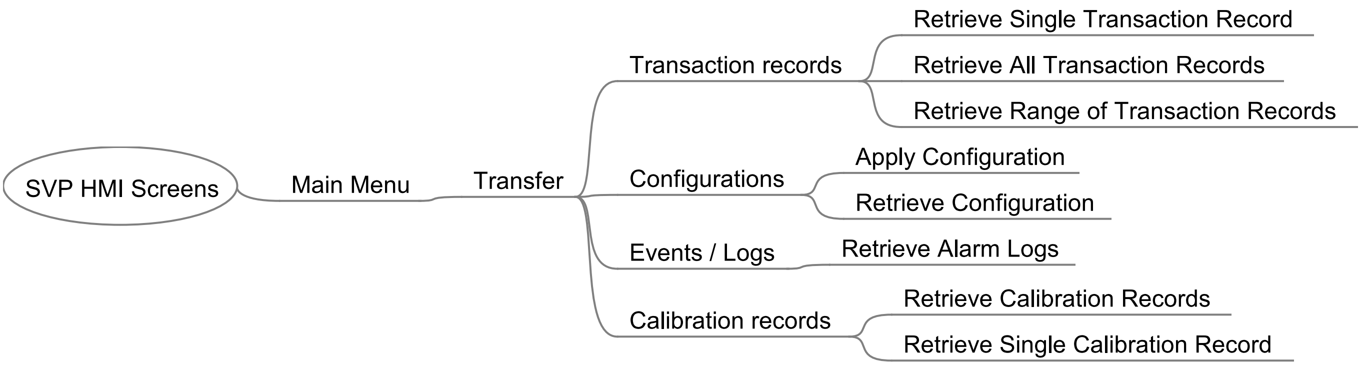


Figure 3-20: Transfer Menu Tree

3.3.12 LAD Settings 

Note: Only when the LAD is connected!

This is the user interface to the LAD specific functionality:

- Firmware download to the SVP Controller and the LAD
- Management of the LAD's stored records
- Format SD card

Figure 3-21: LAD Settings

The diagram below shows all of the information available to you.

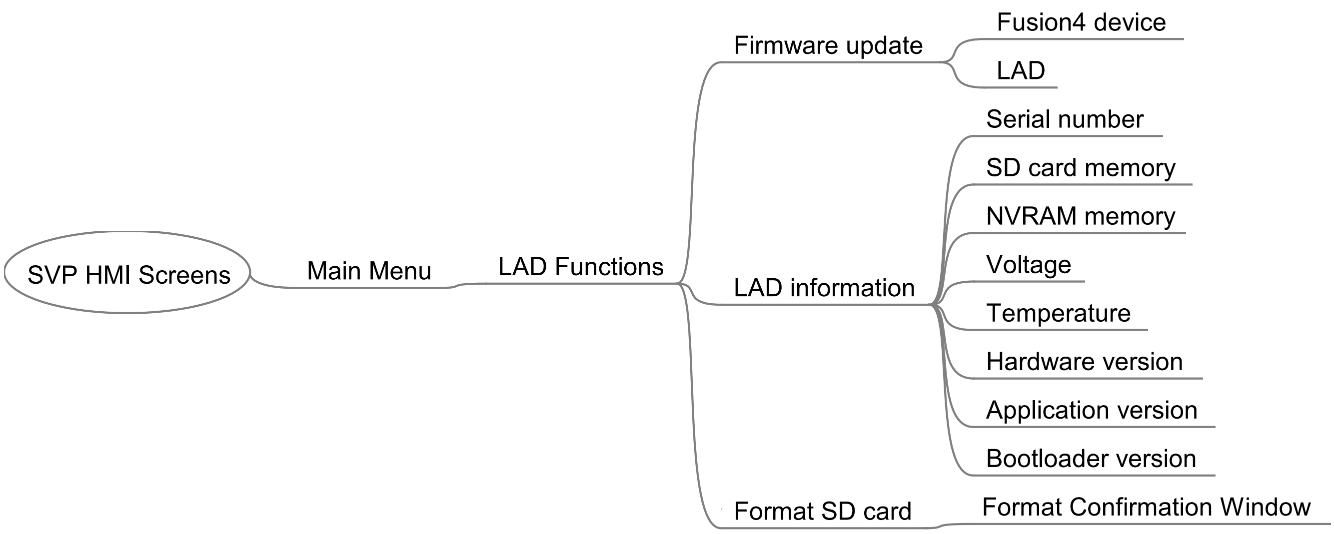


Figure 3-22: LAD Settings Menu Tree

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4.1 Operating Instructions

1. *Firstly, carry out the removal and replacement of transit seals with the operation seals (as supplied) prior to introducing liquid into the Honeywell Enraf small volume prover.*
2. Open fluid inlet valve slowly. After the inlet valve is completely open, open fluid outlet valve, connecting the prover to the process line, Figure 2-1.
3. Vent trapped air from the prover by opening the vent valves located at the top of the prover flow tube.
4. Close process diverter valve, Figure 2-1, slowly to divert the flow through the prover.
5. The Honeywell Enraf small volume prover is now ready for meter proving. Refer to the appropriate proving computer manual for procedures for performing meter proving runs.
6. After meter proving runs have been completed, open process diverter valve, and slowly close the prover connection valves.

If you have the optional third optical switch installed on your prover refer to Chapter 3 section 3.3.6.2.6 for Sensor Pair configuration prior to operating your prover in any of the following three modes of operation.

4.2 Meter Calibration

Upon initial power up of the SVP Controller the Prover Status screen will indicate that the operating mode of the controller is Meter Calibration. This is the default operating mode of the controller. The other two operating modes, Prover Test and Prover Calibration, require entering into those modes via the LAD. In order to do proving runs on a meter make sure that you are operating in the Meter Calibration mode as indicated by the "Prover Status – Meter Calibration" screen as shown below.

Prover Status · Meter Calibration	
Piston	Unknown Position
Motor	Idle
Error Status	No Error
Cycle	779
Stop Time	10-31-12 11:32:32 AM
Sweep Time	00:00:01:102

Press OK to enter menu	Stop	

On the first power up and after any machine fault alarm, the piston position will be unknown and one proving run needs to be successfully completed in order to initialize the piston position status. Upon sending the signal from the PROVEit software or the other flow computers, the prover motor will retract the piston assembly and the proving run will start. At the end of the proving run the flow rate will be displayed on the screen and the next proving run can be initiated.

During the return and proving mode different piston positions and the motor status will be displayed on the SVP controller screen. At the end of the proving run the sweep time, cycle count and the stop time will be updated. If any errors occur during the proving run the error will be reported on the screen and will need to be cleared via the LAD (Main menu/Diagnostics/Dashboard/Alarm Clear – see Chapter 6 - Troubleshooting).

4.3 Prover Test

The Prover Test mode can be useful to become familiar with your prover and to verify proper operation. This mode is accessed by navigating with the LAD through the following menus: Main Menu/Diagnostics/Prover Service Test/Run Prover Test.

Pressing OK on the LAD at Run Prover Test causes a prover run cycle to be executed, and the SVP Controller display will appear as shown below. With the piston at the extreme downstream position, the Parked Position, the motor will pull the piston upstream and the piston position will be shown on the Prover Status screen as the associated optical sensor flag passes through the Downstream sensor and the Upstream sensor until the motor stop switch is activated. Run Prover Test can be executed repeatedly while the liquid flows through the prover pushing the piston towards the downstream side. This test will only run in the absence of a Flow Computer run permissive signal; it will not be executed if the run permissive has been asserted by a Flow Computer.

See Chapter 6 - Troubleshooting if an error status is indicated.

To exit this operating mode use the LAD to navigate to Main Menu/ Diagnostics/Prover Service Test/Exit Prover Test

Prover Status · Prover Test	
Piston	Parked Position
Motor	Idle
Error Status	No Error
Cycle	787
Stop Time	10-31-12 11:39:32 AM
Sweep Time	00:00:01:020

Press OK to enter menu	Stop	

4.4 Prover Calibration

The third operating mode of the controller is Prover Calibration and will be described in more detail in the next chapter.

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5.1 General

It is recommended that prior to doing any volumetric calibration that the personnel involved read the API Manual of Petroleum Measurement Standards (MPMS) Chapter 4 – Proving Systems sec 4.8, and the MPMS Chapters 4.9, and 12.2.4 – pertaining to the calculation for the volume of provers.

Although the prover may be calibrated with procedures traceable to the National Institute of Standards and Technology (NIST) by a number of techniques, only two techniques for volume determination will be described here, a volumetric calibration and a gravimetric (mass) calibration.

The gravimetric calibration method requires collecting the volume of water displaced by the prover during a prove pass and determining its mass by weighing it with a precision scale or balance. Corrections are made for the density of the water and the buoyancy of the air displaced by the volume of water per API 14.6, and applying various other correction factors such as the temperature and pressure effects on the flow tube and the volume switch position. De-ionized or distilled water should be utilized for the gravimetric method. API 4.9.4 is the API standard used for the density determination of water.

The displaced volume has been calibrated as described in the MPMS API chapters,: 4.2, 4.9 and 12.2.4.

The Honeywell Enraf small volume prover base volume has been determined at the factory. Recalibration is recommended either at 1 year intervals, or as determined by the authorities and parties responsible for the measurement. Recalibration is also required after any maintenance which may affect the base volume, i.e.: complete switch bar replacement. Honeywell Enraf small volume prover optical switches are field replaceable and adjusted to an extremely high degree of precision. Individual switch replacement does not necessitate re-calibration. See Section 6.7 for more information on optical switches.

5.2 Static Leak Detection

The Honeywell Enraf static leak detection procedure should be used prior to water draw or at any time that meter proof repeatability is difficult to attain. It is not necessary to remove the prover from the process line to perform a leak test. It is only necessary to block off the inlet and outlet of the prover with it full of fluid. Block off the drain valves and verify there is no leak path from the prover. If necessary, insert blind flanges into the inlet and outlet ports to isolate the prover from the system. It is also necessary to have a differential pressure gauge with a sufficient pressure rating to withstand line pressure if the prover is not removed from the process line. Temperatures, both ambient and fluid, should be stable during the procedure.

5.2.1 Equipment

1. Static leak differential pressure creator assembly, included with prover.
2. Differential pressure gauge 0-69 kPa (10 psi) or greater with sufficient static pressure specifications to be equal or greater than the current prover pressure.
3. Plumbing and valve arrangement similar to that shown in Figure 5-1.

5.2.2 Static Leak Detection Procedure

1. Block all inlet and outlet ports on the prover (including drains).
2. Refer to Figure 5-1, 5-2 & 5-4 below and install the differential pressure gauge (1) between the inlet and outlet ends of the prover.
3. Fill the prover with liquid and vent off all air from the system.
4. Determine there are not leaks from the prover ports.
5. If necessary, blind the inlet, outlet ***and drain lines*** with blind flanges.
6. Power up the proving computer and the Honeywell Enraf prover.
7. From the proving computer, initiate a proving run to pull the piston upstream.
8. Remove the plug from the drive cover end panel.
9. Install the differential pressure creator (2) in the threaded hole provided in the drive system end plate and hand tighten, refer to Figure 5-3.
10. Rotate the adjustment screw (3) Figure 5-4 clockwise to push the plunger out to apply force to the piston shaft and create a differential pressure between the inlet and the outlet of the prover. Rotate the adjustment screw until a differential pressure of 6 psid has been created. Pressurize the unit slowly and watch the pressure gauge. In some cases it might happen that applied pressure of 6 psid will be significantly lost in the first couple of minutes. The reason is that the poppet valve will need short period of time to fully close and stabilize.

    Therefore, it is our recommendation to allow at least 5 minutes between the applied pressure and actual data recording.
11. Look the prover over for any obvious external leaks.
12. Start observing the differential pressure gauge for a period of 20 minutes. If the pressure has not dropped by more than 25% of the starting differential pressure, it may be assumed that there are no

piston seal leaks. If the pressure has dropped to lower levels, it should be assumed that there is a seal leak, and the prover piston seals should be replaced. Refer to Figure 5-5.

Figure 5-1: Static Leak Detection Set-up

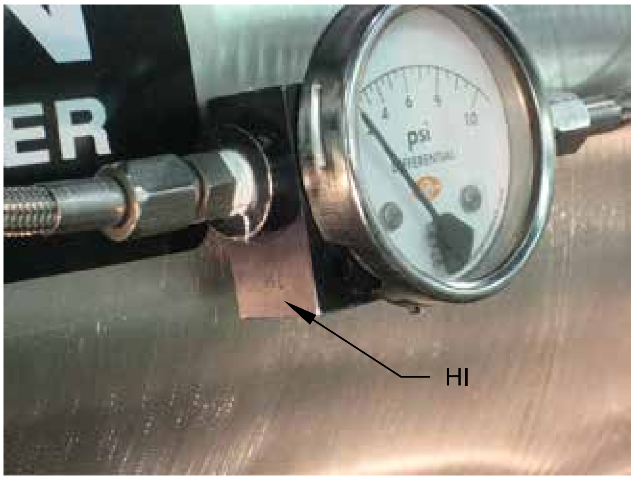


Figure 5-2: Gauge with HI & LOW markings

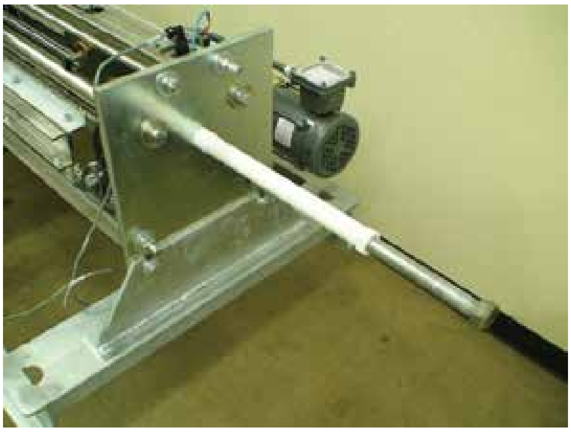


Figure 5-3: Differential pressure creator inserted in drive end plate.

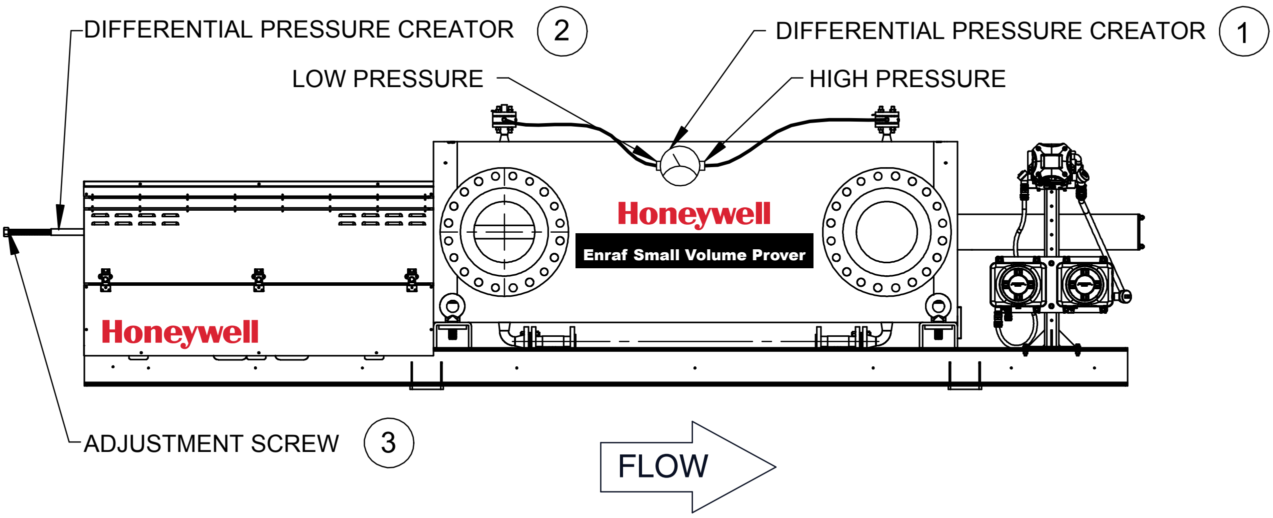


Figure 5-4: Static Leak Detection set-up overview

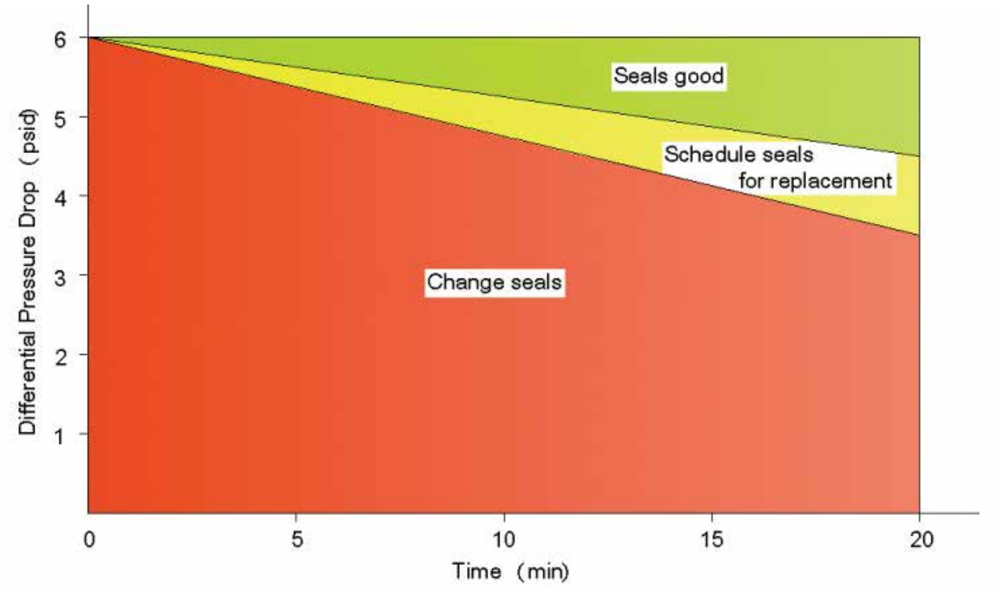


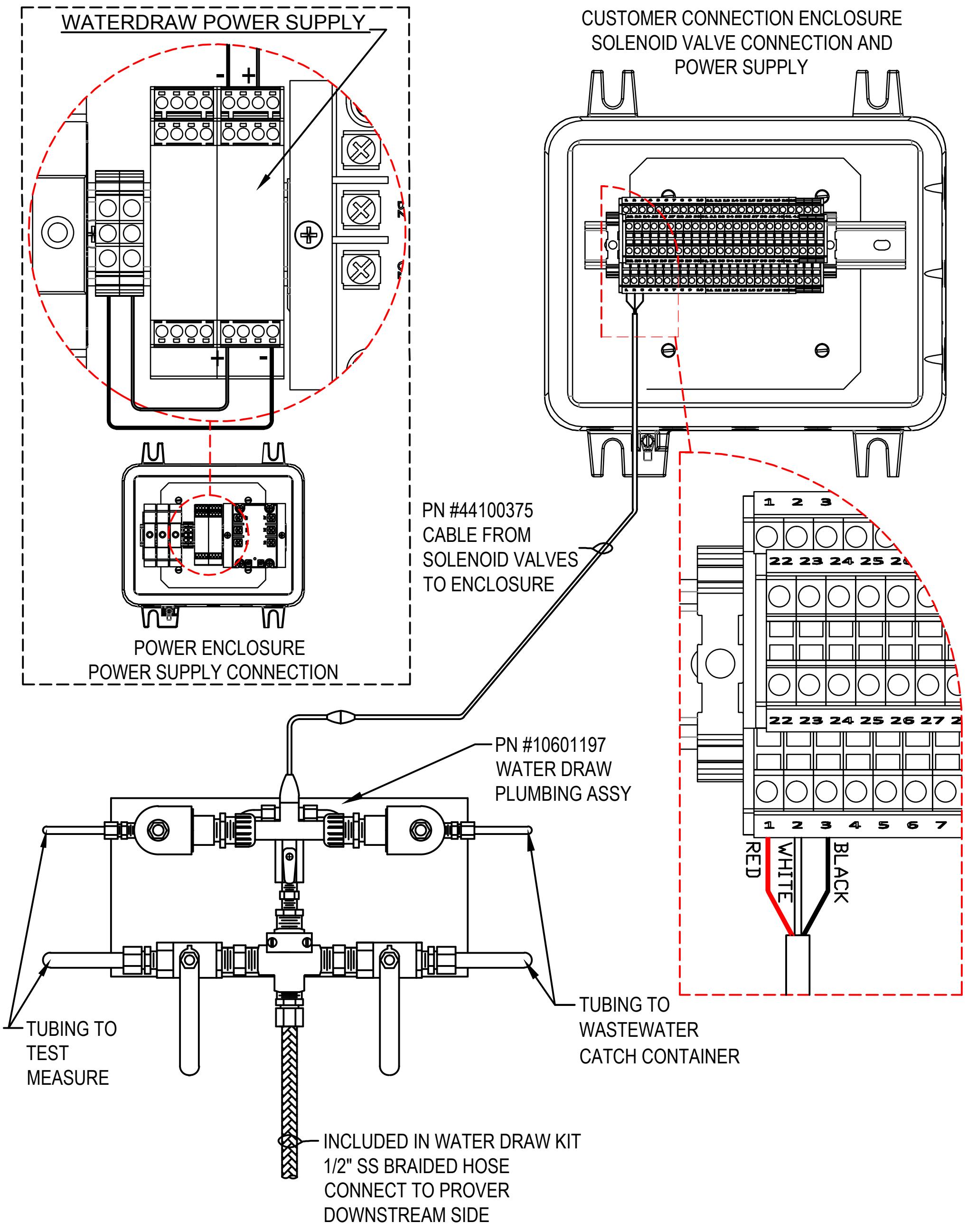
Figure 5-5: Recommendation for seal change

5.3 Volume Water Draw

Equipment

1. Water draw kit: Contact Honeywell Enraf representative or factory directly to obtain a water draw kit, (see Figure 5-6).
2. Source of clean potable water. Pump or water supply must have steady flow of approximately 38 Lpm (10 GPM) at 172-690 kPa (25-100 psi) Water supply must maintain non-pulsating pressure.
3. Certified volume test measures (conforming to API chapter 4 section 7) traceable to the U.S. NIST (or other National standards). The test measure should be of the same volume as the displaced volume of the prover. If, however, the test measure is smaller than the prover volume, there must be at least two test measures, as the flow during water draws should be continuous for the greatest precision. *Example:* For a 20-gallon prover uses a single 76 L (20 gal) test measure.
4. Certified high resolution pressure gauge: 0-690 kPag (0-100 psig) psig
5. Three traceable thermometers with 0.1°C (0.2°F) degree graduations (for thermometer reference positions see Figure 5-7).
6. Water overboard container, volume to be at least as large as test measure, and approximately the same height.

Note: Honeywell Enraf Water Draw P&T kit or equivalent assembly eases installation of water draw prover instrumentation. The Honeywell Enraf Water Draw P&T kit consists of four traceable temperature thermometers (one spare thermometer included) and one pressure gauge. All thermometers come with the calibration certifications if ordered from Honeywell Enraf.



Customer Connection Enclosure		
Description	**Terminal Number**	**Wire Color**
Water Draw SV1	1	Red - Water Draw Cable
Water Draw SV2	2	White - Water Draw Cable
Water Draw Common	3	Black - Water Draw Cable

Figure 5-6: Water Draw Kit

Procedure

Water draw notes:

Perform steps 12-17 at least twice prior to taking data to purge the system of air, assure the temperature is stable, and to get familiar with the procedure.

Repeat the water draw procedure until at least 3 consecutive draws repeat within 0.02% or other repeatability criteria that the certifying parties agree upon. The flow rate on at least one run must vary by 25% to assure integrity of prover seals and absence of leakage.

Failure to achieve the necessary repeatability may be caused by leaking valves, air in the system, varying pressure, leaking seals, or faulty calibration technique.

1. Be certain that all maintenance that needs to be done to the prover has been accomplished before starting the volumetric calibration. It is advisable to perform a static leak test prior to performing a water draw, see Section 5.2. Replace the seals on the prover if there is any doubt as to their integrity.
2. Block prover inlet and outlet by using a blind flanges or double block and bleed valves.
3. Refer to Honeywell Enraf water draw configuration, Figure 5-7, and install Honeywell Enraf available water draw kit, see Figure 5-6. Install certified thermometers and certified pressure gauge, even if the prover is equipped with P&T transmitters.

   If using Honeywell Enraf Water Draw P&T kit, remove the plug in the wafer spacer and connect the pressure gauge P1 to the opening (see Figure 5-7 for reference).

   The thermometer used to monitor prover fluid temperature T1 is supposed to be installed into the spare thermowell located on the downstream side of the flow tube (see Figure 5-7 for reference).

   The thermometer used to monitor switch bar temperature T2 is supposed to be installed on top of the switch bar close to the center line between two optical switches (see Figure 5-7 for reference).

   The thermometer used to monitor test measure temperature T3 is supposed to be installed on the test measure (see Figure 5-7 for reference).

   Have available Table 13 to record data from prover calibration using volumetric water draw technique.
4. Connect water supply to prover, (refer to Figure 5-7).
5. Make sure that the water draw kit is wired to the customer connection enclosure as specified in the Figure 5-6.
6. Turn water supply on, and open valves V1, V2, and V3. After all air is bled off, close V2 and V3. Open V5 valve and allow water to circulate until the temperature has stabilized and is not changing.

7. Valve V2 may be opened slightly to allow just a very small stream of water to flow; this will bleed off air, which may be in the water supply. At the end of the temperature stabilization close the V5 valve.
8. Place properly wetted and drained test measure under the water draw valves.
9. Ensure power is applied to the prover. Navigate to Calibration screen from the Main Menu as shown below.

Prover Calibration

Enter Calibration Mode
Run Calibration
Exit Calibration Mode
Enter Average Volume
Abort Calibration

Press OK to choose	Stop	

10. Enter the prover calibration mode using "Enter Calibration Mode" submenu.

Notification to user after selecting Enter Calibration Mode will show up on the SVP Controller screen (see below).

Please note that permissive signal from the flow computer will be ignored while in prover calibration mode.

Entering Calibration Mode

Pressing OK will enter the controller into Calibration Mode. The bypass valve will open immediately.
To perform calibration run, select Run Calibration from next menu

Press OK to proceed	Stop	

11. Bypass valve (SV2) will be turned ON immediately after entering the prover calibration mode and the water from the prover will be drained into the wastewater catch container.

12. Select “Run Calibration” which will cause the prover piston to be returned to the upstream position and start the draw sequence. See resulting Prover Status screen as shown below.

After selecting Run Calibration following screen appears.

Prover Status · Prover Calibration	
Piston	Retract To Down Sensor
Motor	Waiting Motor Switch
Error Status	No Error
Cycle	774
Stop Time	00-00-00 00:00:00 AM
Sweep Time	00:00:01:101

Press OK to enter menu	Run	

13. Water should now be draining into the wastewater container until the flag reaches the first optical (volume) switch. When the first optical switch is reached, the signal will be sent to the SVP controller to switch the valves (turn the SV2 valve OFF and turn the SV1 valve ON). At that time the water will start flowing into the Test Measure.
14. Record the prover pressure (Pp) at P1 while only the water draw valve is open (SV1). Valves V5 and V6 must be closed while recording this pressure, which is the pressure at the start and the end of volume switching.
15. Record temperature (Td) at T2, which is the detector temperature, by opening the drive cover and placing the thermometer midway between volume switches, which is the location of the switch bar temperature transmitter thermowell.
16. Record fluid temperature (Tp) at T1.
17. When the flag reaches the second optical (volume) switch, the draw valve (SV1) is turned OFF and the bypass valve (SV2) is turned ON. Carefully record scale reading (SR) and test measure temperature (Ttm) at T3.
18. After all data is collected, drain the test measure.
19. Repeat steps 12 through 18 as necessary to obtain the required number of well repeating runs (including one run at 25% flow rate variance).

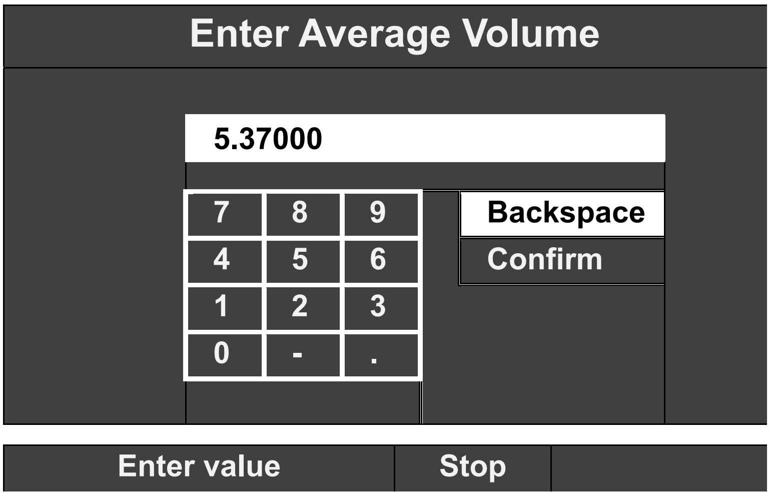
Please note that a log will be saved with start time and sweep time after each calibration run.

20. Once you have completed the calibration, select the “Exit Calibration” menu which will turn the bypass valve (SV2) OFF.

21. Calculate prover volume per Section 5.5.

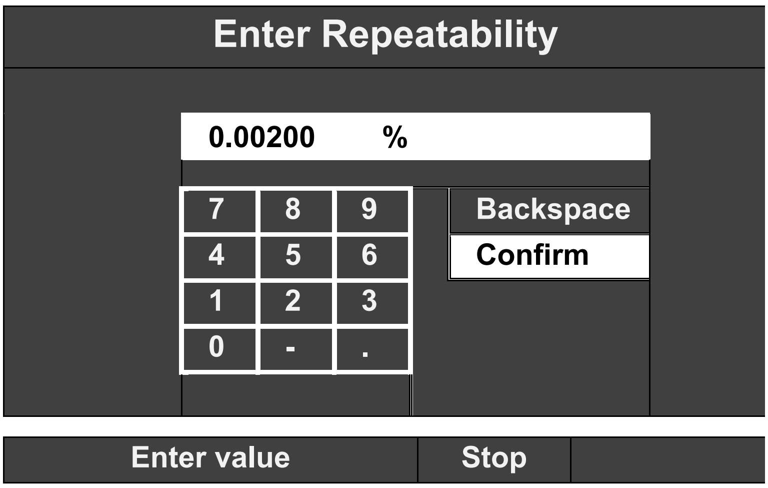
22. Enter the average calibration volume calculated in the previous step by selecting the “Enter Average Volume” menu. This screen can be accessed while still in the Calibration mode or at a later time by entering the Calibration menu and then accessing this screen directly.

After selecting Enter Average Volume following screen appears



23. After the Average Volume has been entered and confirmed the following screen is displayed to enter the Repeatability in percent (%). The entered average volume and the repeatability values will be stored in the log with a timestamp of the entry.

After selecting Enter Average Volume following screen appears



Selecting “Abort Calibration” will stop the calibration process. This action will stop the motor if in running state, bypass value (SV2) will be turned ON and draw valve (SV1) will be turned OFF. If the Prover is in sweep mode with the piston moving downstream no action will be taken for upstream and downstream sensor inputs. Calibration log entry will not be made.

In calibration mode alarms will be generated as per the configuration, and the run permissive signal from the flow computer or the run prover test signal will be ignored. The operating mode of the prover will be saved in NVM so that the mode will be restored if power is turned off while in Prover Calibration mode.

To exit calibration mode navigate to the Exit Calibration Mode menu and press OK.

A copy of Table 13 can be used to enter water draw data.

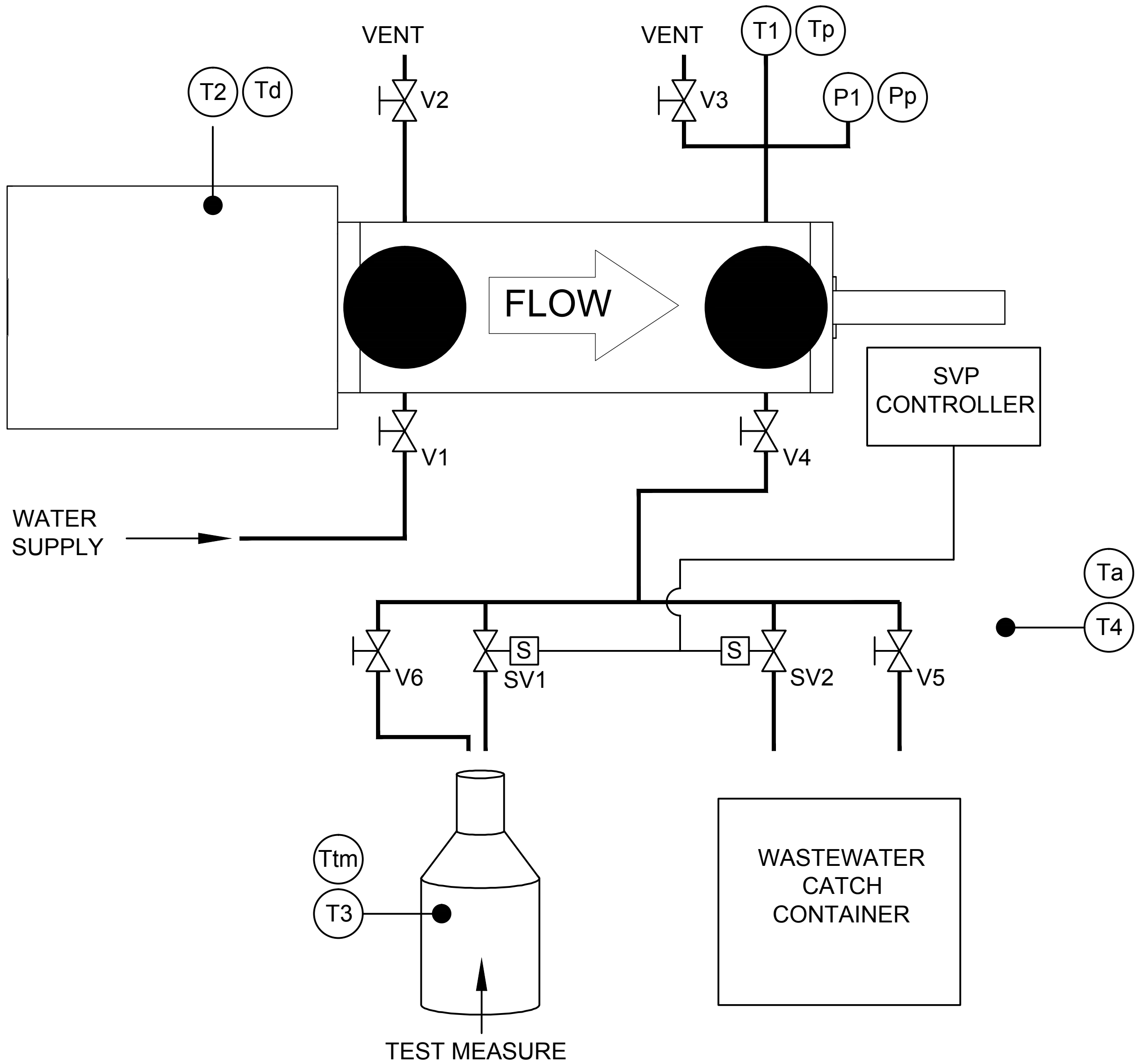


Figure 5-7: Water Draw Plumbing Diagram

Volumetric Water Draw Data Sheet

Date:					
Prover Serial Number:					
Prover Model Number:					
Report Number:					
Location:					
Base Temperature (Tb):					
Base Measure Volume-from calibration cert. (BMV):					
Volume Measure Thermal Coefficient (Gc):					
Compressibility Factor (water) (CPL):					
Flow Tube Area Thermal Expansion Coefficient (Ga):					
Detector Linear Thermal Expansion Coefficient (Gl):					
Modulus of Elasticity of flow tube (E):					
Flow Tube Inside Diameter (inches) (ID):					
Flow Tube Wall Thickness (inches) (WT):					
	Fill 1	Fill 2	Fill 3	Fill 4	Fill 5
Fill Time (minutes) =					
Flow Rate (Nominal Volume/Fill Time) =					
Temperature Prover (*Tp*) =					
Temperature Detector (*Td*) =					
Prover Pressure (*Pp*) =					
Scale Reading on Volume Measure (*SR*) =					
Volume of Water adjusted for SR (*BMVa*) =					
Test Measure Temperature (*Ttm*) =					
Correction for Temp. Differential (*Ctdw*) =					
Effect of Temp. on Test Measure (*CTStm*) =					
Effect of Temperature on Prover (*CTSp*) =					
Combined effect of CTSM & CTSP (*CCTs*) =					
Volume Waterdraw (*WD*) =					
Effect of Pressure on Flow Tube (*CPSp*) =					
Compressibility of water in prover (*CPLp*) =					
Corrected Water Drawn Volume (*WDzb*) =					

Table 23: Volumetric Water Draw Data Sheet

5.4 Gravimetric Water Draw

Equipment

1. Water draw kit: Contact Honeywell Enraf representative or factory directly to obtain a water draw kit, Figure 5-6.
2. Precision electronic weigh scales of the correct size and resolution: for example for an S25 prover, balance must have a capacity of at least 100kg and +/-4 gram (200 lb. and +/- 0.01 lb.). resolution. (1 part out of 20,000 or better resolution). For proper scale verification prior to the gravimetric water draw refer to API 4.9.4.
3. Certified test weight set: ANSI/ASTM Class 3 equivalent or better.
4. Source of air-free or deaerated deionized or distilled water with approximately 38 Lpm at 172-690 kPag (10 GPM at 25-100 psig) steady, non-fluctuating, pressure.
5. A volume catch container ideally, large enough for the volume of fluid dispensed by the prover. Container must be designed to be placed on the precision balance or scales.
6. Certified high resolution pressure gauge: 0-690 kPag (0-100 psig).
7. Three traceable thermometers with 0.1°C (0.2°F) graduations (for thermometer reference positions see Figure 5-7).
8. Water draw data sheet, Table 14.
9. Water overboard container, volume to be at least as large as test measure.

Note: Honeywell Enraf Water Draw P&T kit or equivalent assembly eases installation of water draw prover instrumentation. The Honeywell Enraf Water Draw P&T kit consists of four traceable temperature thermometers (one spare thermometer included) and one pressure gauge. All thermometers come with the calibration certifications if ordered from Honeywell Enraf.

Procedure

Water draw notes:
Perform steps 14 – 21 at least twice prior to taking data to purge the system of air, assure the temperature is stable, and to get familiar with the procedure.

Repeat water draw procedure until at least 3 consecutive draws repeat within 0.02% or other repeatability criteria that the certifying parties agree upon. The flow rate on at least one run must vary by 25% to assure integrity of prover seals and absence of leakage.

Failure to achieve the necessary repeatability may be caused by leaking valves, air in the system, varying pressure, leaking seals, or faulty calibration technique.

1. Be certain that all maintenance that needs to be done to the prover has been accomplished before starting the gravimetric calibration. It is advisable to perform a static leak test prior to performing a water draw, see Section 5.2. Replace the seals on the prover if there is any doubt as to their integrity.
2. Block prover inlet and outlet by using a blind flanges or double block and bleed valves.
3. Refer to Honeywell Enraf water draw configuration, Figure 5-7, and install Honeywell Enraf available water draw kit, see Figure 5-6. Install certified thermometers and certified pressure gauge, even if the prover is equipped with P&T transmitters.

   If using Honeywell Enraf Water Draw P&T kit, remove the plug in the wafer spacer and connect the pressure gauge P1 to the opening (see Figure 5-7 for reference).

   The thermometer used to monitor prover fluid temperature T1 is supposed to be installed into the spare thermowell located on the downstream side of the flow tube (see Figure 5-7 for reference).

   The thermometer used to monitor switch bar temperature T2 is supposed to be installed on top of the switch bar close to the center line between two optical switches (see Figure 5-7 for reference).

   The thermometer T4 is supposed to be used to monitor ambient temperature (see Figure 5-7 for reference).

   Have available Table 14 to record data from prover calibration using gravimetric water draw technique.
4. Calibrate the scale as specified in API 4.9.4.
5. Connect water supply to prover, (refer to Figure 5-7)
6. Make sure that the water draw kit is wired to the customer connection enclosure as specified in the Figure 5-6.
7. Turn water supply on, and open valves V1, V2, V3. After all air is bled off, close V2 and V3. Open V5 valve and allow water to circulate until the temperature has stabilized and is not changing.
8. Valve V2 may be opened slightly to allow just a very small stream of water to flow; this will bleed off air, which may be in the water supply.
9. Calibrate scales with test weights totaling +/- 10% of draw weight per API 4.9.4.
10. With volume catch container on the scales and under water draw valve, tare scales.

11. Ensure power is applied to the prover. Navigate to Calibration screen from the Main Menu as shown below.

Prover Calibration

Enter Calibration Mode
Run Calibration
Exit Calibration Mode
Enter Average Volume
Abort Calibration

Press OK to choose	Stop	

12. Enter the prover calibration mode using “Enter Calibration Mode” submenu. Notification to user after selecting Enter Calibration Mode will show up on the SVP Controller screen (see below).

Please note that permissive signal from the flow computer will be ignored while in prover calibration mode.

Entering Calibration Mode

Pressing OK will enter the controller into Calibration Mode. The bypass valve will open immediately.
To perform calibration run, select Run Calibration from next menu

Press OK to proceed	Stop	

13. Bypass valve (SV2) will be turned ON immediately after entering the prover calibration mode and the water from the prover will be drained into the wastewater catch container.

14. Select “Run Calibration” which will cause the prover piston to be returned to the upstream position and start the draw sequence. See resulting Prover Status screen as shown below.

After selecting Run Calibration following screen appears.

Prover Status · Prover Calibration	
Piston	Retract To Down Sensor
Motor	Waiting Motor Switch
Error Status	No Error
Cycle	774
Stop Time	00-00-00 00:00:00 AM
Sweep Time	00:00:01:101

Press OK to enter menu	Run	

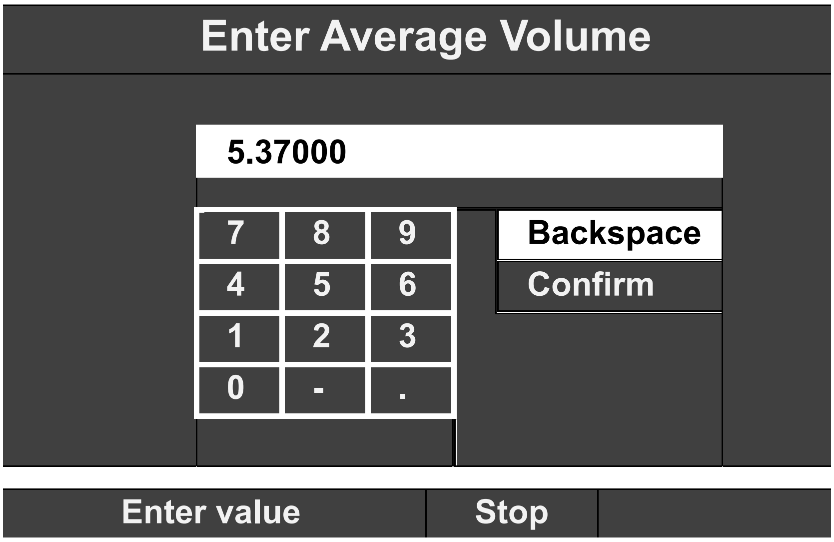
15. Water should now be draining into the wastewater container until the flag reaches the first optical (volume) switch. Note: To decrease the time necessary to reach the first volume switch, valve V5 may be opened until just before the first volume switch has been reached.
16. When the first optical switch is reached, the signal will be sent to the SVP controller to switch the valves (turn the bypass valve SV2 OFF and turn the draw valve SV1 ON). At that time the water will start flowing into the Test Measure.
17. Record the prover pressure (Pp) at P1 while only the water draw valve is open (SV1). Valves V5 and V6 must be closed while recording this pressure, which is the pressure at the start and the end of volume switching. Note: The draw can be sped up by opening valve V6 after the valves have switched to flowing into the Test Measure located on the scale and the prover pressure (Pp) is recorded. Again close V6 at least 13mm or 2L (1/2" or 1/2 gal) prior to solenoid draw valve switching.
18. Record ambient temperature (Ta) at T4.
19. Record temperature (Td) at T2, which is the detector temperature, by opening the drive cover and placing the thermometer midway between volume switches, which is the location of the switch bar temperature transmitter thermowell.
20. Record fluid temperature (Tp) at T1 (at prover).
21. Allow Test Measure located on the scale to fill until the second volume switch (downstream sensor) is reached resulting in the draw valve (SV1) turning OFF and bypass valve (SV2) turning ON. Carefully record scale reading (Ww).

22. After all data is collected, drain the catch container and tare scales.
23. Repeat steps 14 through 22 as necessary to obtain the required number of well repeating runs (including one run at 25% flow rate variance).

Please note that a log will be saved with start time and sweep time after each calibration run.

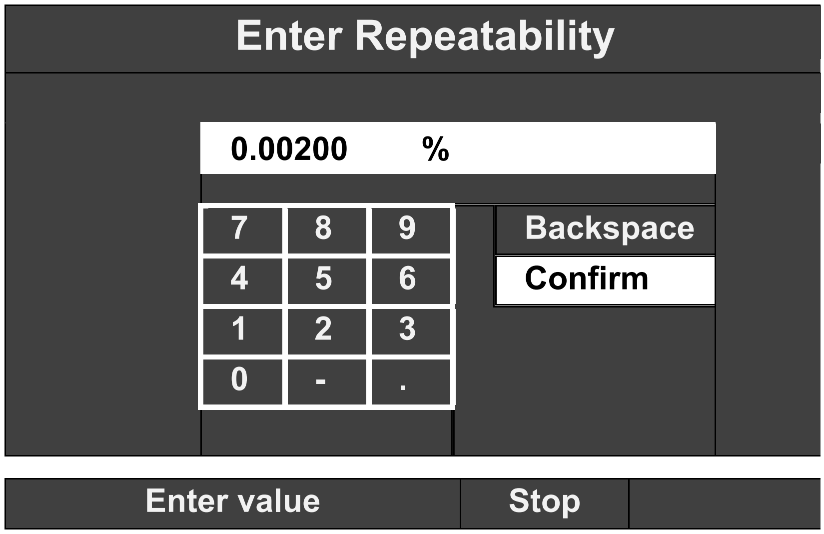
24. Once you have completed the calibration, select the "Exit Calibration" menu which will turn the bypass valve (SV2) OFF.
25. Calculate prover volume per Section 5.5.
26. **Please Note:** A copy of Table 14 for gravimetric calibration can be used to enter water draw data. An Excel readable file is available from Honeywell Enraf which will calculate the corrected prover volume using the gravimetric method.

After selecting Enter Average Volume following screen appears



27. Enter the average calibration volume calculated in the previous step by selecting the "Enter Average Volume" menu. This screen can be accessed while still in the Calibration mode or at a later time by entering the Calibration menu and then accessing this screen directly.
28. After the Average Volume has been entered and confirmed the following screen is displayed to enter the Repeatability in percent (%). The entered average volume and the repeatability values will be stored in the log with a timestamp of the entry.

After selecting Enter Average Volume following screen appears



Selecting “Abort Calibration” will stop the calibration process. This action will stop the motor if in running state, bypass value (SV2) will be turned ON and draw valve (SV1) will be turned OFF. If the Prover is in sweep mode with the piston moving downstream no action will be taken for upstream and downstream sensor inputs. Calibration log entry will not be made.

In calibration mode alarms will be generated as per the configuration, and the run permissive signal from the flow computer or the run prover test signal will be ignored.

The operating mode of the prover will be saved in NVM so that the mode will be restored if power is turned off while in Prover Calibration mode.

To exit calibration mode navigate to the Exit Calibration Mode menu and press OK.

A copy of Table 14 can be used to enter water draw data.

Gravimetric Water Draw Data Sheet

Date:					
Prover Serial Number:					
Prover Model Number:					
Report Number:					
Location:					
Standard Temperature (Tb):					
Standard Pressure (Pb)					
Elevation (h)					
Field Test Weight Density					
Reference Test Weight Density					
Compressibility Factor (water) (CPL):					
Flow Tube Area Thermal Expansion Coefficient (Ga):					
Detector Linear Thermal Expansion Coefficient (Gl):					
Modulus of Elasticity of flow tube (E):					
Flow Tube Inside Diameter (inches) (ID):					
Flow Tube Wall Thickness (inches) (WT):					
	Fill 1	Fill 2	Fill 3	Fill 4	Fill 5
Fill Time (minutes) =					
Temperature Air (*Ta*) =					
Temperature Prover (*Tp*) =					
Temperature Detector (*Td*) =					
Prover Pressure (*Pp*) =					
Water Electrical Conductivity =					
Total Mass of Water (*Ww*) =					
Density of Air (ρA) =					
Calculated Density of Water (ρw) =					
Correction of Air Buoyancy of Weighing (*CBW*) =					
Corrected Mass of Water (*Mw*) =					
Volume of Water (*Vw*) =					
Effect of Pressure on Water (*CPL*) =					
Temperature Correction on Prover (*CTS*) =					
Pressure Correction on Prover (*CPS*) =					
Corrected Water Volume (*WD*) =					

Table 24: Gravimetric Water Draw Data Sheet

5.5 Calculations

Volumetric Water Draw Calculations

Water draw volume corrections taken from API Manual of Petroleum Measurement Standards API chapters,: 4.2, 4.9 and 12.2.4. and Appendix B.4 F2.a, 11.2.3.5.

Symbols and Calculations from API 12.2.4:

Given:

RHOtm = Density of liquid (water) in test measure. (API 12.2.4)

RHOp = Density of liquid (water) in prover. (API 12.2.4)

CPL = Correction for the compressibility of liquid. (For water 3.2E-6)

T_b = Base calibration temperature. (60 deg. F. in US)

G_a = Area coefficient of expansion for flow tube. (API 12.2.1.11.2.1)

G_l = Linear coefficient of expansion for detector. (API 12.2.1.11.2.1)

G_c = Coefficient of expansion for the test measure (from calibration certificate)

E = Modulus of elasticity for flow tube material (from API 12.2 Appendix A)

WT = Thickness of flow tube wall. (inches)

ID = Diameter of flow tube. (inches)

Calculate:

BMVa	=	Base Measured Volume adjusted for scale reading.
	=	BMV + SR
CTDW	=	Correction for prover/test measure liquid temperature difference.
	=	RHOtm ÷ RHOp
CTStm	=	Correction for effect of temperature on test measure.
	=	1 + (Ttm - 60) × (Gc)
CTSp	=	Correction for effect of temperature on prover.
	=	{(1+[(Tp-Tb)*Ga]) * (1+[(Td-Tb)*Gl])}
CCTs	=	Correction for prover/test measure steel temperature difference
	=	(CTStm)/(CTSp)
WD	=	Adjusted Base Volume of Draw
	=	BMVa*CTDW*CCTs
CPSp	=	Correction for the effect of pressure on prover
	=	1 + [(Pp*ID)/(E*WT)]

CPLp = Correction for effect of pressure on liquid (water)
= 1/[1-(0.0000032*Pp)]

WDz = Average of all WD's
= [@sum (WDz Fill 1..WDz Fill5)]/n

WDzb = Volume of Prover at 60 deg F and 1 atm
= WDz/(CPSp * CPLp)

Gravimetric Water Draw Calculations

Gravimetric Water Draw technique is completed in accordance with API 4.9.4. Volume correction factors are based on API Manual of Petroleum Measurement Standards API chapters,: 4.2, 4.9 and 12.2.4.

Corrections and representations:

Given:

Td = Temperature of detector bar. (deg F)

Tp = Temperature of prover. (deg F)

Ta = Temperature of ambient air. (deg F)

Pp = Pressure in prover. (psig)

Ww= Weight of water. (grams)

h = Elevation above sea level. (feet)

Dtw= Density of test weights. (gm/cc)

Ga = Area coefficient of expansion for flow tube. (API 12.2.4)

Gl = Linear coefficient of expansion for detector. (API 12.2.4)

E = Modulus of elasticity for flow tube material. (API 12.2 Appendix A)

WT = Thickness of flow tube wall. (inches)

ID = Diameter of flow tube. (inches)

Calculate:

Calculation of Air Density in USC Units:

ρA = 0.001223068*(1-(0.032 x h/1000))*(519.67/(Tf + 459.67))

Where: ρA is the density of air (gm/cc) (Per API 4.9.4)
h is the elevation above sea level (ft)
Tf is the test temperature (°F)

Calculation for the Correction for Air Buoyancy on Weighing (CBW)

CBW= {[1-(0.0012/ρTWr)]/[1- (0.0012/ρTWf)]} * {[1-(ρA/ρTWf)]/[1- (ρA/ρFtp)]}

Where: CBW is the correction for air buoyancy on weighing,
ρTWr is the density of reference test weights (gm/cc),
ρTWf is the density of the field test weights (gm/cc) as per certificate of traceability,
ρFtp is the density of fluid at test temperature and test pressure (gm/cc),
ρA is the density of dry air (gm/cc)

Calculation for the Density of the Calibration Water

ρwtF = Density of water at temperature t °F (kg/cm) (From API 12.2.4 or calculate by algorithm taken from API 4.9.4)

Using the algorithm taken from API 4.9.4

ρwtF = ρ0*[1-((A* ρtF)+(B*(ρtF)^2)-(C*(ρtF)^3)+(D*(ρtF)^4)-(E*(ρtF)^5)))/1000]

Where: ρwtF is density at temperature t °F (kg/cm)
ρ0 is density at temperature t0, 999.97358 kg/m3
t is temperature (°F)
ΔtF is [(t – 32)/1.8]- t0
t0 is 3.9818E+00 (°C)
A is 7.0134E-08 (°C)-1
B is 7.926504E-06 (°C)-2
C is -7.575677E-08 (°C)-3
D is 7.314894E-10 (°C)-4
E is -3.596458E-12 (°C)-5

Note: Above provided equation provide density correlations for density of distilled water. If the water to be used in the Gravimetric Method does not meet the criteria of distilled or deionized water, water from an approved public water (potable) supply may be used in this procedure. However, the conductivity must not exceed 50µs. If the conductivity of the test water is between 50µs and 1,000µs, the density shall be determined as per API 4.9.4 section A.5.

Mw	=	Corrected Mass of Water (gm)
	=	Ww ÷ CBW
Vw	=	Volume of Water (cc)
	=	Mw ÷ ρwtF
CPLp	=	Correction for the effect of pressure on water
	=	1/[1 - (Pp * 0.0000032)]
CTSp	=	Correction for effect of temperature on prover
	=	{(1+[(Tp-Tb)*Ga])*(1+[(Td-Tb)*Gl])}
CPSp	=	Correction for effect of pressure
	=	1 + ((Pp - Pb) × ID)/(E × WT))
WD	=	Corrected Water Volume
	=	(Vw * CTS)/(CPL * CPS)

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CHAPTER 6 TROUBLESHOOTING

6.1 Run Prover Test

Running the prover in the Prover Test operating mode is a good way to verify proper operation. See Section 4.3 for more information.

6.2 Error Messages

If any device on the prover malfunctions the error will be shown on the controller screen. The following are possible errors and how to correct them.

6.2.1 Sensor out of sequence

This error message means that the proving sequence was not completed successfully. In order to clear the error check if:

- the optical switches are functioning (using the dashboard function – see 6.3.1),
- motor stop switch is functioning (using the dashboard function – see 6.3.1),
- the ramp (located on the guide block) is adjusted properly,
- the flag (located on the guide block) is correctly positioned.

6.2.2 Motor time out

This error message means that the signal from the motor stop has not been sent. To clear the error check if:

- motor stop switch is functioning (using the dashboard function – see 6.3.1),
- the ramp (located on the guide block) is adjusted properly,
- or any part of the drive mechanism is broken (such as main driving chain, etc.)

6.2.3 Sensor stuck

This error message means that one of the sensors is triggered and is sending the signal to controller at the beginning of the proving run. To clear the error check if:

- the optical switches are functioning (using the dashboard function – see 6.3.1),
- ensuring that the flag is not triggering one of the optical switches (if repositioning is required user can use dashboard function – “Motor run command” to relocate the piston assembly),
- motor stop switch is functioning (using the dashboard function – see 6.3.1),

6.2.4 Service due

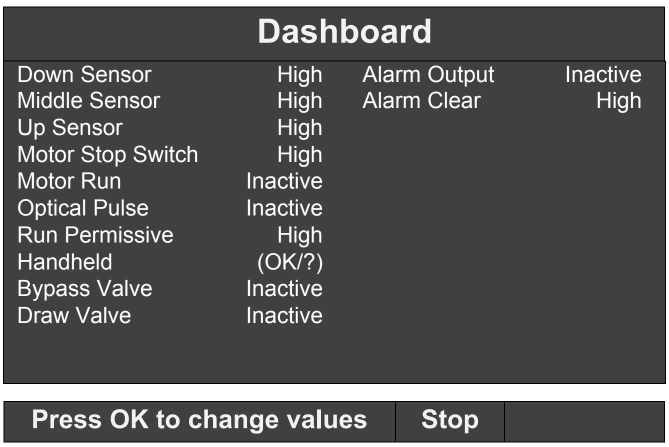
The prover is due for service as determined by the entry at Main Menu/ Configuration/Alarms/Service Due Reminder.

6.3 Diagnostics

There are several screens inside the Main Menu/Diagnostics menu to aid in troubleshooting.

6.3.1 Dashboard

The dashboard screen allows you to verify the status of the inputs and outputs of the SVP Controller. Each output function can be tested by selecting it and activating it.



A properly functioning optical switch will normally indicate “High” at the dashboard screen. Inserting an opaque flag into the optical switch will cause the state to change to “Low”.

To check if the motor stop switch is working properly you should select “Motor stop switch” and trigger the motor stop. The state should change from “High” to “Low”.

To check if the motor is working you should scroll down to the “Motor run command” and press OK. The state of the motor will be changed from “Inactive” to “Active”. You will need to press OK again in order to stop the motor.

6.3.2 System Health

The System Health screen allows you to check the status of the various assemblies that are contained in the SVP Controller. Contact Honeywell support if there are errors.

6.3.3 Active Alarms

The Active Alarms screen allows you to see if any alarms have been activated and to re-enable the device.

6.4 Troubleshooting Chart

Prover does not cycle when proving pass is initiated	
No power to Honeywell Enraf small volume prover	Check for continuity of power to prover, see Section 7
Interface cable between CIU or flow computer and Honeywell Enraf small volume prover is not properly connected	Check connections and integrity of cables, see Section 7 and flow computer manual
Above checks do not resolve problem	See Section 6 for troubleshooting controller, optical switches, and motor stop switch
Honeywell SVP Controller is not in Meter Calibration Mode	Exit Prover Test Mode (Section 4.3) or Prover Calibration Mode (Section 5.3 and 5.4)
Unsteady or absence of pulse from flow meter	
Defective flow meter signal cable or connection	Refer to applicable proving computer manual and check cables and connections
Defective pickup or pulser	Check for electrical or mechanical failure
Defective flow meter	Observe for pulse width variation and possible noise from meter (repair or replace flow meter)
Defective flow meter signal	Test input and output signals preamplifier with an oscilloscope
Defective CONDAT® interface unit or signal conditioners, if using CONDAT® prover control	Input a frequency signal with a signal generator and check for signal at computer or output of signal conditioner with an oscilloscope
If using flow computer of other manufacture	Check flow computer’s operation manual for possible solution to problem

Table 25: Honeywell Enraf Troubleshooting Chart

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CHAPTER 7 ELECTRICAL SCHEMATICS & DRAWINGS

This section contains various electrical schematics and drawings for the Honeywell Enraf small volume prover. If there are electrical questions not addressed by these figures contact your nearest Honeywell Enraf representative or the factory directly.

7.1 Schematics for prover wiring

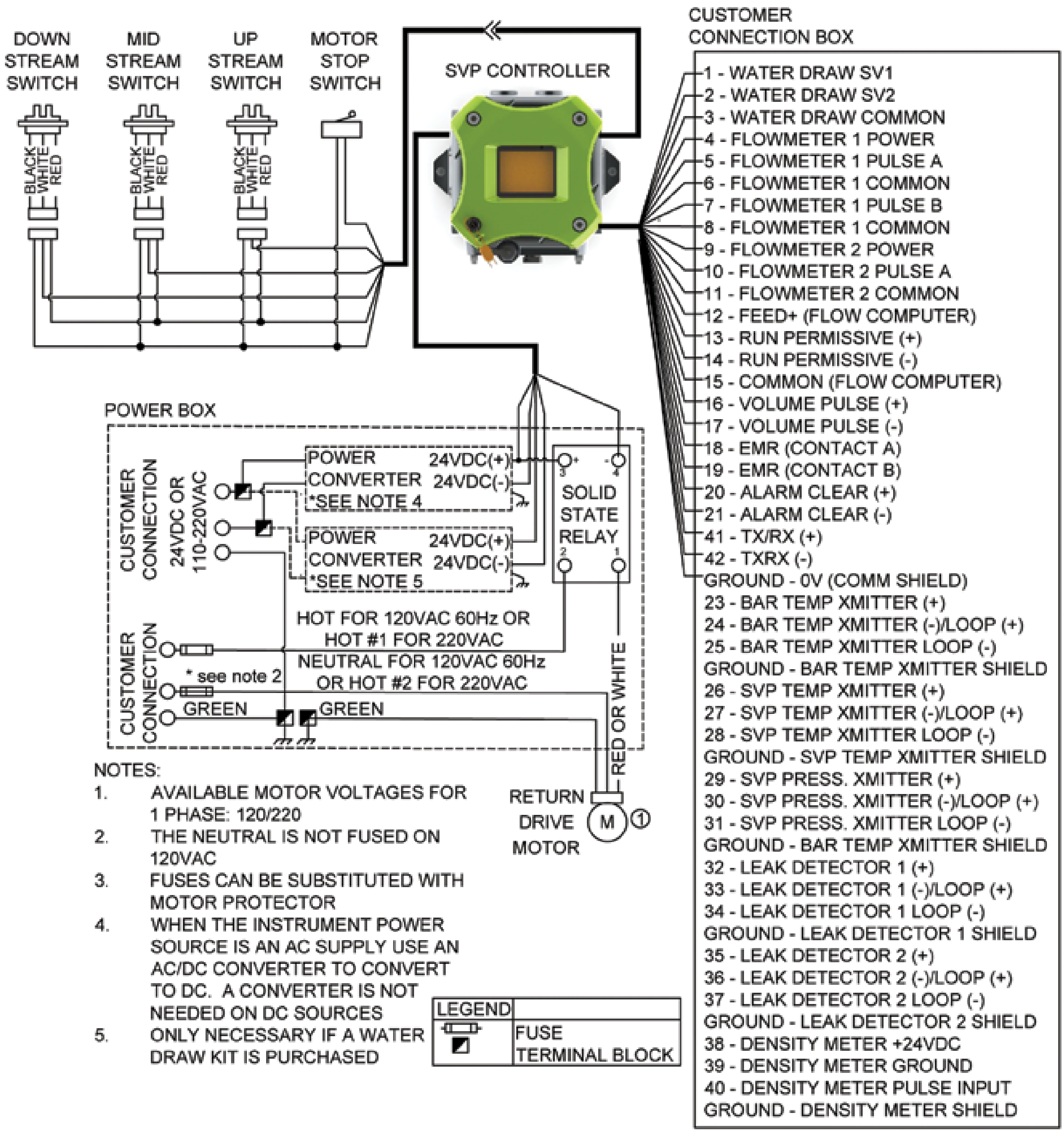


Figure 7-1: Wiring Diagram 1 Phase

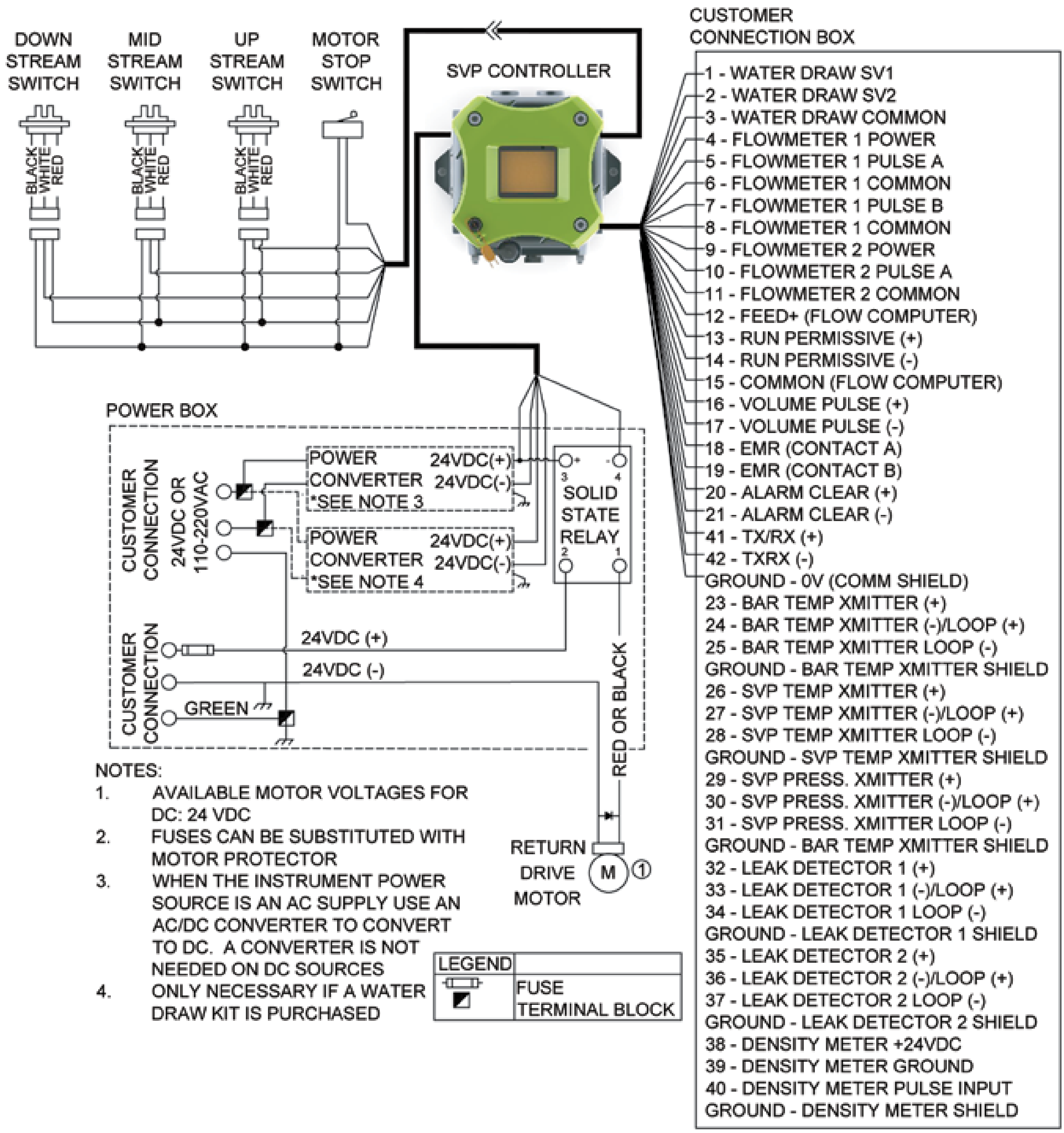


Figure 7-2: Wiring Diagram DC

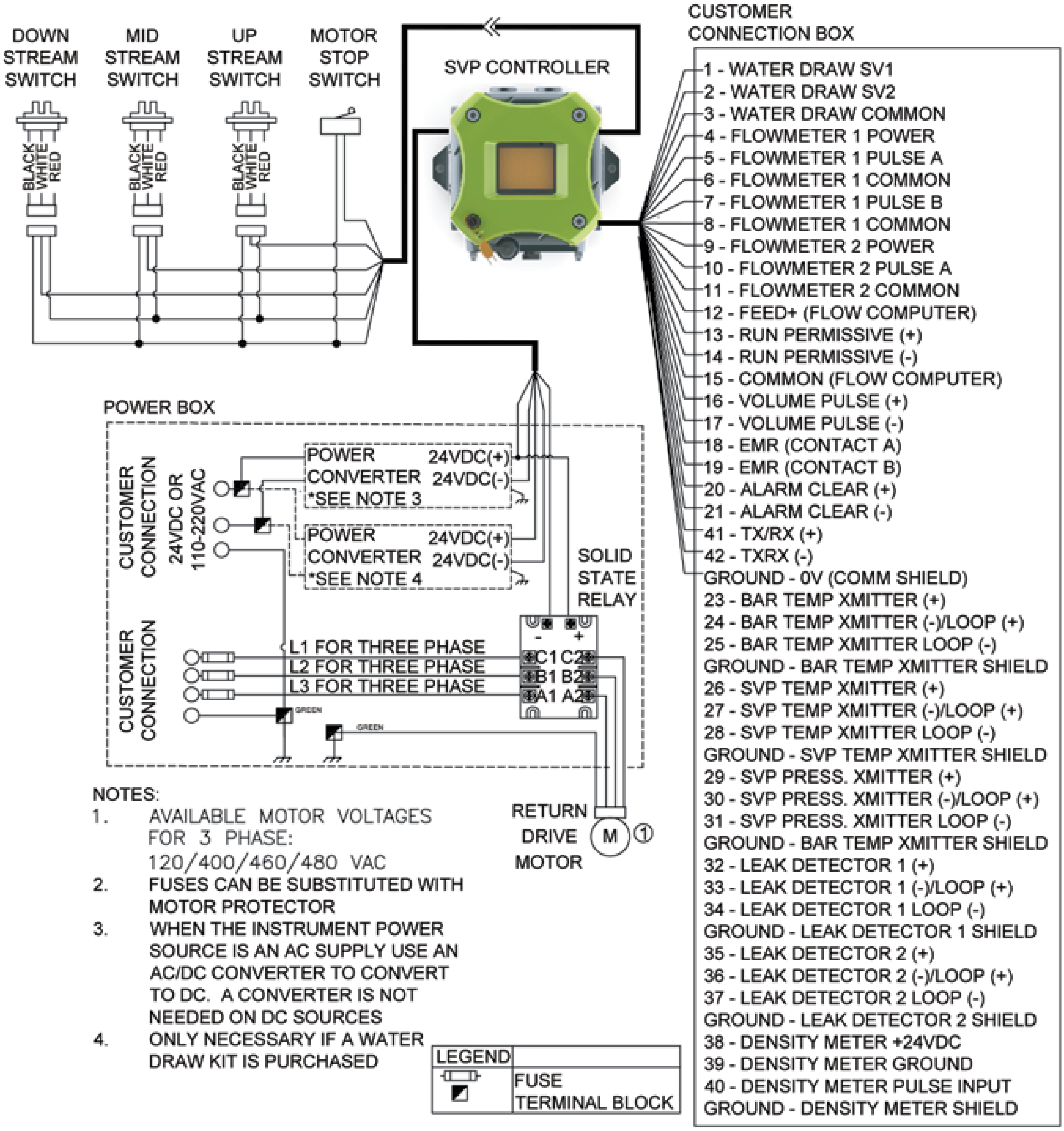


Figure 7-3: Wiring Diagram 3 Phase

7.2 Connections to Flow Computers

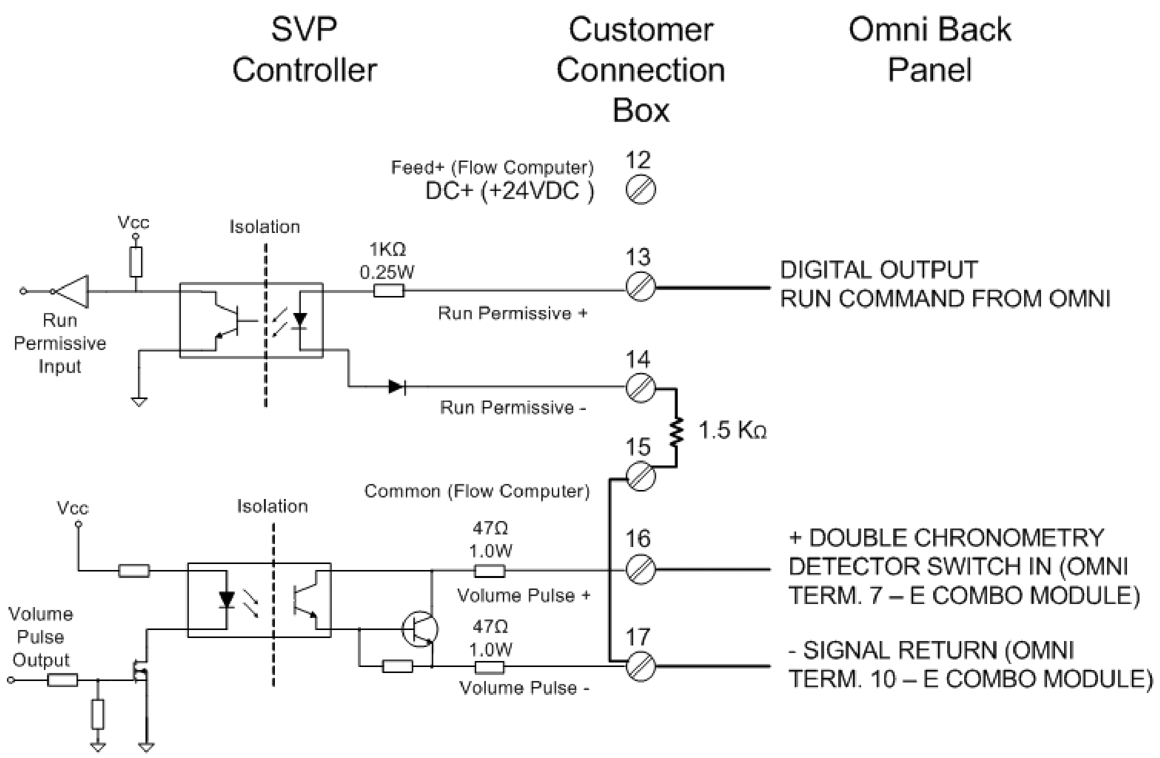
Shown below are diagrams showing how to connect the SVP Controller via the Customer Connection Box to various models of flow computers. Note that the first diagram shows a simplified representation of the Run Permissive Input and the Volume Pulse Output circuits in the SVP Controller. The 1500 ohm current limiting resistor shown in the diagrams is required with operating voltages from 12 to 24 volts DC. For operating voltages from 6 up to 12 volts, the 1500 ohm resistor must be replaced with a zero ohm jumper. The resistor and jumper must be connected to the terminals in the Customer Connection Box.

7.2.1 Omni

An Omni flow computer requires that the meter be connected to one of the two E Combo card pulse inputs. The E combo card will use the double chronometry proving method. Although there are other ways to make the connections, we will describe the connections according to the diagram below. The Volume Pulse + (terminal 16 of the Customer Connection Box) connects to the prover detector input of the E Combo Module. The prover detector input on the Omni is usually Pin #7. Connect Volume Pulse – (terminal 17 of the Customer Connection Box) to common on the rear of the Omni. This is usually Pin #10 which is tied to common on the power supply. The prover Run permissive + command (terminal 13 of the Customer Connection Box) connects to any Omni Digital I/O point. That point must be assigned a Boolean point that has been programmed with the value of/1927. Then the Digital I/O point must be assigned the Boolean point.

Example: Program the Boolean point 1025 with the statement/1927. Then program Digital I/O point #12 with the number 1025. Connect the run command wire to Digital Point # 12.

A 1500 ohm resistor must be installed between the Run permissive - (terminal 14 of the Customer Connection Box) and the common (terminal 15) for the run command to work properly. This setup will launch the prover when the I/O point goes high (voltage applied). When it is low (no voltage) the prover motor will be idle. A jumper must be connected between the Volume Pulse – (terminal 17 of the Customer Connection Box) and the Common (terminal 15 of the Customer Connection Box). Please read the Omni's Operator's manual prior to connection and or operation of the Honeywell Enraf small volume prover.



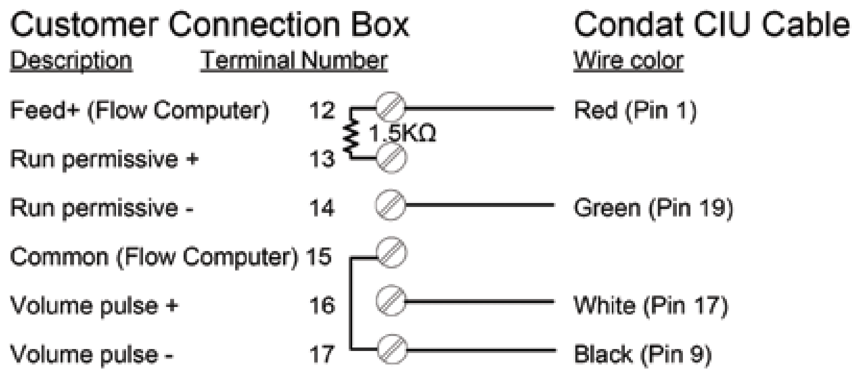
7.2.2 CONDAT CIU

The Condat Interface Unit (CIU aka PIU) connects to the SVP controller using cable (Honeywell PN 44108889). The cable features a connector that attaches to the CIU at the connector labeled “Control”. The opposite end of the cable has colored leads for connection in the terminals in the Customer Connect Box. Please refer to the PROVEit Manuals for further connection instructions.

Note: The pin numbers listed adjacent to the colors signify the pin locations on the CIUs “Control” connector.

Within the Customer Connection Box, the terminals 12 and 15 are provided to securely land customer provided voltage or ground leads as needed. For the CIU the ground (earth) reference is Black (Customer Connection Box Terminal 17) and the nominal 15VDC supply is Red (Customer Connection Box Terminal 12).

While idle, Green (Customer Connection Box Terminal 14) will read nominal 15VDC and White (Customer Connection Box Terminal 16) will read nominally 5 VDC. When the run command is given, the CIU will drop Green to ground (earth) and the SVP controller starts the proving run. When either optical switch is triggered on the downstream pass, the SVP controller will drop White to 0VDC for 25mS and the CIU will instruct the proving program to start or stop recording meter pulses. After the run is complete the CIU will return to idle conditions until the next run command is sent.

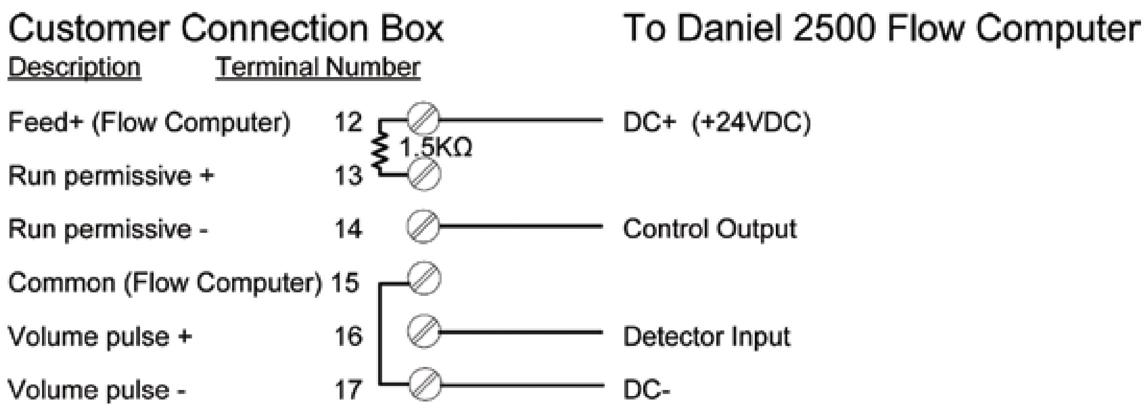


7.2.3 Daniels

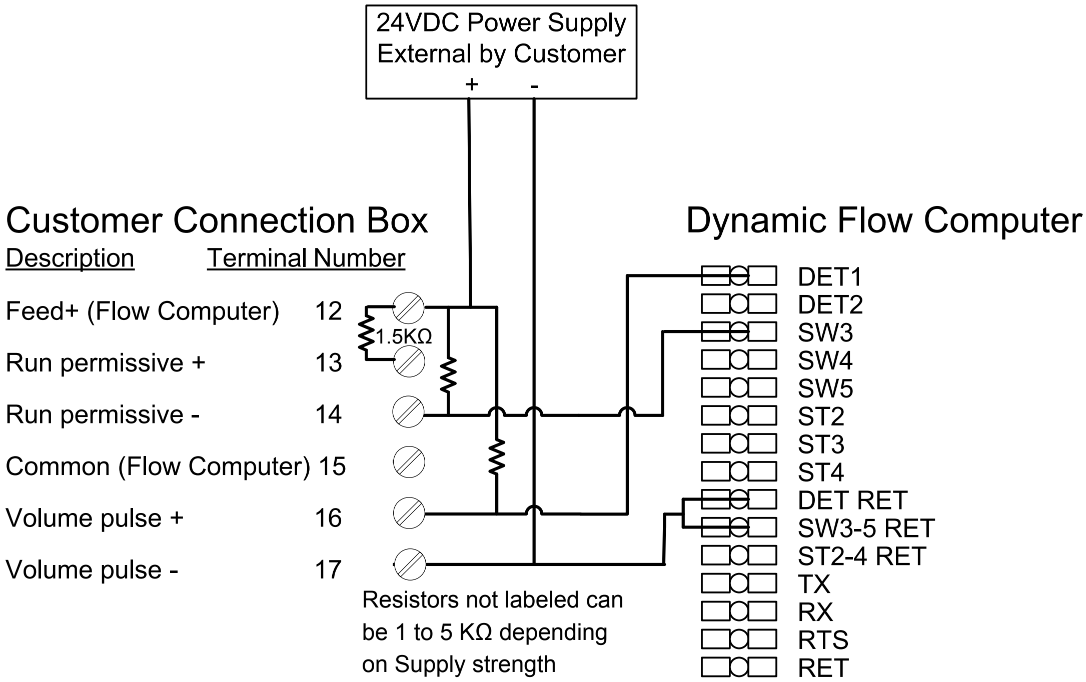
Actual terminal locations for the Daniel flow computer is dependent upon the application software being used in the Daniel flow computer. See the appropriate Daniel manual and software information for more information.

Warning

Due to scan speed, the 2500 has limitations in flow rate when used with small volume flow provers due to short time period between volume detectors.



7.2.4 Dynamic


24VDC Power Supply
External by Customer
+
-
Customer Connection Box
Description
Terminal Number
Feed+ (Flow Computer) 12
Run permissive + 13
Run permissive - 14
Common (Flow Computer) 15
Volume pulse + 16
Volume pulse - 17
1.5KΩ
Resistors not labeled can be 1 to 5 KΩ depending on Supply strength
Dynamic Flow Computer
DET1
DET2
SW3
SW4
SW5
ST2
ST3
ST4
DET RET
SW3-5 RET
ST2-4 RET
TX
RX
RTS
RET

Intentionally left blank.

CHAPTER 8 PROVER MAINTENANCE

Servicing the prover should be done in a de-engergized state but may require reactivating power for the motor or flow through the prover to position the piston. Use extreme caution and keep clear of all moving components including the downstream shaft. All covers should remain in place while the prover is energized if at all possible. Metal tools should not be used inside the flow tube so as not to damage the surface finish.

8.1 Portable Prover

- Lock out AC or DC power to motor with padlock
- Install Condat System and computer
- Install fake flow meter/signal generator (if checking optical switches)
- Turn on the 24VDC to the Condat

8.2 Stationary prover

- Lock out AC power to prover with padlock

8.3 General Prover Maintenance Information

Preventative Maintenance

Honeywell Enraf small volume provers are designed to require minimal maintenance; however, several key components require periodic inspection and/or replacement to prevent undue wear, damage, or possibly failure. The following recommended maintenance intervals are based on an average usage rate of 100 passes per day proving refined petroleum products at average temperatures of 77ºF [25ºC]. The fluid is typified as clean of foreign objects or debris and possessing moderate lubricity.

If the fluid being introduced into the prover is high in entrained solids, i.e.: sand in crude oil, or low in lubricity, i.e.: LPG's and certain chemicals, then it is recommended to reduce the time between preventative maintenance intervals by 50%. This also applies for applications involving high duty load cycles, i.e.: 3rd party service portables. Extra time spent on careful preventative maintenance can often prevent otherwise avoidable costly repairs and calibration downtime.

Always remember to depressurize, drain, and block & blind your prover in addition to meeting your site required electric power lockout/tag-out procedures before performing maintenance procedures.

A - Prior to Each Proving Session:

1. Visually inspect pressure retaining components (i.e.: flow tube flanges, bleed manifolds and valves, drain valves, shaft seal assemblies, transmitter ports) for signs of leakage, damage, or failure. Repair or replace any suspect items.

2. Verify Return Drive Assembly protective cover set and Downstream Shaft Cover are intact with no signs of tampering or unauthorized entry.
3. Verify all required safety devices are functioning and any exposed pressure relief blow down is directed away from personnel.
4. Verify Purge Gas is present for units using Purge Cover Assemblies.

B - Monthly:

1. All items in A.
2. Remove Return Drive Assembly Side Panels. Visually examine return drive assembly (i.e.: conveyor shaft assemblies with bearings and pullers/chains, motor and speed reducer, drive end plates and anchor bolts, guide bars, guide block assembly including optical switch and ground assembly, switch bar assembly) for any loose fasteners or signs of adverse wear and/or damage. Repair or replace any suspect items.
3. Visually inspect all electrical cabling for signs of wear or damage.

C – Semi-Annually:

1. All items in B.
2. Remove upstream and downstream bleed manifolds. Insert boroscope with flashlight attachment into both upstream and downstream vent flanges. Visually inspect both upstream and downstream piston seals for and signs of damage or wear. Inspect poppet valve seal for any signs of damage or wear. Inspect flow tube calibrated surface for damage to chrome plating. Repair or replace any suspect items.
3. Verify prover anchor bolts are tight.

This maintenance section covers most of the routine maintenance procedures to be performed on your prover. Trouble shooting information is contained in Section 6 while wiring diagrams and schematics common to all Honeywell Enraf small volume models are found in Section 7.

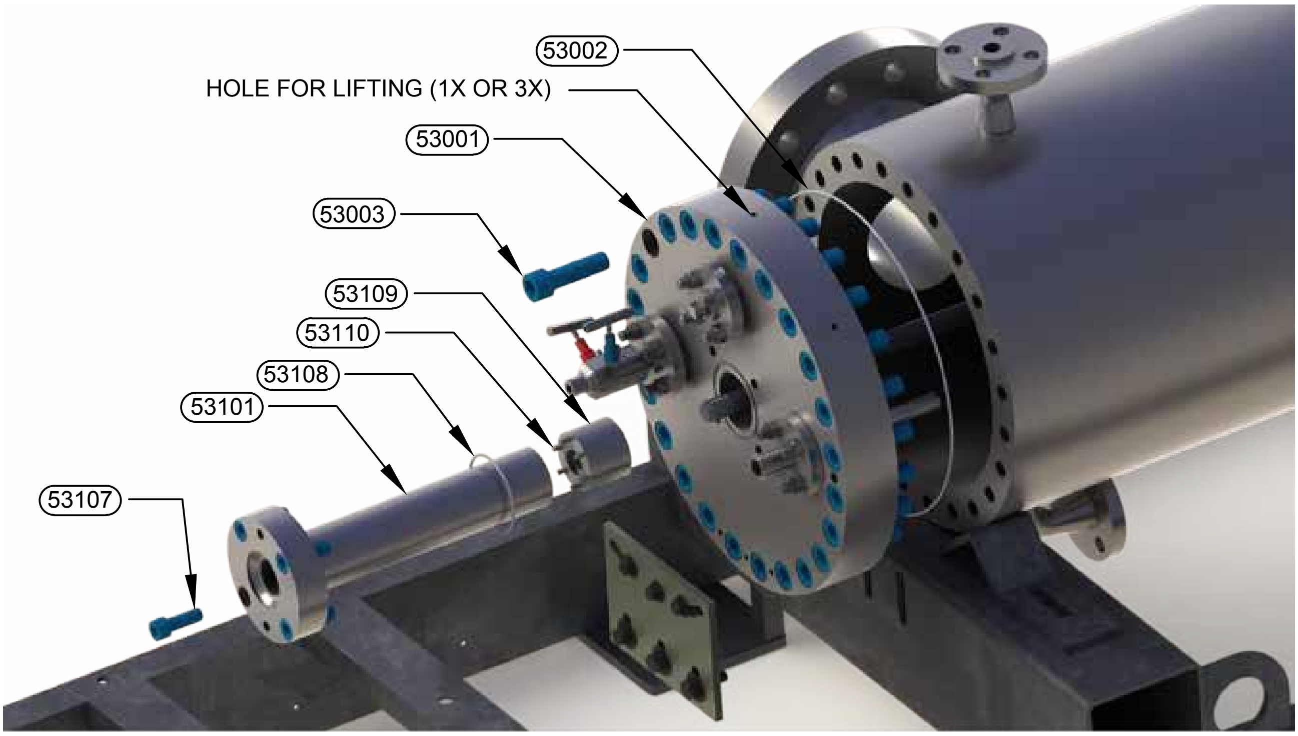
Please contact the Honeywell Enraf factory for information on problems or repairs not covered by Honeywell Enraf small volume Operation Manual.

8.4 Downstream Shaft Seal Replacement

Please Note: When referring to an item # in the following instructions, please refer to Figure 8-1 through Figure 8-8.

1. Do not remove upstream seal retainer at this time.
2. Move the piston to the downstream position.
3. Disconnect power from prover.
4. Disconnect prover from line, or block off from line, and drain it completely.
5. Remove downstream shaft cover by removing outer support, carefully sliding tube cover from the shaft, and unscrew the threaded rod from the downstream stop, Figure 8-1 #53101.

6. Remove the 4 bolts, Figure 8-1 #53107, in order to remove the downstream stop from the downstream end flange, Figure 8-1 #53001.
7. Disassemble the downstream seal retainer, Figure 8-1 #53109 from the downstream stop.
8. Remove the retaining rings, seals and washers from the downstream seal retainer as showed in the Figure 8-2.

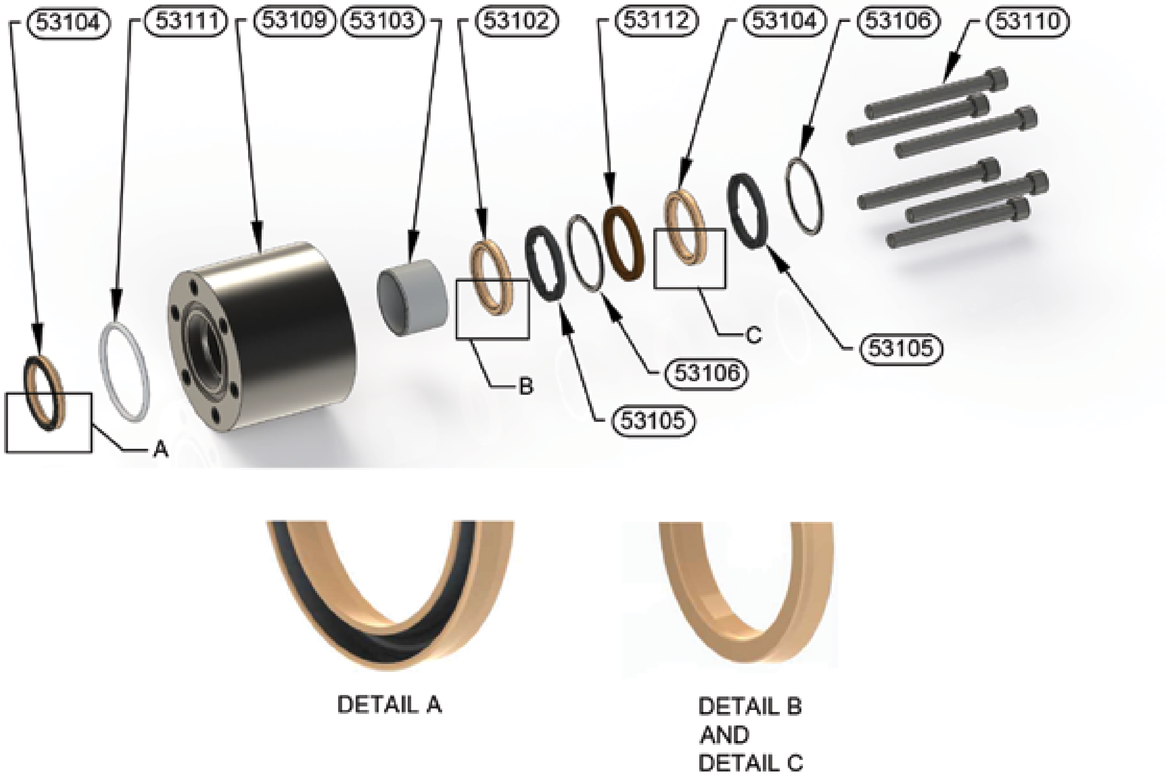


ITEM NO.	DESCRIPTION
53001	DOWNSTREAM FLANGE
53002	O-RING SEAL DOWNSTREAM FLANGE
53003	FLANGE RETAINING BOLT
53101	DOWNSTREAM STOP
53107	DOWNSTREAM STOP RETAINING BOLT
53108	O-RING SEAL DOWNSTREAM STOP
53109	DOWNSTREAM SEAL RETAINER
53110	DOWNSTREAM SEAL RETAINER BOLT

Figure 8-1: Downstream Side Exploded View

9. Clean and inspect seal retainer.
10. Check seal surfaces for scratches and a surface finish of 12rms. If necessary, polish the seal surfaces.

11. Carefully install new seals and washers in proper orientation as showed in the Figure 8-2. Note the direction of the seal lips for correct installation of the new seals. In a case of cracked or broken washers they need to be replaced when new seals are installed.
12. Assemble the downstream seal retainer, Figure 8-1 #53109, to the downstream stop, Figure 8-1 #53101, using hex socket bolts, Figure 8-2 #53110. Make sure that the O-ring seal, Figure 8-2 #53111, is in place before the seal retainer is assembled to the downstream stop.
13. Snug bolts evenly, using a cross pattern, so as to not damage the seal or distort the flange. Refer to Table 16 for bolt torque specifications, and carefully tighten bolts evenly, using a cross pattern, and moving in increments to the full torque value.



ITEM NO.	DESCRIPTION
53102	SHAFT SEAL
53103	IGUS BUSHING
53104	SHAFT SEAL
53105	NOTCHED RYTON WASHER
53109	DOWNSTREAM SEAL RETAINER
53110	DOWN STREAM SEAL RETAINER BOLT
53111	O-RING SEAL
53112	RYTON WASHER
53106	RETAINING RING

Figure 8-2: Downstream Seal Retainer Assembly

Please Note: On the provers models S05/O05, S15/O15, S25/O25 and S35/O35 all three shaft seals are the same.

8.5 Prover Piston Assembly Seal Replacement

1. Complete the steps from 1 thru 6 mentioned in the Section 8.4.
2. Remove the bracket securing the flow tube and downstream end flange to the frame.
3. Remove pressure and temperature transmitters from the downstream end flange.
4. Remove the hex socket bolts, Figure 8-1 #53003, securing the downstream end flange Figure 8-1 #53001 to the flow tube except for 1 bolt at the top. Connect a hoist to the threaded hole in the top of the downstream end flange. Remove the last hex socket bolt, and using the hoist to support the flange, remove it from the flow tube.
5. Open the drive end cover and remove the securing nut (locking nut), the standard hexagonal nut and the washer, Figure 8-3 position 1 , from the guide block, Figure 8-3 position 2 on the upstream side of the flow tube.

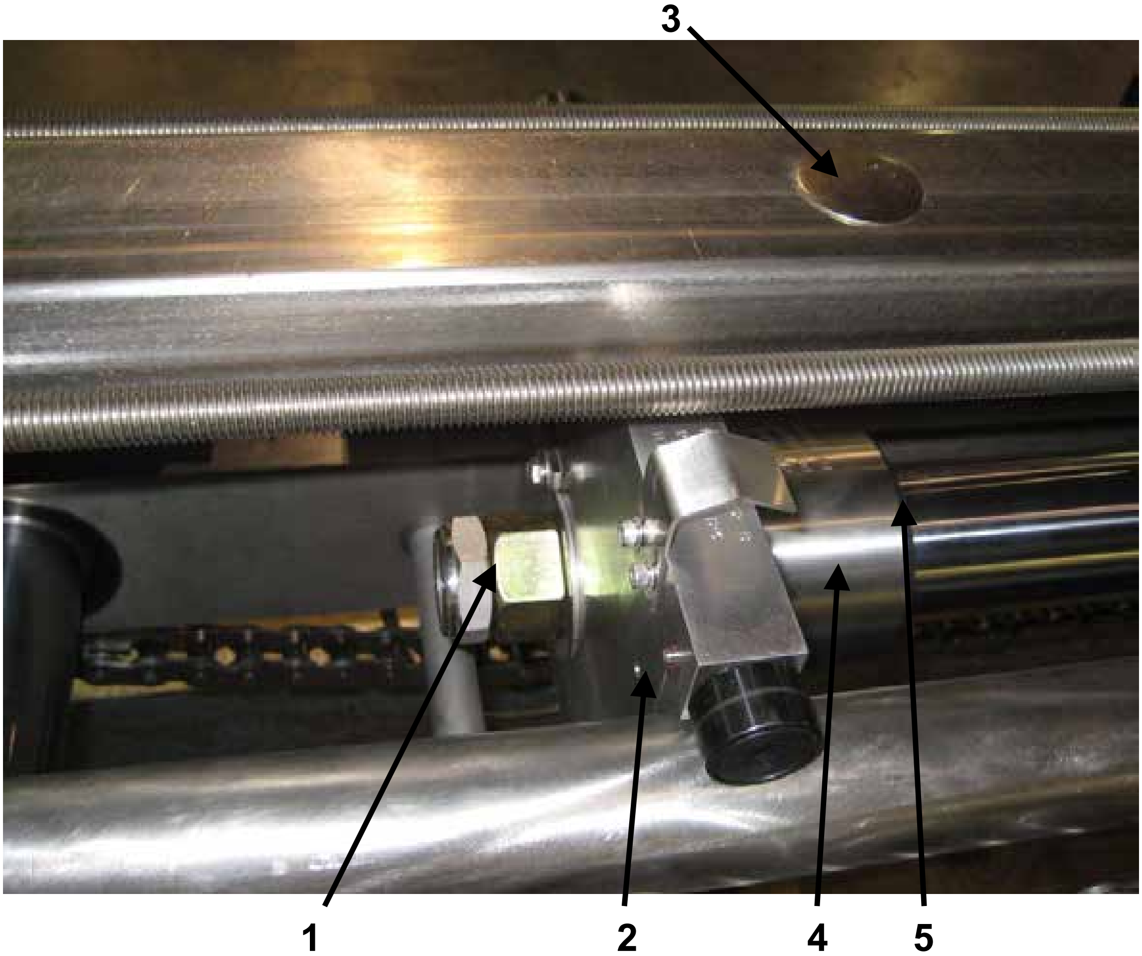


Figure 8-3: Guide Block Assembly

6. Remove the guide block Figure 8-3 position 2 and the mechanical stop Figure 8-3 position 4 with the rubber bumper Figure 8-3 position 5 from the upstream piston shaft.

7. Remove the upstream seal retainer assembly, Figure 8-7 #52101, from the upstream flange by first removing the shock absorbers, Figure 8-7 #52108, and then removing the hex socket cap screws, Figure 8-7 #52107 holding the seal retainer to the end flange. Then remove the upstream seal retainer assembly.

8. With sufficient personnel and/or a hoist or crane at the downstream end of the prover, lift the piston assembly and pull it out of the flow tube, see Figure 8-4. Be extremely careful to remove the piston assembly in such a manner to not cause damage to the piston or to the precision bore flow tube. Note: Lift the piston assembly with a nylon strap wrapped through piston support to prevent damage or injury. NEVER lift the piston assembly with the strap positioned far away from the piston support, Figure 8-5 #54002.

9. For piston disassembly on most models, use procedure 9a, for older models, use 9b.

9a. Referring to Figure 8-5, disassemble the piston, by first removing the downstream shaft #54005 from the poppet valve #54003. Then remove the piston support #54002 from the piston body by placing the piston body #54001 face down on a clean surface and hold pressure to keep the spring #54009 compressed and removing the #54020 hex head cap screws. The poppet assembly may now be removed from the piston body. Remove poppet seal #54014 from piston body #54001. Remove the main piston seals #54013 and riders #54008 very carefully so as not to damage the seal surfaces on the piston.

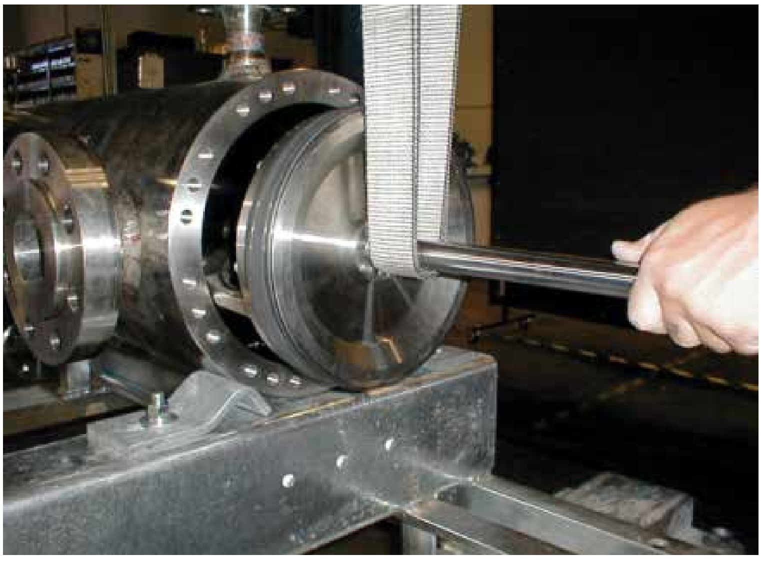
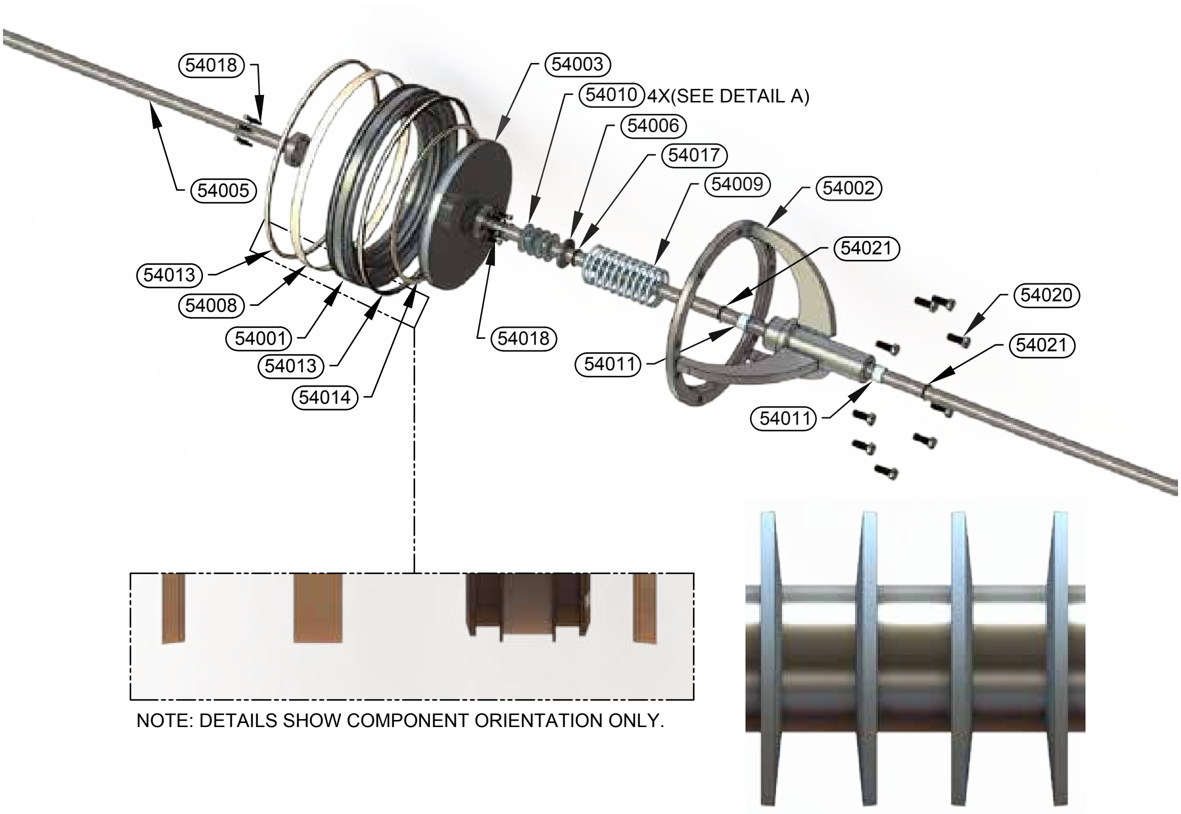


Figure 8-4: Piston Removal



NOTE: DETAILS SHOW COMPONENT ORIENTATION ONLY.

DETAIL A: BELLEVILLE WASHER #54010 ORIENTATION

ITEM NO.	DESCRIPTION
54001	PISTON BODY
54002	PISTON SUPPORT
54003	POPPET
54004	UPSTREAM SHAFT
54005	DOWNSTREAM SHAFT
54006	BELLEVILLE RETAINER WASHER
54008	PISTON SEAL RIDER (QUANTITY MAY VARY BASED ON PROVER MODEL)
54009	PISTON SPRING
54010	PISTON BELLEVILLE SPRING (NOT INSTALLED ON ALL UNITS)
54011	IGUS BUSHING
54013	PISTON SEAL (QUANTITY MAY VARY BASED ON PROVER MODEL)
54014	POPPET SEAL
54017	BELLEVILLE RETAINER SEAL (NOT INSTALLED ON ALL UNITS)
54018	SOCKET HEAD CAP SCREW
54020	HEX HEAD BOLT

Figure 8-5: Piston Assembly Exploded View

9b. Referring to Figure 8-5, disassemble the piston, by first removing the downstream shaft #54005 from the poppet valve #54003. Then remove the piston support #54002 from the piston body by placing the piston body #54001 face down on a clean surface and hold pressure to keep the spring #54009 compressed and removing the #54020 hex head cap screws. The poppet assembly may now be removed from the piston body. Remove seal retainer flange #54023 (not shown) from #54003, and remove poppet seal #54014 from #54003. Remove the main piston seals #54013 and riders #54008 very carefully so as not to damage the seal surfaces on the piston.

Note: Use caution on larger units (S85 and S120) as it takes three people to remove the piston support, two to stand on the support and the other one to remove the bolts. If the support should be stuck in the piston body, the two people standing on the support should remain until the third person can tap it loose using a dead blow hammer.

10. Clean and inspect all parts.

11. Check seal groove width for proper seal fit, use gauge if available. If the groove is too small check with factory to get the proper dimensions to have the piston body machined.

12. Reassemble the piston by reversing the disassembly procedure and use new seals in all locations, refer to Figure 8-5. Note the direction of the seal lips for correct installation of the new seals, see Figure 8-5. To assist in installing the riders and main piston seals, put them in hot water [60 - 65°C (140 - 150°F)] to make the seals and riders more flexible and to reduce the chance for damage. All piston bolts should have a thread lock compound applied to them, Loctite 242 is recommended. Note: If piston appears tight when installing new seal kits into the tube a groove could be cut on the rider surface. This will consist of two 45-degree grooves cut in the rider spaced 90 or 180 degrees apart. Use a sharp utility knife to create groove. Depth of groove is to be 80% of the rider thickness and 3mm (1/8") wide. Cut grooves after rider is installed on piston body. All riders should have chamfered inside edges to allow for proper seating in the piston.

Note: Be extremely careful to not damage the piston seals in any way or to lay the piston on the seals and cause them to be deformed.

13. Clean and inspect flow tube. Check for gouges, excessive wear, de-plating, pitting, etc.

14. Insert the piston by carefully guiding the piston assembly into the flow tube being very careful to not damage the new seals or the precision bore flow tube. It will be necessary to apply some considerable force to the piston assembly to compress the piston seals to enter the flow tube bore. It may be necessary to use a length of the appropriate size threaded rod, inserted through the hole in the drive end plate where the static leak detector is inserted, refer to Figure 8-6. Screw the threaded rod into the piston shaft. A piece of 13mm (1/2") PVC

pipe over the threaded rod will prevent the threads from hanging up in the upstream flange. Install a large flat washer and a nut on to the threaded rod and pull the piston into the flow tube while wiggling the downstream shaft to be certain of correct alignment with the seals and the flow tube bore.

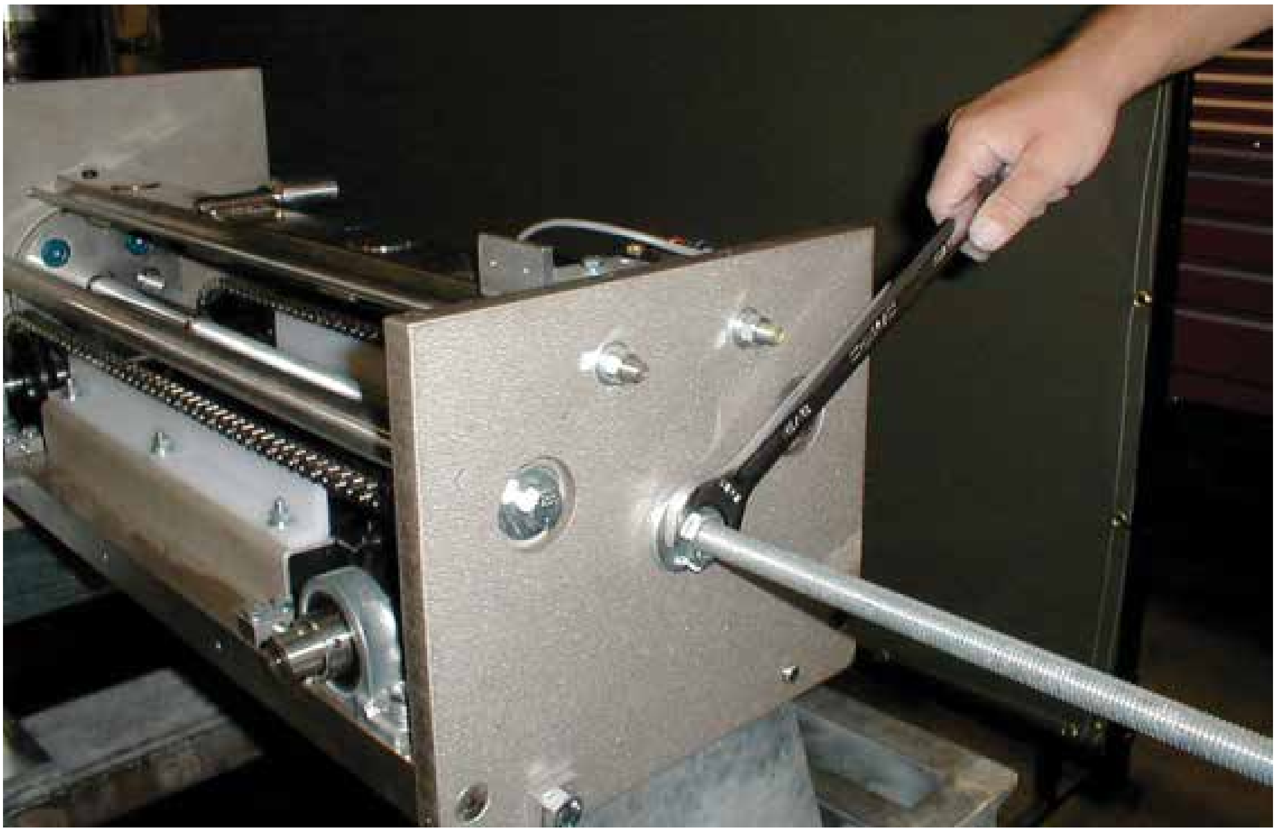


Figure 8-6: Piston Insertion into Flow Tube – Pulling Method

Notes: Refer to Table 16 for bolt torque values for assembling flow prover.

Upstream flange to flow tube seal does not usually need replacement during normal maintenance, nor is it necessary to remove upstream flange, Figure 8-7 #52201.

15. Put a new o-ring seal, Figure 8-1 #53002, onto downstream end flange, Figure 8-1 #53001, carefully re-install flange into flow tube. Re-install hex socket bolts, Figure 8-1 #53003, securing the downstream end flange, Figure 8-1 #53001, to the flow tube. Snug bolts evenly, using a cross pattern, so as to not damage the seal or distort the flange.

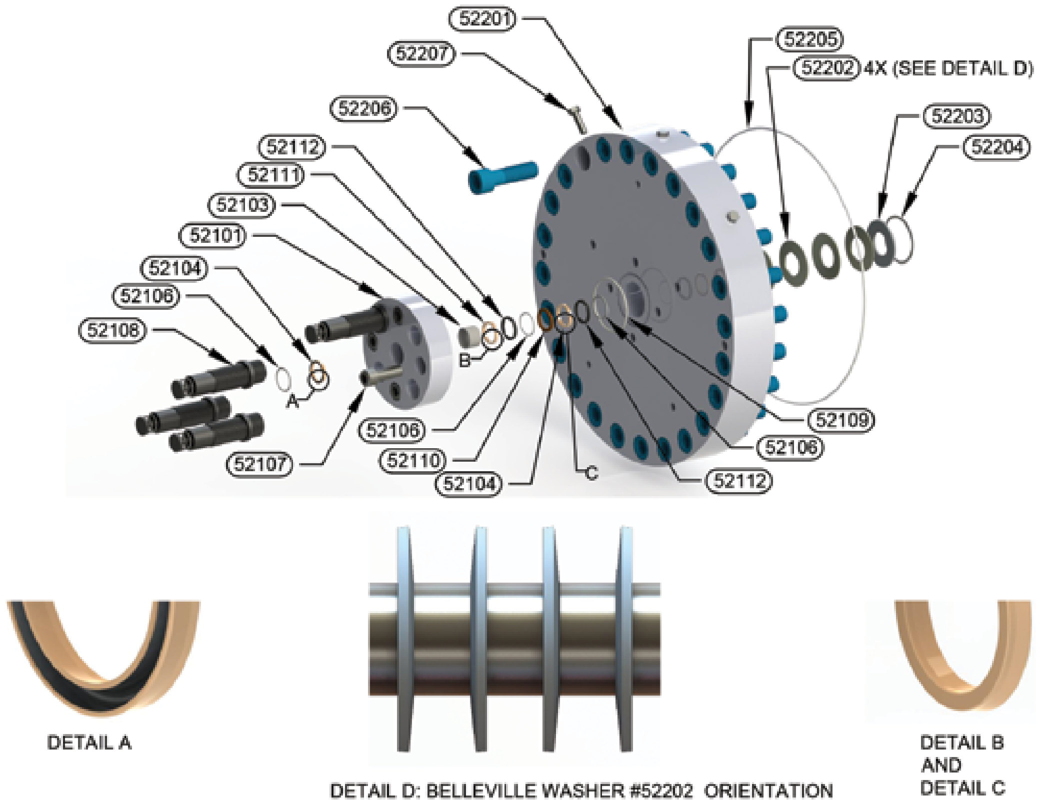
    Refer to Table 16 for bolt torque specifications, and carefully tighten bolts evenly, using a cross pattern, and moving in increments to the full torque value.

16. With downstream seal retainer assembled to the downstream stop (refer to Section 8.4 steps 11 & 12), finish re-assembly of the downstream side of the prover using the reverse of the procedure from # 1 through # 4 making sure that critical bolts are tightend as per torque specification, see Table 16.

8.6 Upstream Shaft Seals Replacement

1. Make sure that the steps from 2 thru 4 mentioned in the Section 8.4 and the steps from 5 thru 7 mentioned in the Section 8.5 are fully completed.
2. Remove the retaining rings, seals and washers from the upstream seal retainer, Figure 8-7 #52101.
3. Clean and inspect seal retainer.
4. Check seal surfaces for scratches and a surface finish of 12rms. If necessary, polish the seal surfaces.
5. Carefully install new seals and washers in proper orientation (see Figure 8-7 for correct installation). Note the direction of the seal lips for correct installation of the new seals. In a case of cracked or broken washers they need to be replaced when new seals are installed.
6. Install the upstream seal retainer, Figure 8-7 #52101, in the upstream flange, Figure 8-7 #52201.
7. Re-install hex socket bolts, Figure 8-7 #52107 in order to secure the upstream seal retainer to the upstream end flange. Snug bolts evenly, using a cross pattern, so as to not damage the seal or distort the flange.

   Refer to Table 16 for bolt torque specifications, and carefully tighten bolts evenly, using a cross pattern, and moving in increments to the full torque value.
8. Re-install the shock absorbers, Figure 8-7 #52108. Make sure to adjust the setting on all four shock absorbers at the same setting number (see instructions in Section 8.8.10).
9. Install the mechanical stop, Figure 8-3 position 4 with the rubber bumper, Figure 8-3 position 5 on the upstream piston shaft. Note: It is recommended to replace existing rubber bumper with the new one at this time. Make sure to clean the surface on the mechanical stop prior to gluing the rubber bumper to it. Use Loctite 422 or equivalent.
10. Carefully slide the guide block, Figure 8-3 position 2 over the threads of the dimple stud and secure it using the washer, standard hexagonal nut and locking nut, Figure 8-3 position 1. Note: Make sure to clean the threads on the dimple stud and be careful not to damage the optic switches.



ITEM NO.	DESCRIPTION
52201	UPSTREAM FLANGE
52202	BELLEVILLE SPRING
52203	WASHER BELLEVILLE RETAINER
52204	RETAINING RING
52205	UPSTREAM FLANGE O-RING SEAL
52206	SOCKET HEAD CAP SCREW
52207	HEX HEAD CAP SCREW
52101	UPSTREAM SEAL RETAINER
52102	SHAFT SEAL UPSTREAM OUTER
52103	IGUS BUSHING
52104	SHAFT SEAL
52106	RETAINING RING
52107	SOCKET HEAD CAP SCREW
52108	SHOCK ABSORBER
52109	TEFLON O-RING SEAL
52110	RYTON WASHER
52111	SHAFT SEAL
52112	NOTCHED RYTON WASHER

Figure 8-7: Upstream flange and seal retainer assembly

Please Note: On the provers models S05/O05, S15/O15, S25/O25 and S35/O35 all three shaft seals are the same.

8.7 Bolt Torque Specifications

Prover Model Number	Item# 52206	Item# 52107	Item# 53003	Item# 53107	Item# 53110	Item# 54018	Item# 54020	Item# See Note 1
05X3C	120 lbf•ft	150 lbf•ft	120 lbf•ft	150 lbf•ft	75 lbf•in	75 lbf•in	19 lbf•ft	150 lbf•ft
15X1A	120 lbf•ft	150 lbf•ft	120 lbf•ft	150 lbf•ft	75 lbf•in	75 lbf•in	45 lbf•ft	150 lbf•ft
15X2B	120 lbf•ft	150 lbf•ft	120 lbf•ft	150 lbf•ft	75 lbf•in	75 lbf•in	45 lbf•ft	150 lbf•ft
25X1A	120 lbf•ft	150 lbf•ft	120 lbf•ft	150 lbf•ft	75 lbf•in	75 lbf•in	45 lbf•ft	150 lbf•ft
25X2B	120 lbf•ft	150 lbf•ft	120 lbf•ft	150 lbf•ft	75 lbf•in	75 lbf•in	45 lbf•ft	150 lbf•ft
25X3C	500 lbf•ft	150 lbf•ft	500 lbf•ft	150 lbf•ft	75 lbf•in	75 lbf•in	45 lbf•ft	150 lbf•ft
25X4 and 5	500 lbf•ft	150 lbf•ft	500 lbf•ft	150 lbf•ft	75 lbf•in	75 lbf•in	45 lbf•ft	150 lbf•ft
35X1 thru 5	500 lbf•ft	150 lbf•ft	500 lbf•ft	150 lbf•ft	75 lbf•in	75 lbf•in	45 lbf•ft	150 lbf•ft
50X1A	170 lbf•ft	150 lbf•ft	170 lbf•ft	150 lbf•ft	11 lbf•ft	11 lbf•ft	170 lbf•ft	250 lbf•ft
50X2B	170 lbf•ft	150 lbf•ft	170 lbf•ft	150 lbf•ft	11 lbf•ft	11 lbf•ft	170 lbf•ft	250 lbf•ft
50X3 thru 5	1200 lbf•ft	150 lbf•ft	1200 lbf•ft	150 lbf•ft	11 lbf•ft	11 lbf•ft	170 lbf•ft	250 lbf•ft
85X1A	295 lbf•ft	150 lbf•ft	295 lbf•ft	150 lbf•ft	75 lbf•in	11 lbf•ft	170 lbf•ft	250 lbf•ft
85X2B	295 lbf•ft	150 lbf•ft	295 lbf•ft	150 lbf•ft	75 lbf•in	11 lbf•ft	170 lbf•ft	250 lbf•ft
85X3C	1200 lbf•ft	150 lbf•ft	1200 lbf•ft	150 lbf•ft	75 lbf•in	11 lbf•ft	170 lbf•ft	250 lbf•ft
85X4D	1400 lbf•ft	150 lbf•ft	1200 lbf•ft	150 lbf•ft	75 lbf•in	11 lbf•ft	170 lbf•ft	250 lbf•ft
120X1A	500 lbf•ft	150 lbf•ft	500 lbf•ft	150 lbf•ft	11 lbf•ft	11 lbf•ft	170 lbf•ft	250 lbf•ft
120X2B	500 lbf•ft	150 lbf•ft	500 lbf•ft	150 lbf•ft	11 lbf•ft	11 lbf•ft	170 lbf•ft	250 lbf•ft
120X3C	1200 lbf•ft	150 lbf•ft	1200 lbf•ft	150 lbf•ft	11 lbf•ft	11 lbf•ft	170 lbf•ft	250 lbf•ft

Prover Model Number	Item# 52206	Item# 52107	Item# 53003	Item# 53107	Item# 53110	Item# 54018	Item# 54020	Item# See Note 1
05X3C	163 Nm	203 Nm	163 Nm	203 Nm	9 Nm	9 Nm	26 Nm	203 Nm
15X1A	163 Nm	203 Nm	163 Nm	203 Nm	9 Nm	9 Nm	61 Nm	203 Nm
15X2B	163 Nm	203 Nm	163 Nm	203 Nm	9 Nm	9 Nm	61 Nm	203 Nm
25X1A	163 Nm	203 Nm	163 Nm	203 Nm	9 Nm	9 Nm	61 Nm	203 Nm
25X2B	163 Nm	203 Nm	163 Nm	203 Nm	9 Nm	9 Nm	61 Nm	203 Nm
25X3C	678 Nm	203 Nm	678 Nm	203 Nm	9 Nm	9 Nm	61 Nm	203 Nm
25X4 and 5	678 Nm	203 Nm	678 Nm	203 Nm	9 Nm	9 Nm	61 Nm	203 Nm
35X1 thru 5	678 Nm	203 Nm	678 Nm	203 Nm	9 Nm	9 Nm	61 Nm	203 Nm
50X1A	230 Nm	203 Nm	230 Nm	203 Nm	15 Nm	15 Nm	230 Nm	340 Nm
50X2B	230 Nm	203 Nm	230 Nm	203 Nm	15 Nm	15 Nm	230 Nm	340 Nm
50X3 thru 5	1630 Nm	203 Nm	1630 Nm	203 Nm	15 Nm	15 Nm	230 Nm	340 Nm
85X1A	400 Nm	203 Nm	400 Nm	203 Nm	9 Nm	15 Nm	230 Nm	340 Nm
85X2B	400 Nm	203 Nm	400 Nm	203 Nm	9 Nm	15 Nm	230 Nm	340 Nm
85X3C	1630 Nm	203 Nm	1630 Nm	203 Nm	9 Nm	15 Nm	230 Nm	340 Nm
85X4D	1900 Nm	203 Nm	1900 Nm	203 Nm	9 Nm	15 Nm	230 Nm	340 Nm
120X1A	678 Nm	203 Nm	678 Nm	203 Nm	15 Nm	15 Nm	230 Nm	340 Nm
120X2B	678 Nm	203 Nm	678 Nm	203 Nm	15 Nm	15 Nm	230 Nm	340 Nm
120X3C	1630 Nm	203 Nm	1630 Nm	203 Nm	15 Nm	15 Nm	230 Nm	340 Nm

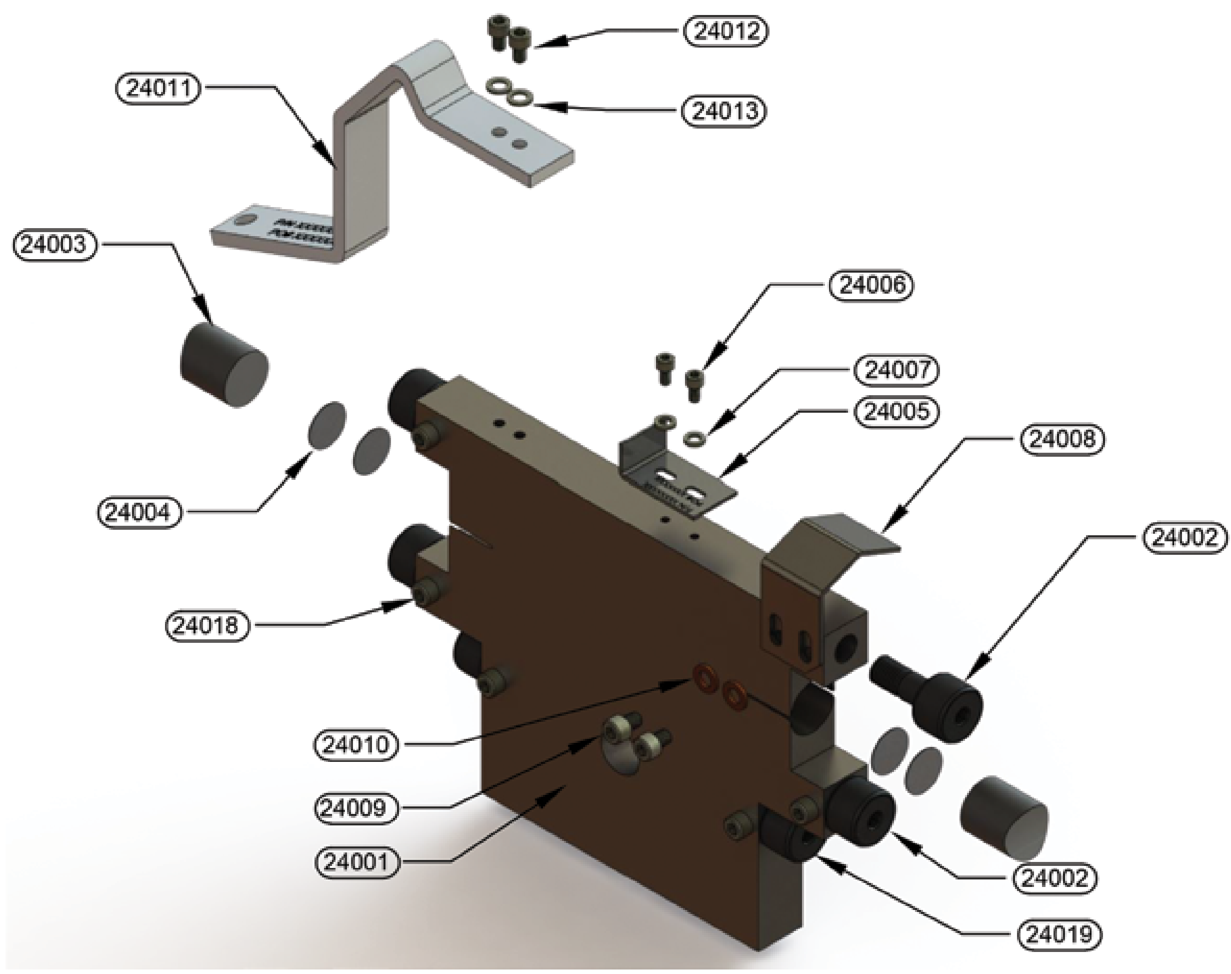
Table 26: Bolt Torque Specifications

Note 1: Hexagonal standard nut, Figure 8-3 position1, holding guide block, Figure 8-3 position 2, to upstream shaft.

<table>
<tr><th rowspan="3">Model</th><th>Item#</th><th>Item#</th><th>Item#</th><th>Item#</th><th>Item#</th><th rowspan="3">Model</th></tr>
<tr><th>24006</th><th>24012</th><th>24018</th><th>24002</th><th>24019</th></tr>
<tr><th>Screw</th><th>Screw</th><th>Screw</th><th>Cam follower</th><th>Cam follower</th></tr>
<tr><td>5</td><td rowspan="7">1.1 Nm
9.6 lbf•in</td><td rowspan="7">2.2 Nm
19.8 lbf•in</td><td rowspan="7">3.6 Nm
31.7 lbf•in</td><td colspan="2">4.0 Nm 35 lbf•in</td><td>5</td></tr>
<tr><td>15</td><td colspan="2" rowspan="2">11 Nm 95 lbf•in</td><td>15</td></tr>
<tr><td>25</td><td>25</td></tr>
<tr><td>35</td><td colspan="2">28 Nm 250 lbf•in</td><td>35</td></tr>
<tr><td>50</td><td>28 Nm 250 lbf•in</td><td>73 Nm 650 lbf•in</td><td>50</td></tr>
<tr><td>85</td><td colspan="2">73 Nm 650 lbf•in</td><td>85</td></tr>
<tr><td>120</td><td colspan="2">141 Nm 1250 lbf•in</td><td>120</td></tr>
</table>

Table 27: Guide Block Bolt Torque Specifications

Note: See Figure 8-8 for items referenced in Table 17.



ITEM NO.	DESCRIPTION
24001	GUIDE BLOCK
24002	CAM FOLLOWER
24003	BEARING GUIDE BAR
24004	BEARING GUIDE BAR SHIM
24005	FLAG
24008	MOTOR STOP RAMP
24009	SOCKET HEAD CAP SCREW
24010	LOCK WASHER
24011	GROUND STRAP
24012	SOCKET HEAD CAP SCREW
24018	SOCKET HEAD CAP SCREW
24019	CAM FOLLOWER

Figure 8-8: Guide Block Exploded View

Please Note: Figure 8-8 shows S35 guide block. The guide blocks for S50, S85 and S120 prover have two cam followers only.

8.8 Drive System Maintenance

The Honeywell Enraf small volume prover mechanical piston return mechanism is rugged and trouble-free, requiring little maintenance. All bearings are sealed, and chains are stainless steel. Maintenance on the drive system normally would be done at the same time as normal prover maintenance, such as seal change and water draw. If at any time the piston return chains need adjustment, adjust only the bearings at the end closest to the flow tube. Adjust chains for even tension.

A. Chains should be lubricated with a dry chain lube or lubricant that has a carrier fluid which evaporates and does not cause dirt and dust to collect. Recommended is a PTFE filled chain lubricant.

Warning

Do not lubricate chains with normal oils which collect dirt and cause wear.

B. Gearbox oil level should be checked periodically. Oil level should be approximately 13mm (1/2") below vent port for horizontally mounted provers, see Figure 8-9. The gear reducers will be supplied with the oil in it based on the ambient temperatures. The reducers will be filled with **synthetic ISO VG 320 oil based on polyglycol when used in applications above -20°C (-4°F) and with synthetic ISO VG 68 or 80 oil based on polyglycol when used in applications below -20°C (-4°F).** If the oil level is low or performing a seasonal change, drain the remaining oil and refill the reducer to the correct level - do not mix types of oil.

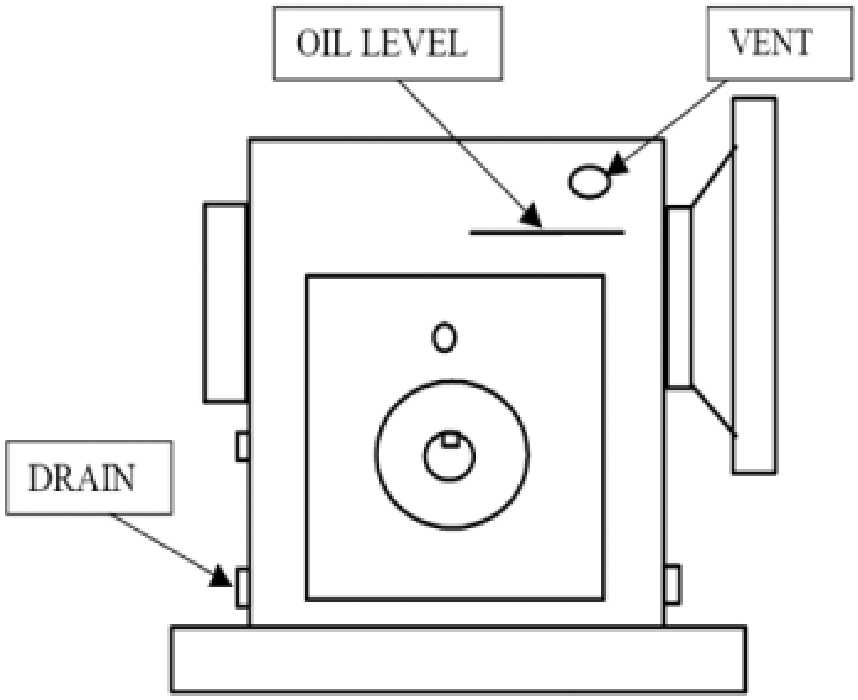


Figure 8-9: Gearbox Lubrication Diagram

8.8.1 Before working on the Drive System

a. Ensure that the power to the motor is removed and locked and tagged.

b. Check that the piston is in the downstream position the distance between the mechanical stop and the upstream seal retainer should be approximately 51 - 76mm (2 - 3 inches).

c. Close and lock the block and bleed valves at inlet and outlet to prover.

d. Bleed and drain prover.

e. Remove the motor (main drive) chain (the chain between the output sprocket on the gear reducer and the main drive sprocket.

8.8.2 Checking Alignment of Drive System (general checking)

a. Check the drive system to see if there are any lose bolts or parts.

b. Be certain to check the washers on the end of the guide bars. If these washers are not thick stainless steel washers replace them, even if they appear to be tight (standard bolt washers do not work correctly).

c. Check to see if all six pins have been installed Figure 8-10.

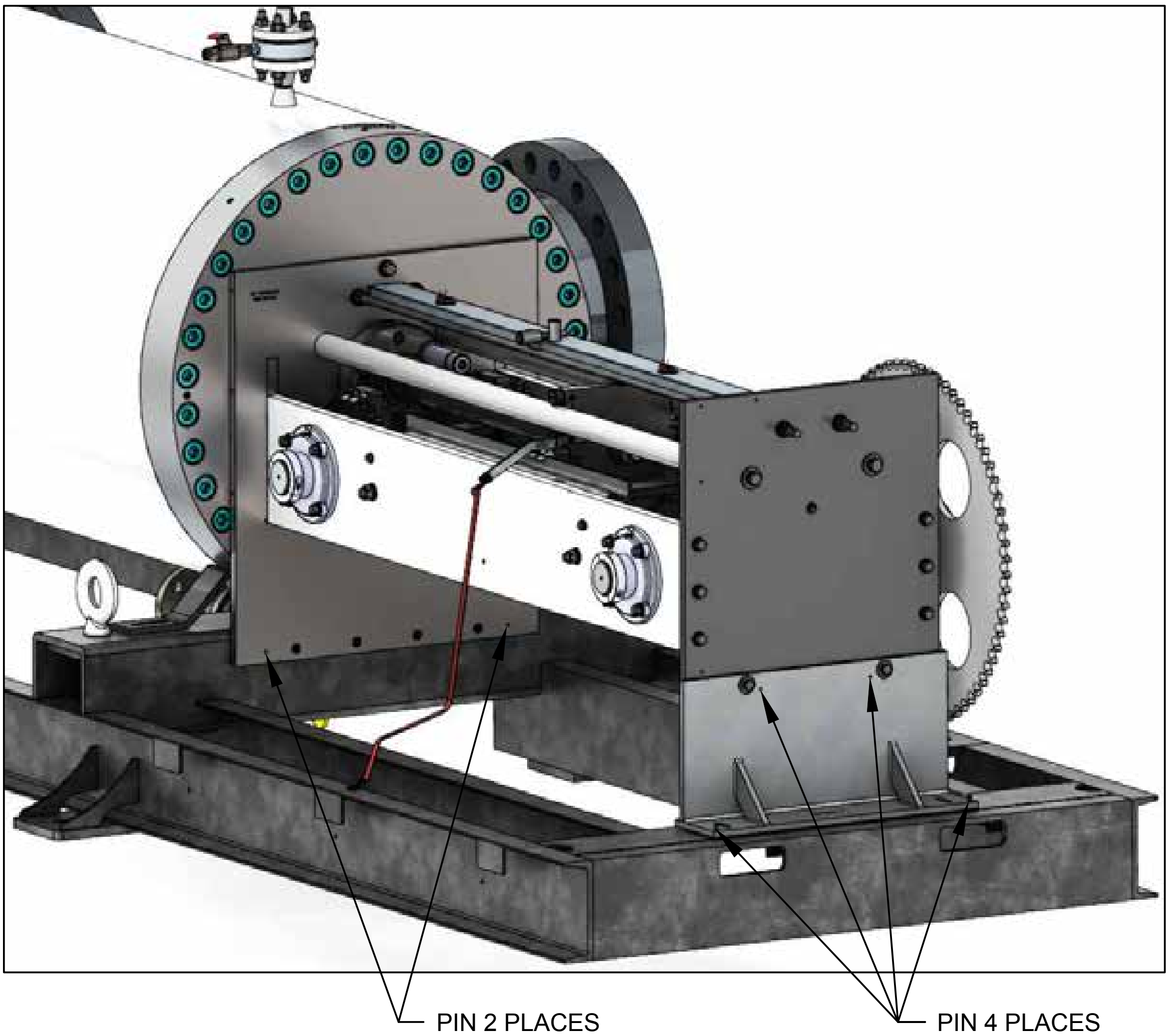


Figure 8-10: Pinning Locations

d. When checking alignment, loosen bolt on end of guide bar and use a wrench to check that the guide bar is tight to the flange Figure 8-11. The guidebar is pocketed in the two plates in the drive end on 85 and 120 models. Tightening the upstream bolt is all that is necessary.

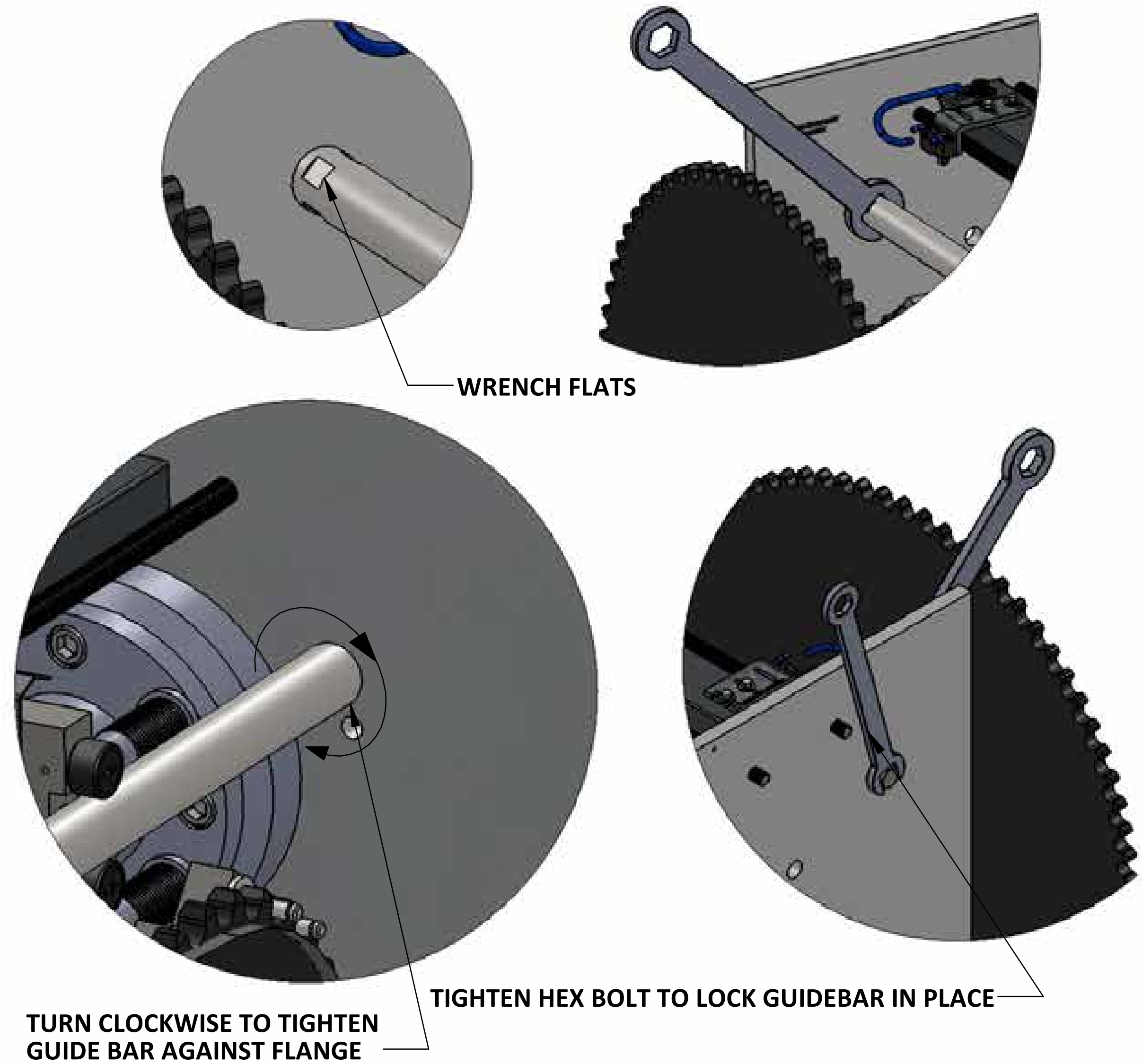


Figure 8-11: Tighten Guidebar

e. Check the ground spring to ensure it is in contact with the ground bar. In the case of larger provers, check that the ground cable is connected to both the ground strap and frame Figure 8-12

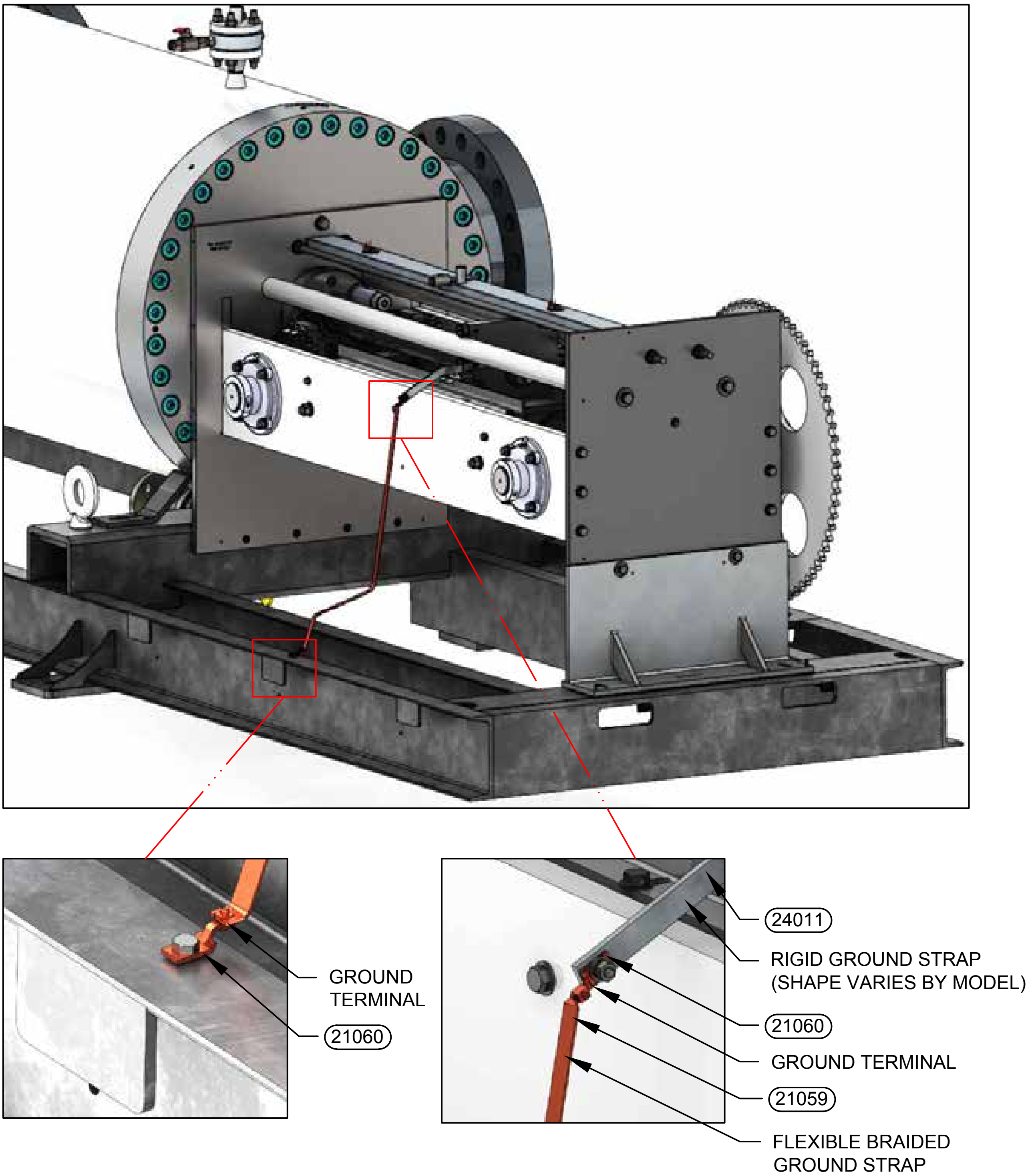
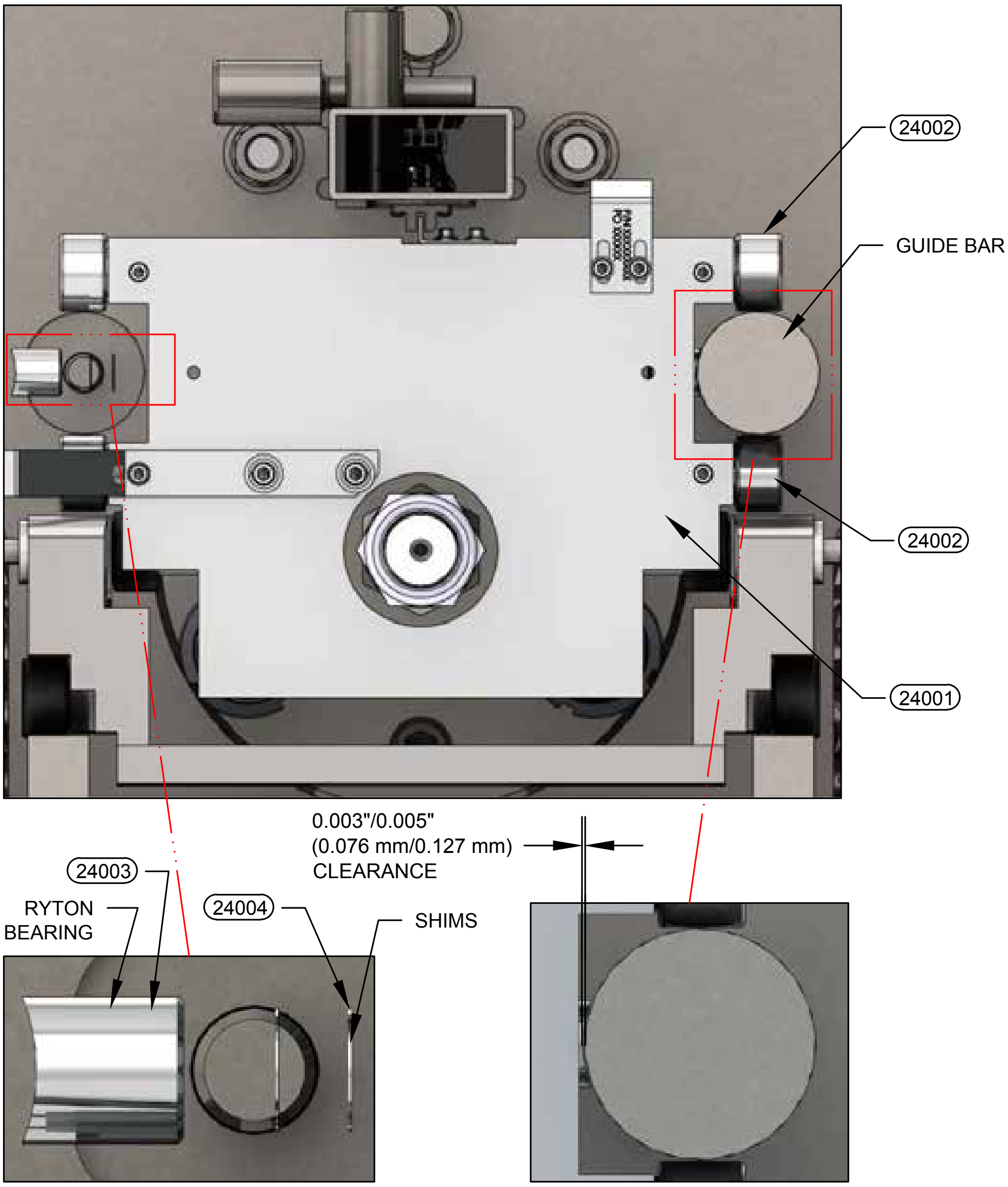


Figure 8-12: Grounding the Prover

8.8.3 Checking Alignment of Guide Block

a. With the piston close to the downstream position, remove the piston shaft nut. Being careful not to break the optic switch, slide the guide block off the stud.

b. Check side play of guide block, clearance should be .076 to 0.127mm (.003 to .005"). If play is excessive, remove and shim Ryton bushing see Figure 8-13.



NOTE: SOME COMPONENTS REMOVED FOR CLARITY

Figure 8-13: Guide Block Shims

Please Note: *Figure 8-13 shows S50, S85 and S120 guide blocks. The guide block for S35 prover has additional two cam followers.*

c. Check that the Dimple Stud is straight and square in all direction to the end of the piston.

Care should be taken to ensure that the hole in the guide block aligns with the Dimple stud in the piston shaft. If the hole does not align with the stud, adjust shims accordingly. Slide the guide block upstream and check the side play. If side play is too tight upstream, you will have to readjust shims, remembering that the guide block MUST always align with the Dimple stud in the downstream position see Figure 8-14

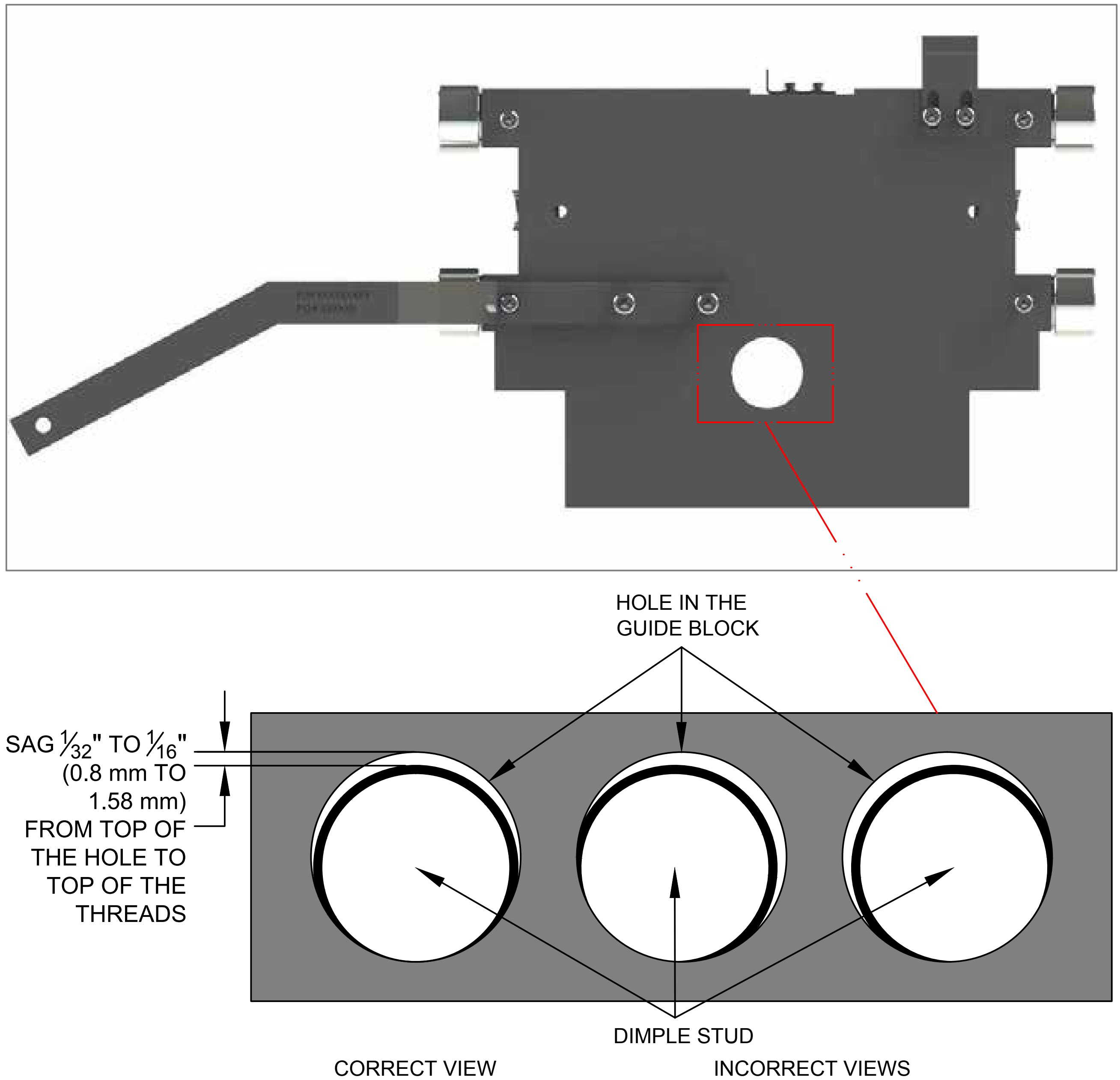


Figure 8-14: Stud Alignment

Please Note: *Figure 8-14 shows S50, S85 and S120 guide blocks. The guide block for S35 prover has additional two cam followers.*

d. Reinstall the guide block to the piston shaft.

e. Pull the piston upstream being careful not to break the optic switches.

f. Use a wrench on the hub of the large drive sprocket and move the piston to the position that you want. Remove nut, slide guide block off the Dimple stud, and check alignment with the guide block.

g. The hole in the guide block should be aligned side to side with the Dimple stud and the shaft should have .8 to 1.6mm (1/32 to 1/16") sag when upstream see Figure 8-14.

h. If the Dimple stud is not aligned properly, adjust the upstream plate by loosening the respective bolts and removing the M6 (1/4") spring pins used to maintain alignment. Once you remove the alignment pins you must drill and tap new holes, after all adjustments have been made see Section **8.8.9.** Adjust the upstream drive end plate so that the side of the plate is perpendicular to the frame. Tighten all the bolts, and check the alignment again.

i. To avoid a twist on the drive system, squareness between the two plates in the drive end must be maintained.

8.8.4 Check the Alignment of the Flag

a. Inspect the upstream and downstream optical switches to verify they are correctly seated, see Figure 8-15. If not, reposition and replace springs and seals as needed.

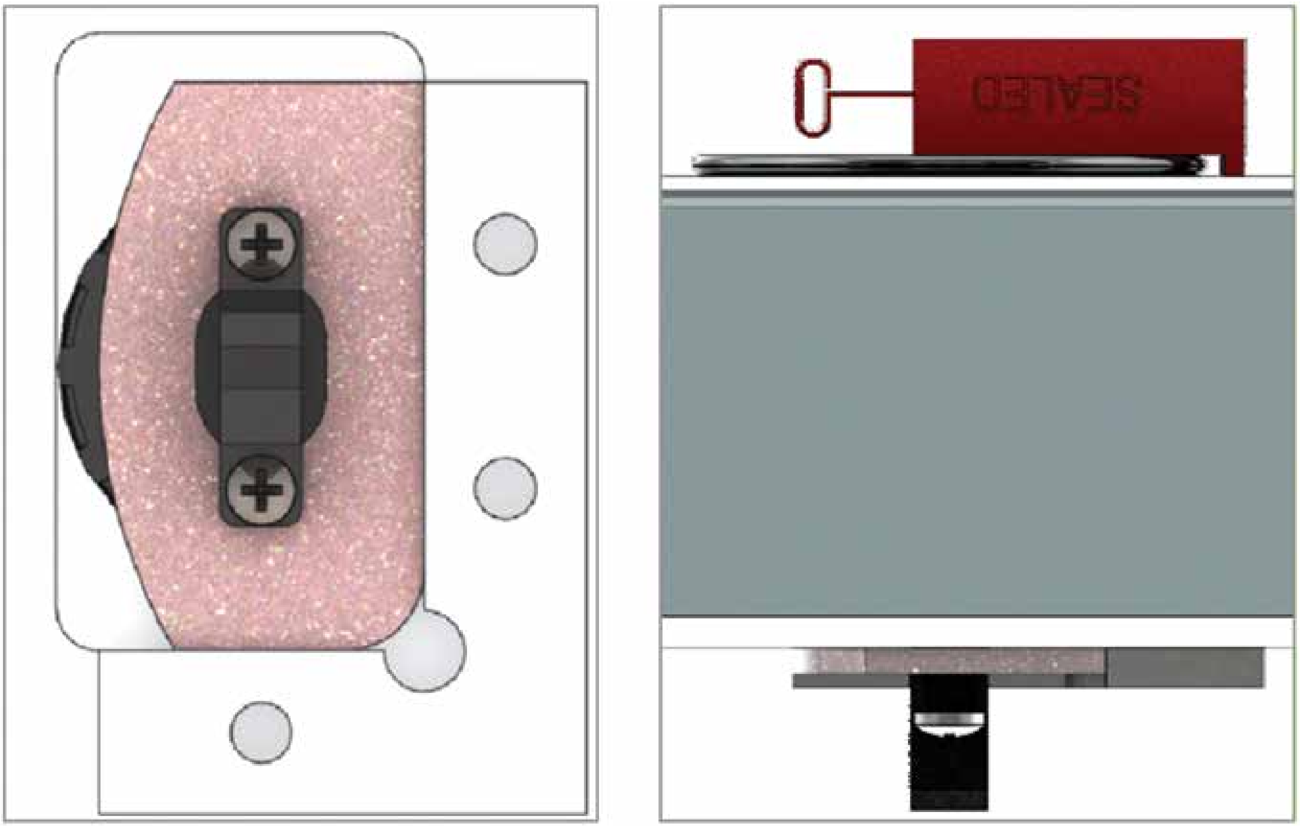


Figure 8-15: Correctly Seated Optical Switch Bottom and Side View

b. Position the flag with the guide block in the opening of the downstream optical switch and check the alignment. The flag should be centered as showed in the Figure 8-16. This can be observed through the hole in the upstream drive end plate or using a mirror positioned close to the optical switch.

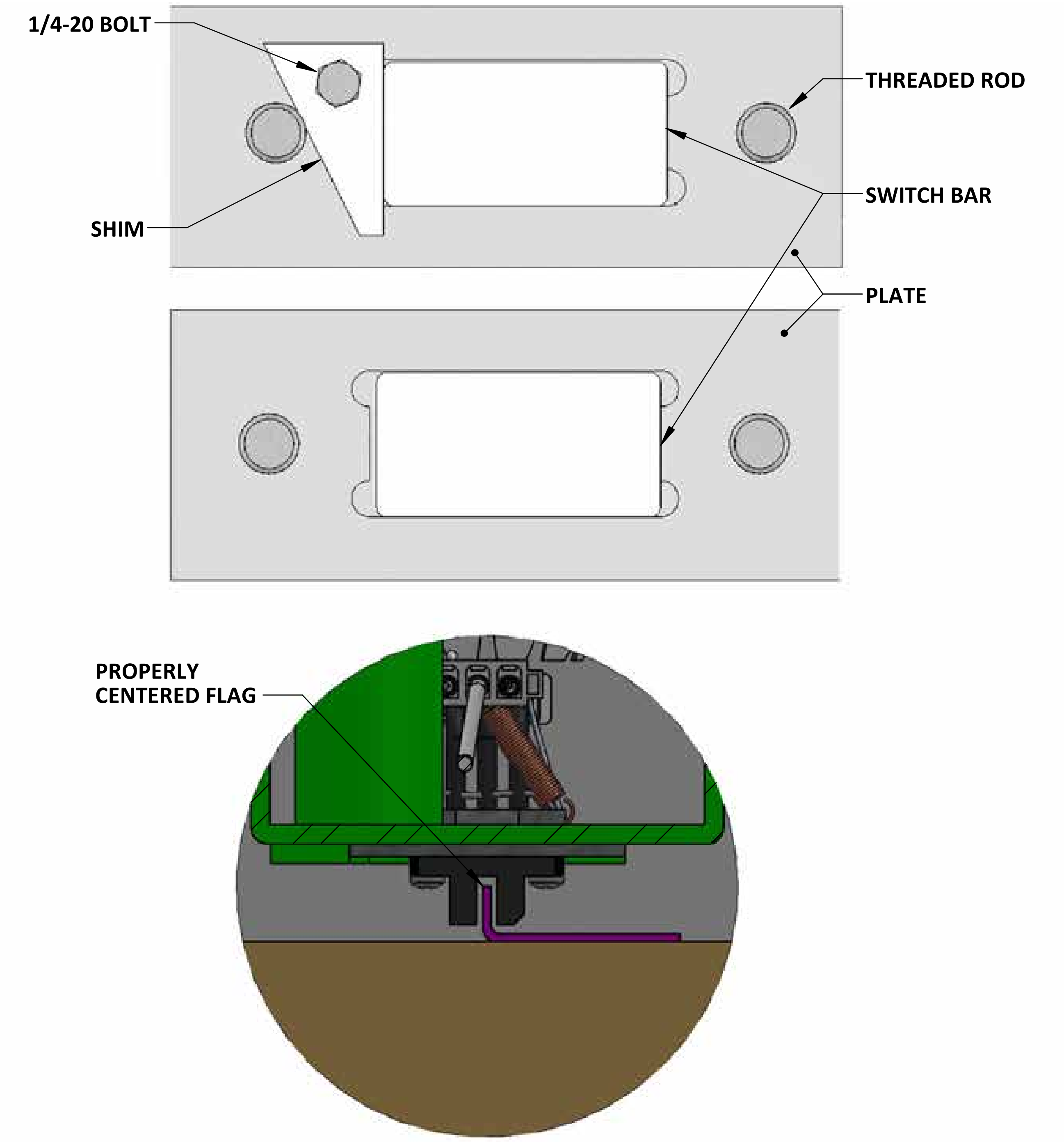


Figure 8-16: Switchbar Position

c. If necessary, gently shift the flag until it is centered.

d. Repeat first two steps at the upstream optical switch.

e. If adjusting the flag does not provide centering of the flag on both switches, the switch bar may not be aligned with the piston assembly.

   a. First confirm that the guide block is aligned with the piston shaft see Section 8.8.3.

   b. Use a pipe clamp and pull the switch bar, if possible, in the direction needed being careful not to affect other adjustments. You may have to move both ends see Figure 8-17.

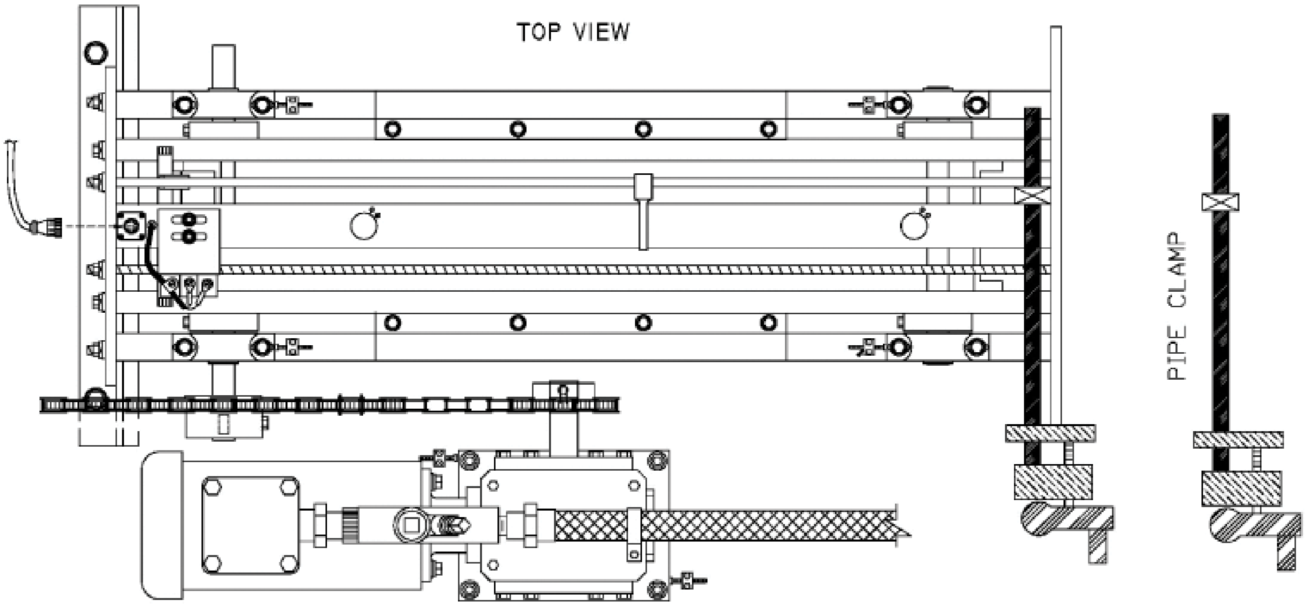


Figure 8-17: Pipe Clamp Position

f. If the pocket in the plate is bigger than the switch bar, the gap will need to be shimed. The shim must be installed between the 16mm (5/8") rod and the switch bar itself. This shim must be bolted to the plate. These adjustments will most likely need to be performed at both ends of the switch bar on opposite sides see Figure 8-16.

g. Recheck the flag alignment.

8.8.5 Shimming the Puller

a. Inspect the puller, verify that the chain pins are straight and not showing any signs of bending or wear. If any damage is noted replace the pins. The cam followers should move freely without play and not exhibit excessive corrosion. Some cosmetic discoloration is expected.

b. Inspect the cam follower contact surface on the guide block or puller depending on prover model. It should have some smoothing and discoloration. Excessive and uneven wear is indicative of puller alignment problems.

c. With the piston close to the downstream position, rotate by hand the main drive sprocket to position puller in contact and behind guide block (in pull position).

d. Check that both cam followers are in contact with the guide block. If there is a gap on one record the gap downstream using a feeler gauge see Figure 8-18.

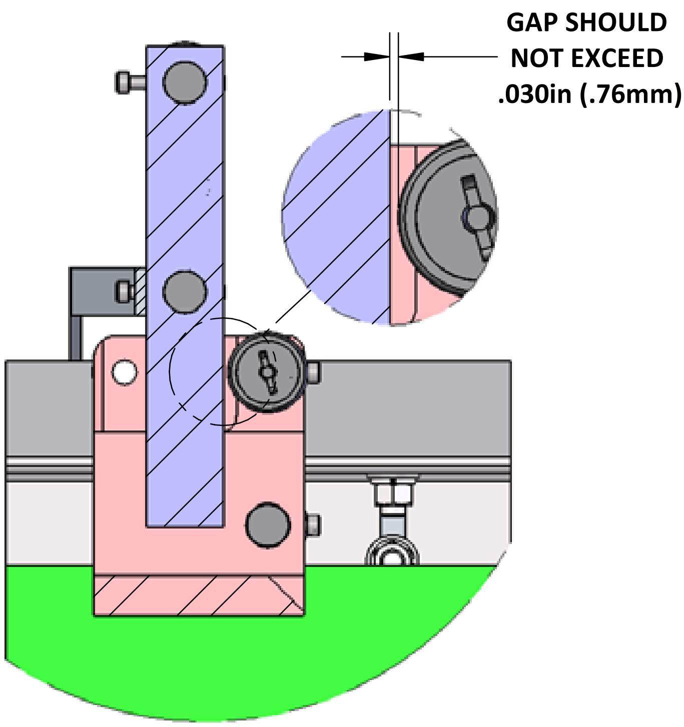


Figure 8-18: Maximum Allowable Gap

Please Note: *Figure 8-18 shows guide block and puller used on S50, S85 and S120 provers. The puller for the S35 prover does not have cam followers on it.*

e. Move the piston to the midstream position, position the puller in the pull position.

f. Check that both cam followers are in contact with the guide block. If there is a gap on one side, record the gap at midstream using a feeler gauge.

g. Move the piston to the upstream position, position the puller in the pull position.

h. Check that both cam followers are in contact with the guide block. If there is a gap on one side, record the gap at the upstream using a feeler gauge.

i. Compare your measurements of the gap. They should be consistent between all three measurements and not exceed 0.8mm (0.03") see Figure 8-18. If not, further diagnosis is required (see 8.8.5 i-a and 8.8.5 i-b below).

   a. Check if the sprockets are matched to each other by removing them from the driving shaft. Place two sprockets back-to-back and align the keyways. A piece keystock placed in the keyway between them can be used to assist. Observe the teeth. They should be well aligned.

If not, replace the sprockets with a matched set. After the sprockets are replaced with the new ones, repeat the procedures mentioned in 8.8.5 c through 8.8.5 i.

b. If both sprockets located on the driving are matched than the chains have stretched and should be replaced with a matched set.

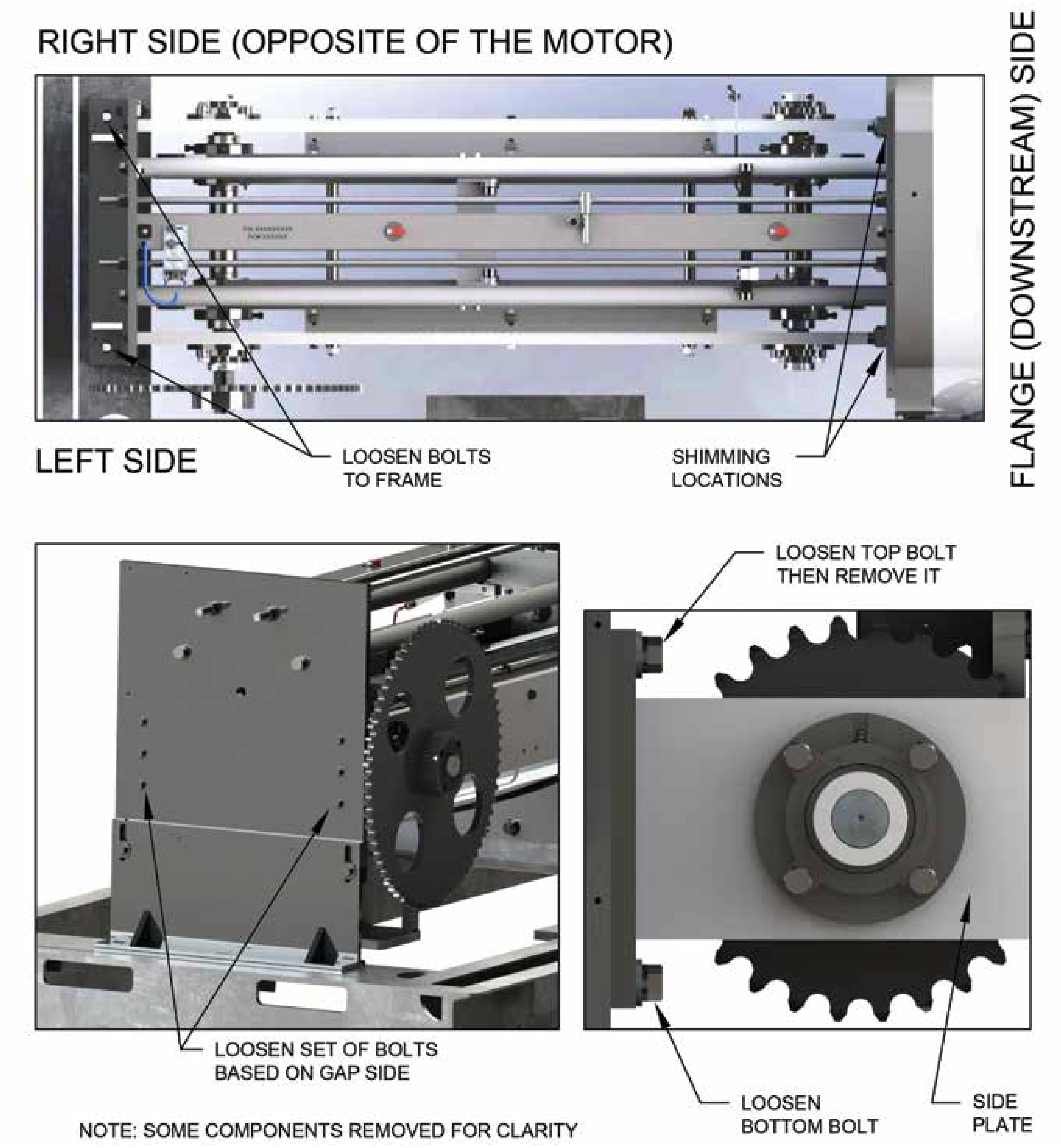


Figure 8-19: Shim Locations

j. If the gap is still the same at all three locations and exceeds 0.8mm (0.03") then the sideplates need to be shimmed. Shimming is only necessary when machining tolerances stack-up unfavorably. This requires that the guide block and flag be realigned.

k. If the gap is on the LEFT SIDE OF THE PULLER, loosen but do not remove the bolts that connect the sideplate located on the left side to the downstream end plate see Figure 8-19.

   a. Loosen but do not remove the bolts connecting the drive end support bracket to the frame.

   b. Loosen but do not remove the bolts connecting the upstream drive end plate to the sideplate located on the right side (motor side).

   c. Remove the top bolt from the sideplate flange (left side) only and place enough shims equal to the gap measured see Figure 8-20 and 8-21. Make sure the shims drop below the top bolt hole. Use a spare shim to help push them down if necessary.

   d. Tighten all the bolts and check the squareness of the drive end in order to avoid twist on the drive system. If necessary, install shims between the side plate on the right side and the upstream drive end plate.

l. If the gap is on the RIGHT SIDE OF THE PULLER, loosen but do not remove the bolts that connect the sideplate located on the right side to the downstream plate see Figure 8-19.

   a. Loosen but do not remove the bolts connecting the drive end support bracket to the frame.

Figure 8-20: Side Plate Bolts

Figure 8-21: Inserting Shim behind Side Plate

b. Loosen but do not remove the bolts connecting the upstream drive end plate to the sideplate on the left side (opposite motor side).

c. Remove the top bolt from the sideplate flange (right side) only and place enough shims equal to the gap measured see Figure 8-21. Make sure the shims drop below the top bolt hole. Use a spare shim to help push them down if necessary.

d. Tighten all the bolts and check the squareness of the drive end in order to avoid twist on the drive system. If necessary, install shims between the side plate on the left side and the upstream drive end plate.

8.8.6 Check the Alignment of the Shafts and Puller

The spacing of the sprockets and guide rail bearings is a fixed distance determined by the shaft and based on the size of the puller. To center the puller, the shafts also must be centered.

a. Complete following steps in order to center the downstream shaft (driven shaft).

b. With the piston close to the downstream position, rotate by hand the main drive sprocket to position puller behind guide block (in pull position). Please note that the main drive chain needs to be disconnected from the main sprocket (chain between the gear reducer and the main drive sprocket).

c. Check the side to side position of the puller relative to the guide block see Figure 8-22. The puller should have equal spacing on either side of the guide block.

d. If the puller is not centered it will need to be repositioned.

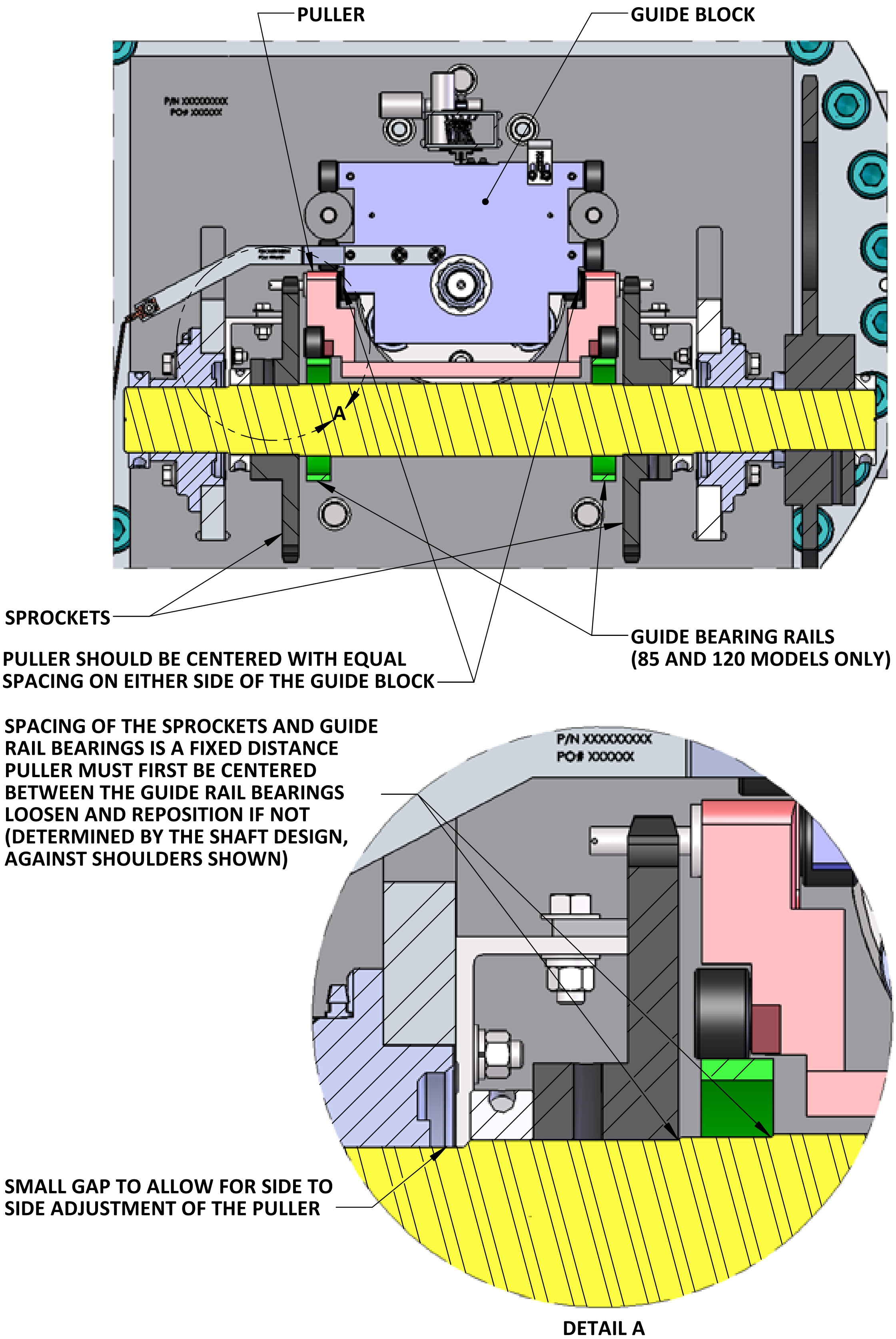


Figure 8-22: Puller Alignment

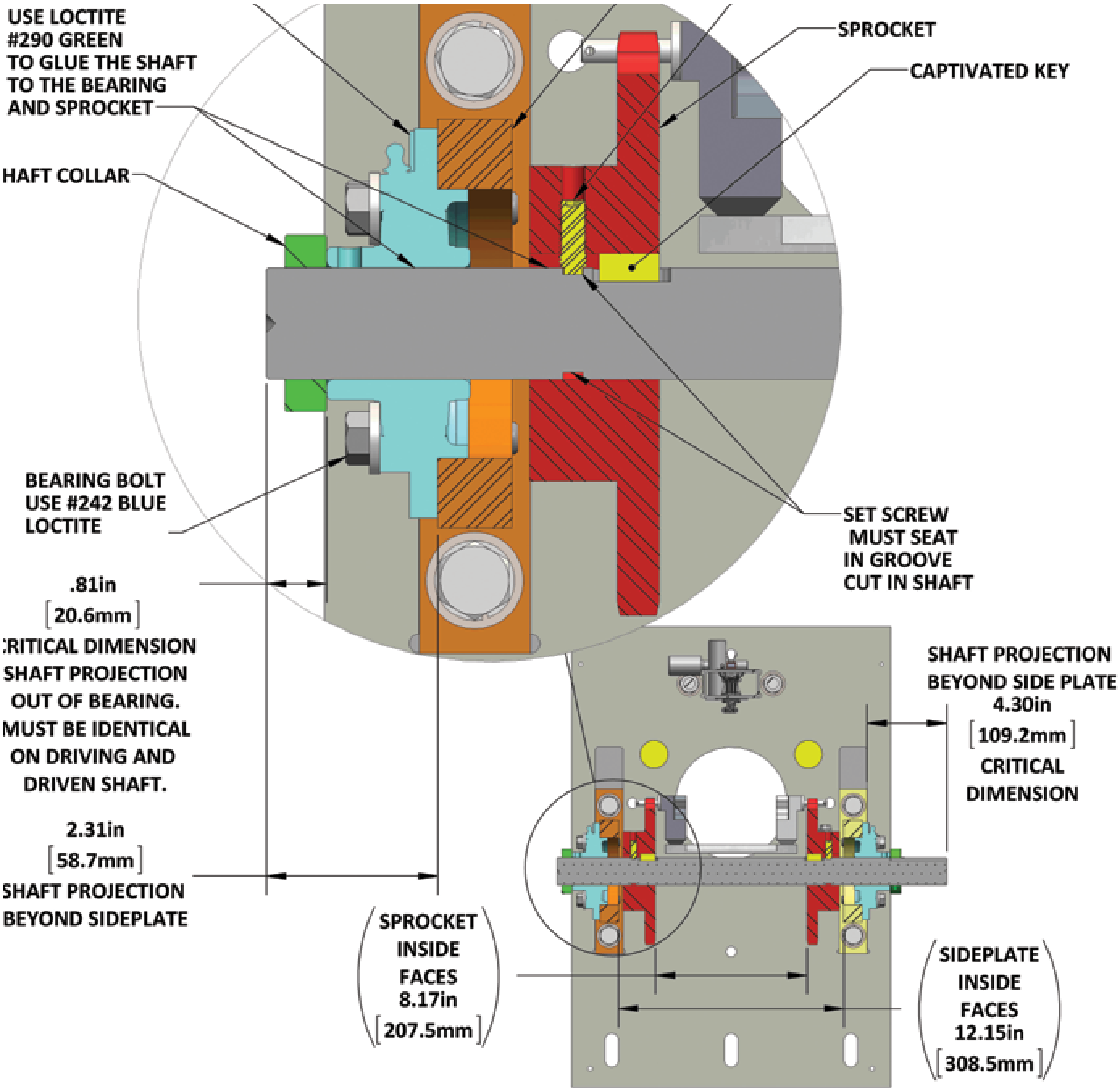


Figure 8-23: S35 Shaft Spacing

e. Remove the shaft collars holding the shaft against the bearings and sprockets, and loosen the set screws on all the bearings.

f. On 85 and 120 models only, loosen the set screws holding the bearings in the guide bearing rails.

g. On 35 models only, the proper sprocket spacing is determined by set screws seated in grooves see Figure 8-23.

    a. Verify that the sprocket set screws are seated in the shaft retaining groove on each sprocket. This can be done by removing one of the two set screws in each sprocket and looking down the hole. The groove should be centered.

    b. If not centered, loosen the second set screw a half turn.

    c. Adjust the position of the sprocket.

    d. Tighten the second set screw. It will now seat several turns lower.

    e. Apply Loctite and reinstall the first set screw.

    f. Reapply Loctite to the second set screw.

h. On 50, 85 and 120 models only, the proper sprockets spacing is determined by a shoulder on the shaft or spacer. Reference Figure 8-24 for 50 models, Figure 8-25 for 85 models and Figure 8-26 for 120 models.

    a. Loosen the set screws holding the sprockets in place. The shaft and sprockets should now all be able to move freely.

    b. Squeeze the sprockets together inward. This should force the sprockets against a shaft shoulder or bearings spacer.

On 85 models the guide bearings on the guide bearing rail must be loose. The bearing spacer must be tight without any side to side movement.

    c. Loctite and tighten the set screws in the sprockets only.

i. Center the shaft so that the puller has equal spacing on either side of the guide block. This can be done by lightly tapping the shaft with a soft mallet and can be observed through the hole in the upstream drive end plate or using a mirror positioned close to the front of the guide see Figure 8-22.

j. Verify the shaft projects equally according to Figure 8-23, Figure 8-24, Figure 8-25 or Figure 8-26 depending on model.

k. Loctite and tighten the sets screws in all the shaft's bearings, Do not forget both the shaft set screws and set screws holding the bearing in place on the 85 and 120 guide bearing rails.

l. Move the piston close to the upstream shaft and position the puller behind the guide block (in the pull position) and repeat the previous steps for the upstream shaft.

m. Rotate by hand the main drive sprocket and make sure that the chain moves freely and easily.

n. Reinstall shaft collars with and Loctite according to the Section 8.10.

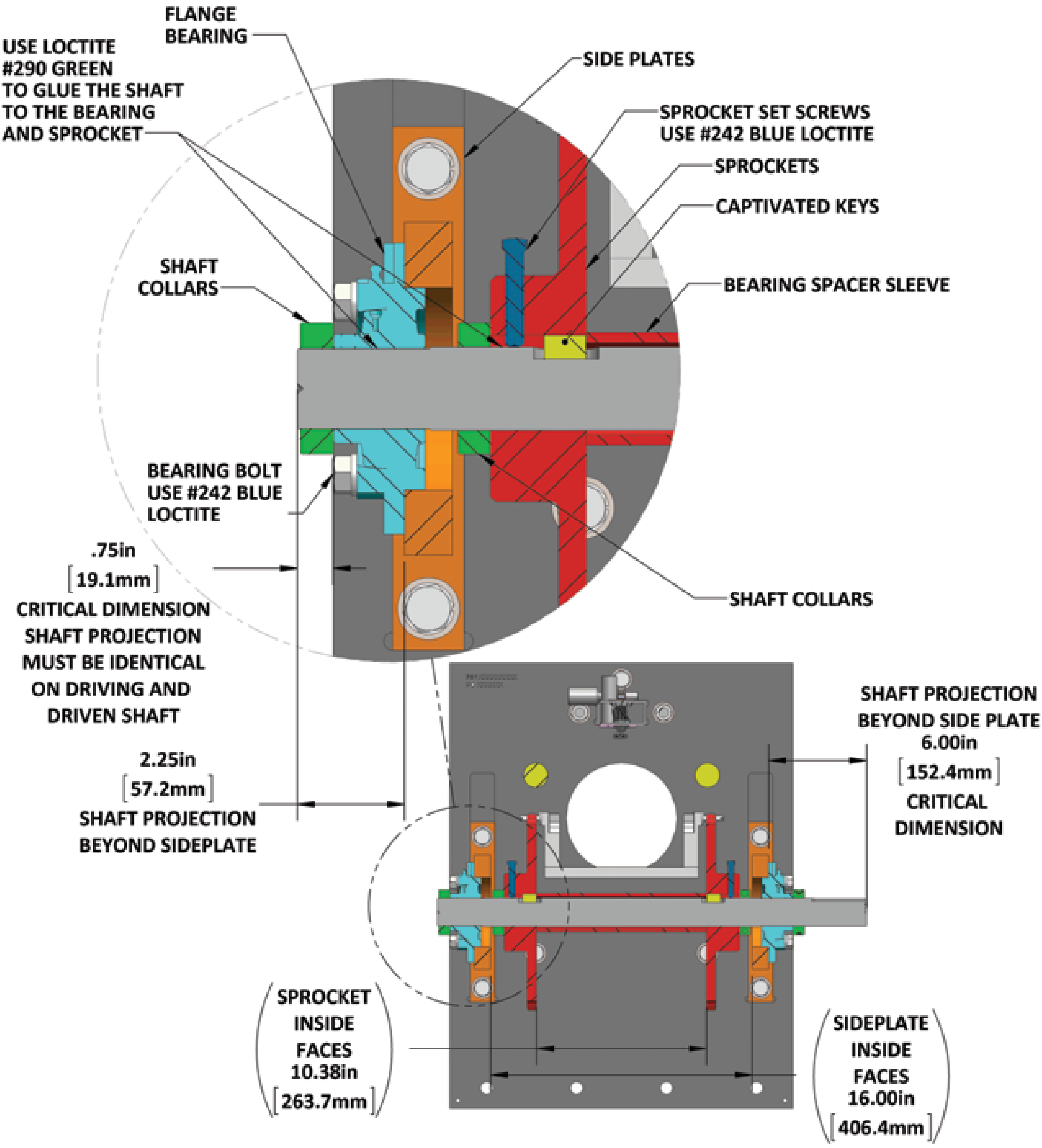


Figure 8-24: S50 Shaft Spacing

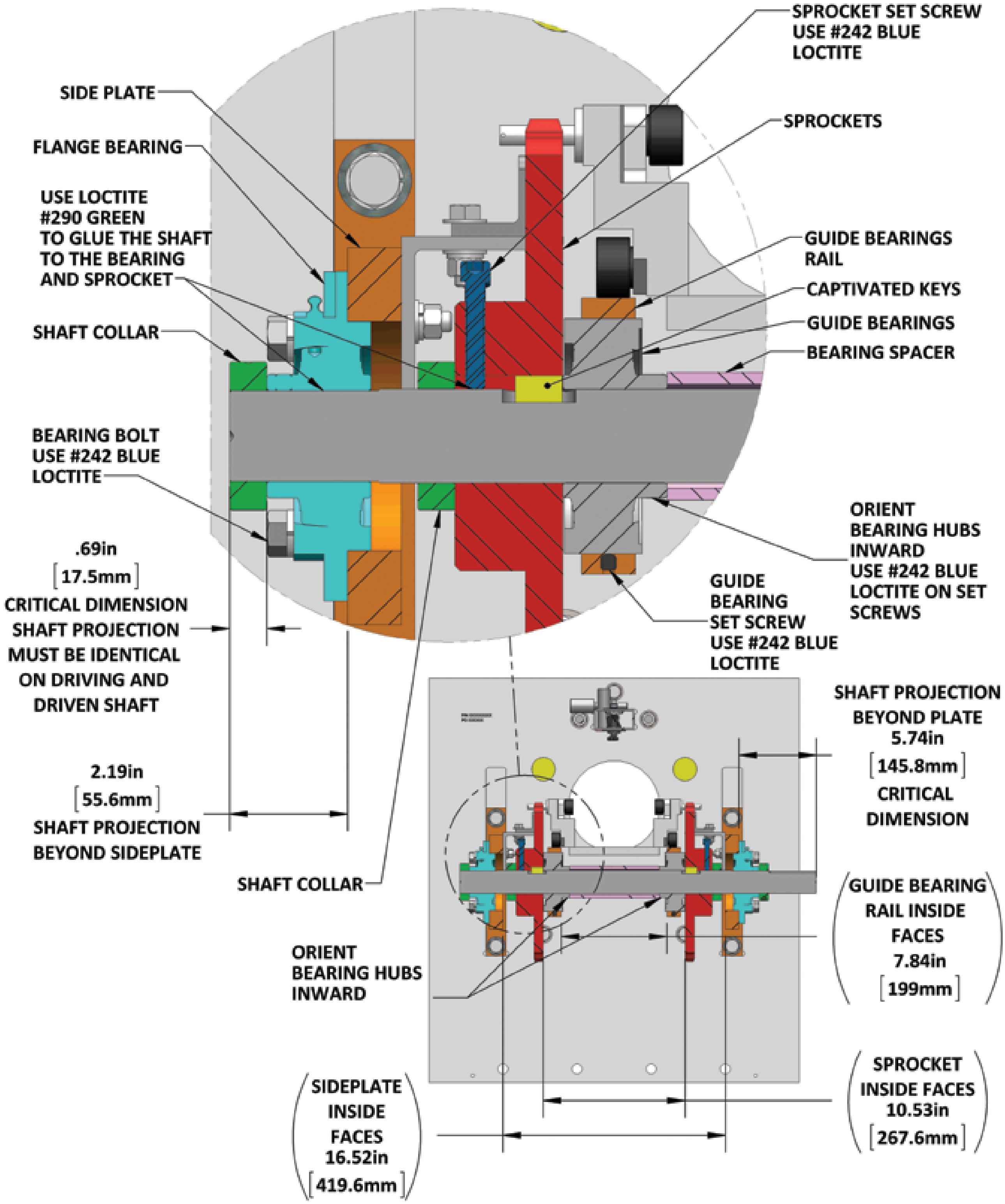


Figure 8-25: S85 Shaft Spacing

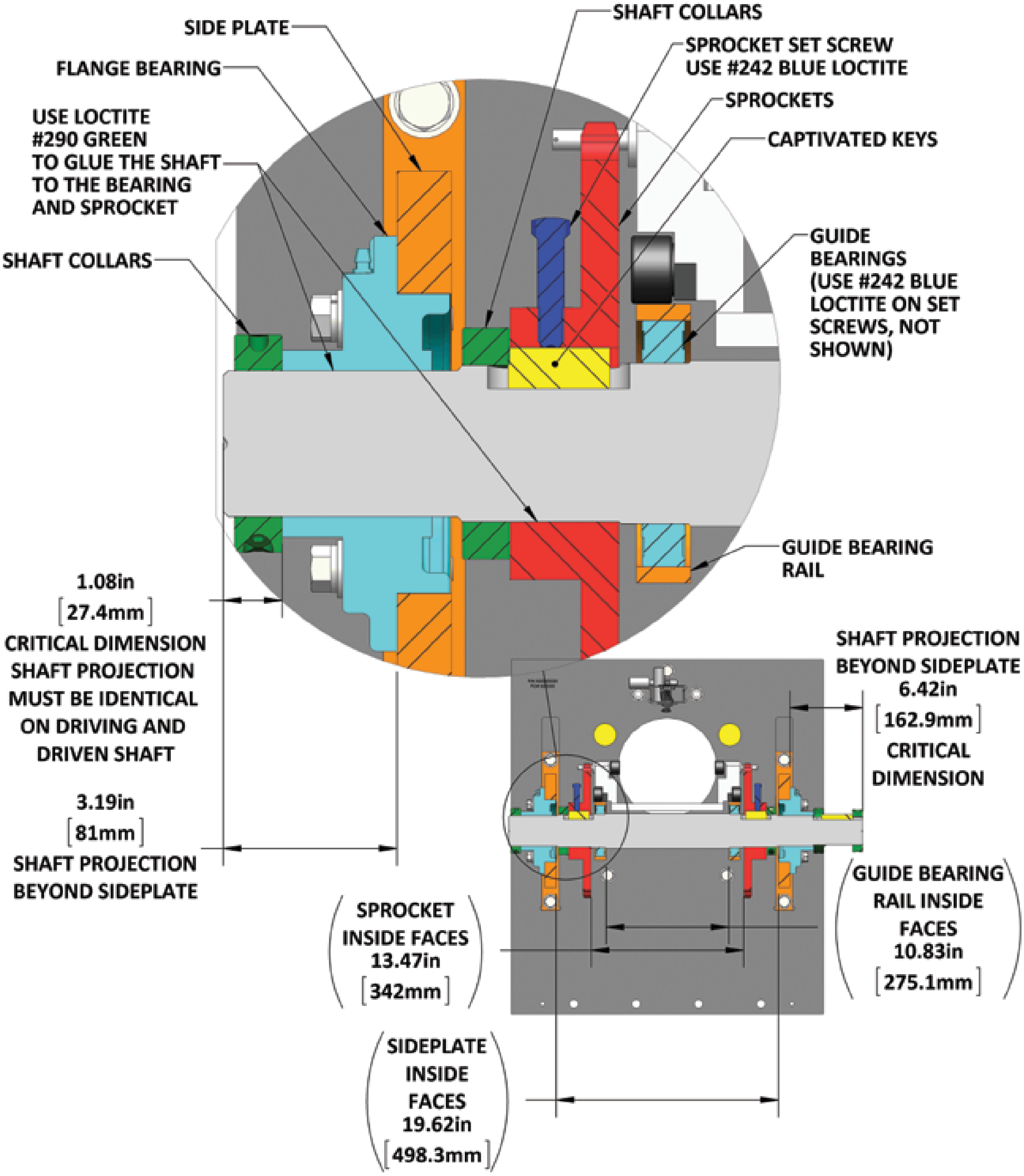


Figure 8-26: S120 Shaft Spacing

8.8.7 UHMW Chain Rail Adjustment

a. Adjust plastic rail so it holds chain flat and even with the top of the sprockets and is centered in the chain see Figure 8-27.

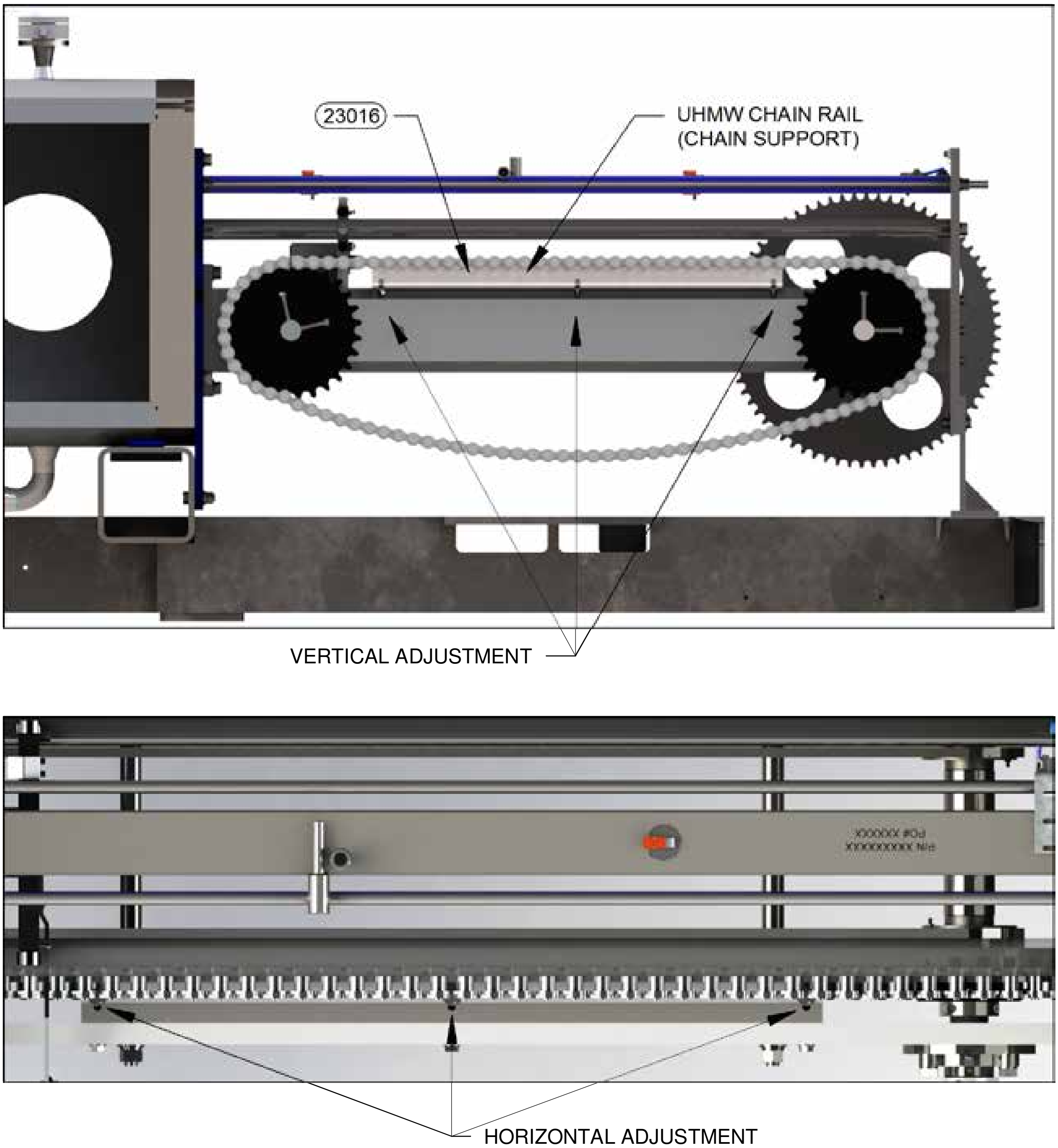


Figure 8-27: Chain Support Adjustment

b. Verify by observing a flat smooth transition from the sprockets to the chain support while moving the chain back and forth.

8.8.8 Check the Chain Tension

1. Checking the motor chain tension:
   a. There must be 19mm (3/4") of play in the motor chain. Any adjustments can be made using the adjustment bolts in the adjustment blocks.
   b. Check everything twice to avoid any missed items. DO NOT OVER TIGHTEN.
   c. Loctite the adjustment bolts with #242 Blue Loctite. If the adjustment blocks are missing install new ones as needed.
2. Checking the tension on two drive chains (chains with puller in between):
   a. The chain droop verification should be completed as showed in the Figure 8-28.

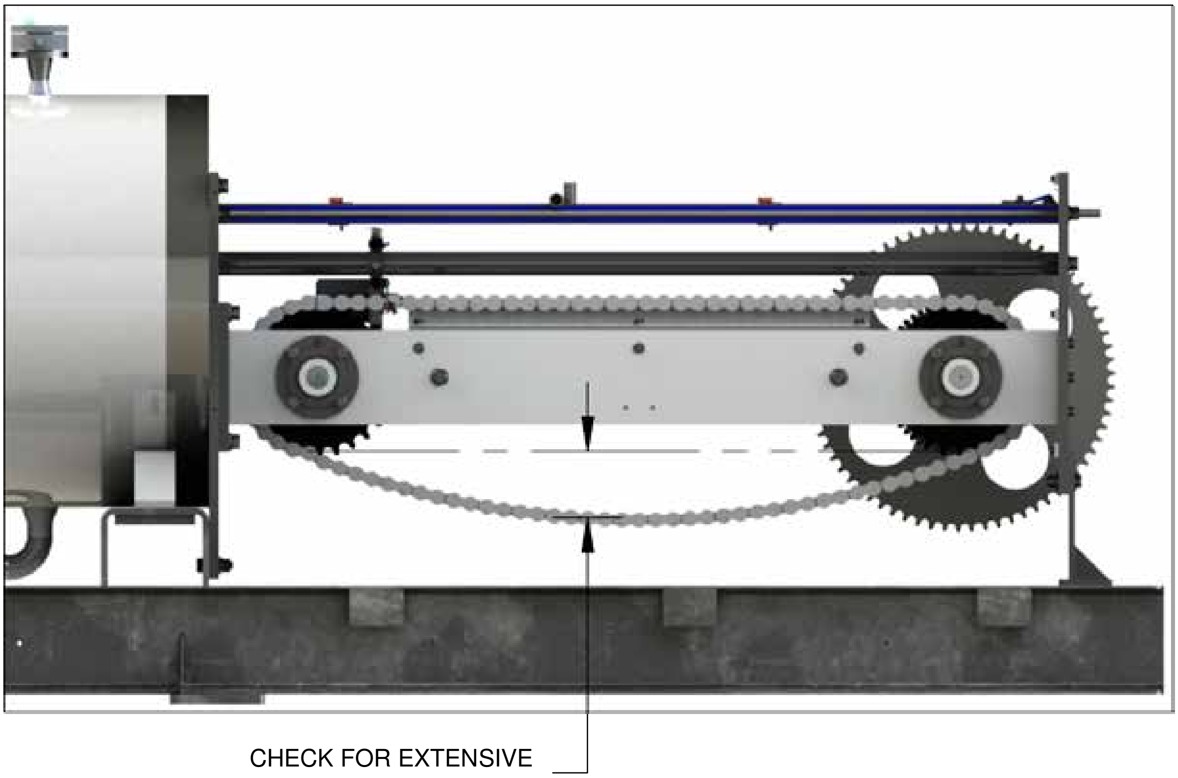


Figure 8-28: Chain Sag

   b. On model S35 the chain drop should not exceed 25mm (1"). On model S50 the chain drop should not exceed 50mm (2"). On models S85 & S120 the chain drop should not exceed 64mm (2.5").

8.8.9 Securing the Drive End

a. All provers must be pinned to maintain drive end alignment see Figure 8-10. Check everything twice to avoid any missed items.

b. Using a M6 (1/4") drill, drill two holes through the mount bracket and the upstream drive end plate, next to the mounting bolts. Drill two holes through the mount plate and the frame, next to the mounting bolts. Drill two holes through the downstream drive end plate and the frame.

c. Insert M6 x 30mm (1/4" x 1.25") Spring Pins into all six of the drilled holes.

8.8.10 Check Shocks

a. Push down on the shock very fast and it should stop, then continue moving some more.

b. If you push down on the shock and it bottoms out check the adjustment Almost all of the shocks are adjustable. All shocks must be on the same setting.

c. If after adjusting and retesting the shock it still does not perform correctly, the shock needs replacement.

d. The shocks depth must also be adjusted on the prover itself see Figure 8-29. This insertion depth must be correct and the same on all four shocks.

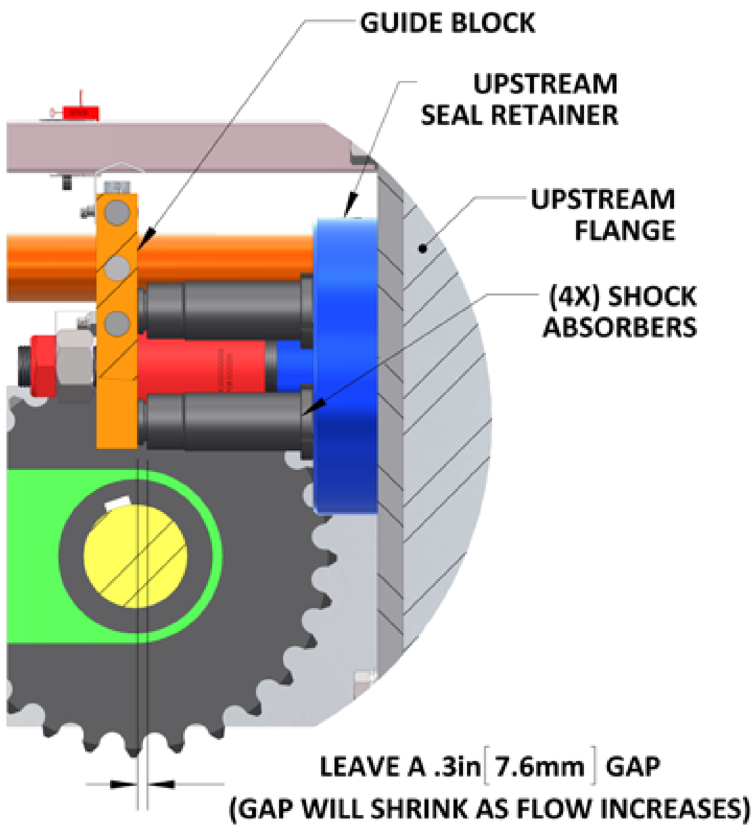


Figure 8-29: Shock Installation Depth

8.9 Volume Switch Replacement

If optical volume switch replacement is necessary, as determined by trouble shooting procedures found in Section 6, follow steps 1 through 5.

1. Remove (3) as shown in Figure 8-3 to access electrical connector.
2. Lift electrical connector very gently from the hole, and disconnect the cable from the switch wires.
3. With a stiff wire with a hook bent in the end, or small needle-nosed pliers, gently disconnect the switch retaining springs from the switch bar and remove the old switch. Prior to dropping the switch out of position, note orientation of the switch in the switch bar L-bracket.
4. Install the one end of the switch retaining springs in the holes of the new optical switch.
5. Position the new switch in the same position noted in step 3, and reverse steps 3 through 1 for re-installation of the new volume switch.

Note: The Honeywell Enraf volume switch assembly has been precision adjusted at the factory. Water draw after switch replacement is not required. Older models may be using optical switches with aluminum base plates. While these switches are still valid for use, the new standard is a stainless steel base plate. Under no circumstance should one aluminum and one stainless steel switch be used together, optical switch base plate material must be identical for both switches.

NOTICE TO Honeywell Enraf small volume prover users.
The following figures detail new optical switch shape. As seen below, the optical switch plate has one straight side and one rounded side. Figures 8-30 and 8-31 below illustrate a correct optical switch installation.

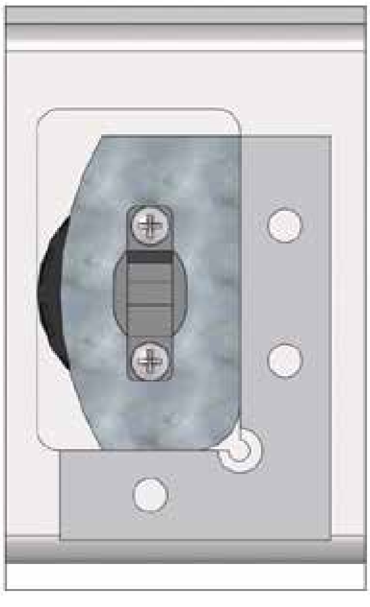


Figure 8-30: Correct Optical Switch Installation Bottom View

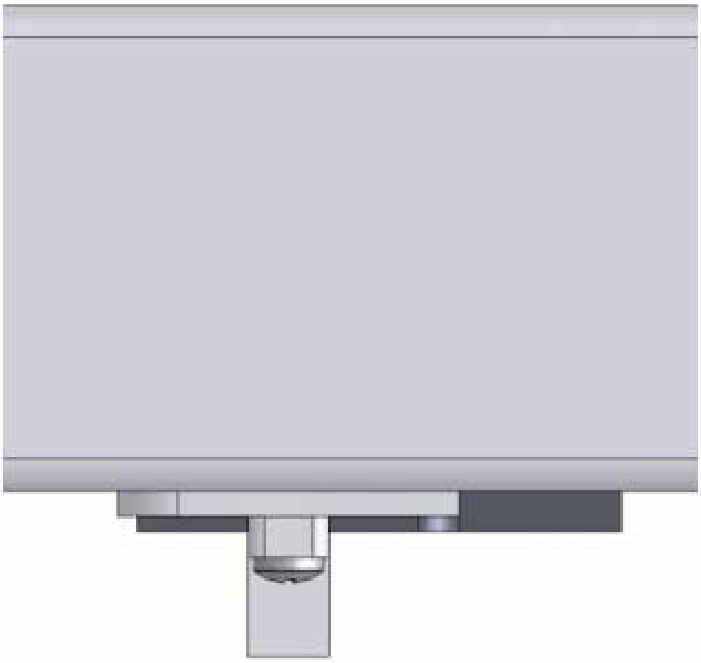


Figure 8-31: Correct Optical Switch Installation Side View

Figure 8-32, Figure 8-33, and Figure 8-34 below show an improper installation. To maintain correct installation, the optical switch must be pushed tightly to the inner corner of the L-bracket and must be seated entirely in the machined pocket of the switch bar. Finally, before installing any optical switches, be sure that the machined pockets of the switch bar and inner faces of the L-brackets are free of any debris.

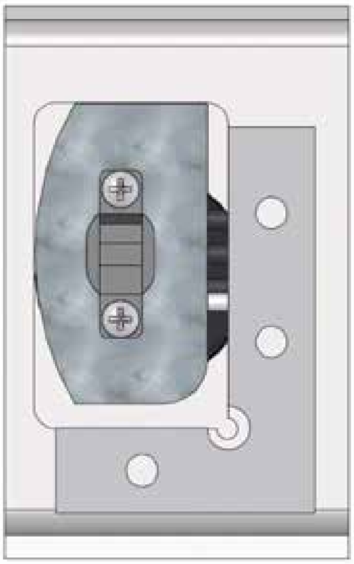


Figure 8-32: Improper Optical Switch Installation Bottom View 1

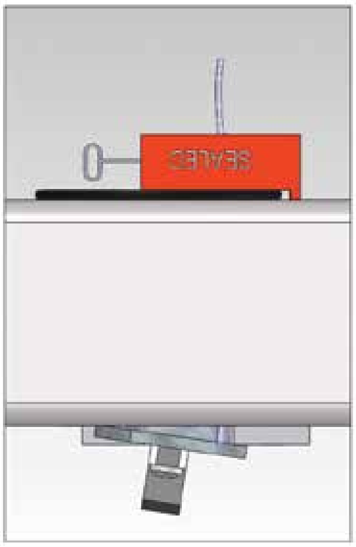


Figure 8-33: Improper Optical Switch Installation Side View

Figure 8-34: Improper Optical Switch Installation Bottom View 2

8.10 Thread Locker Fluid Location List

Back out the bolt and apply Loctite to threads. After application of the Loctite readjust bolt back to a tight position. This procedure must be completed at all the following locations.

a. All bolts on the inside of the prover use # 242 Blue Loctite.

b. Dimple stud assembled in to the piston shaft uses #272 Red Loctite.

c. 2H nut for the Dimple stud uses # 242 Blue Loctite.

d. Tension bolts used to hold the adjustment of the gear box use #242 Blue Loctite.

e. Sprockets and Bearings to shafts use # 290 Green Loctite see Figure 8-35 and 8-36.

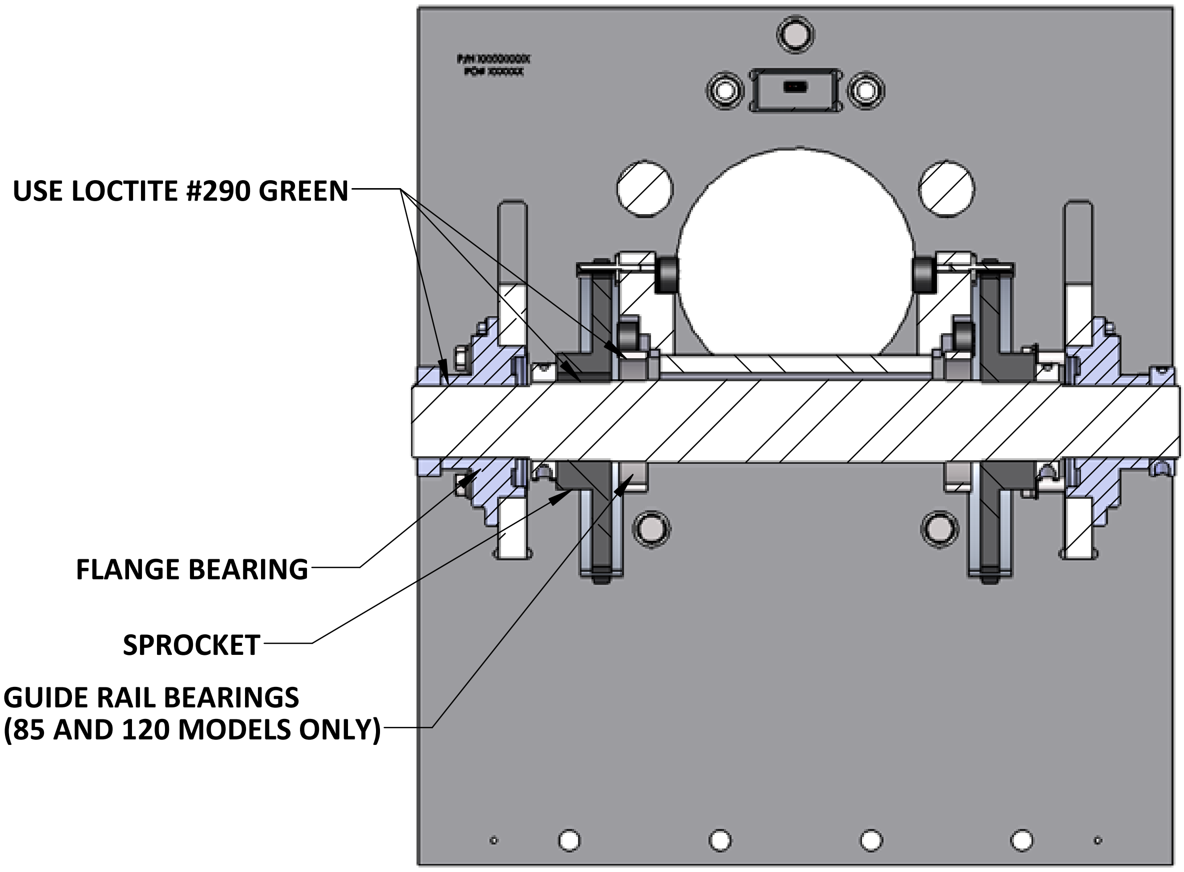


Figure 8-35: Shaft Loctite Locations

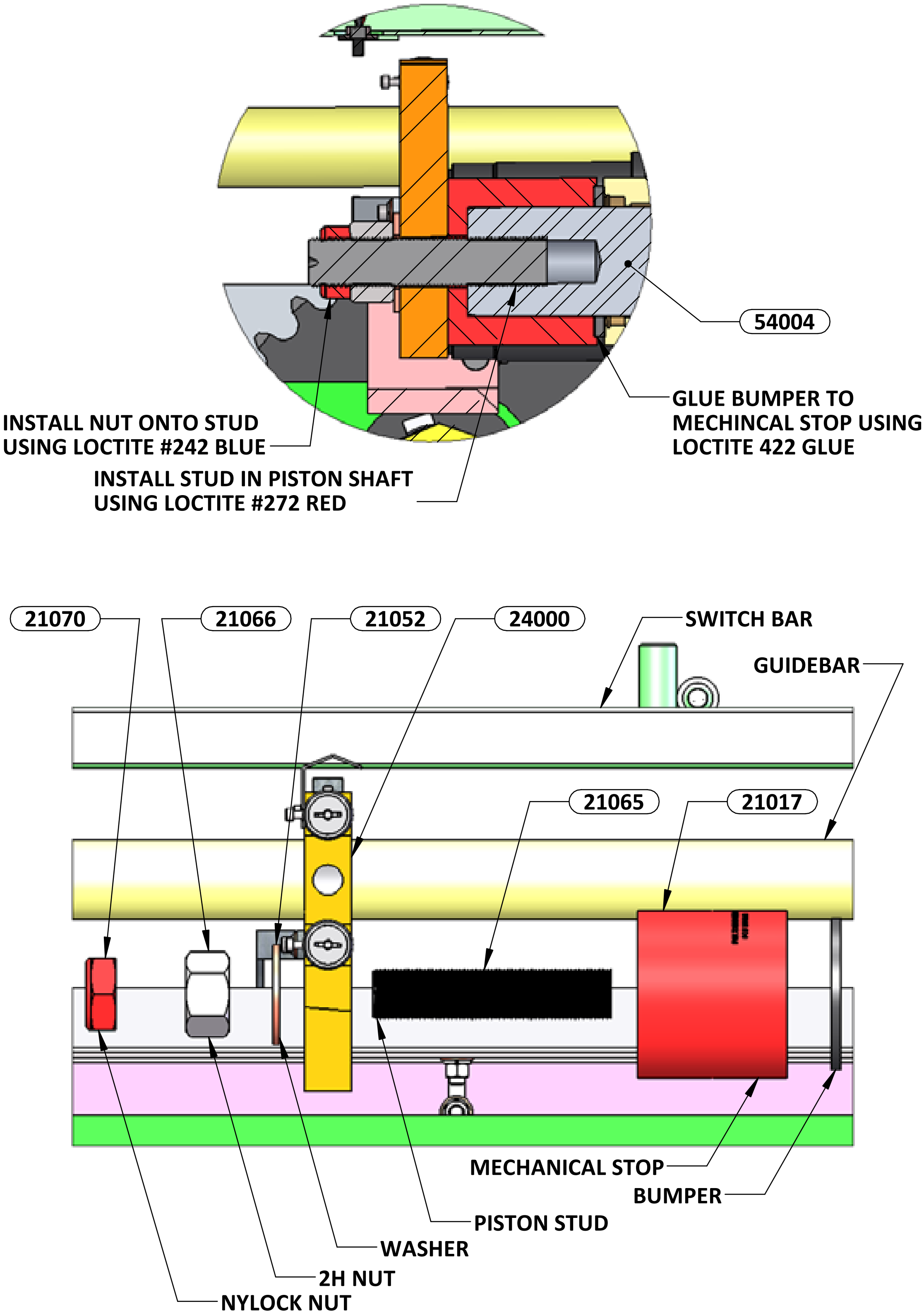


Figure 8-36: Guide Block to Piston Shaft Connection

Please Note: *Figure 8-36 shows S50, S85 and S120 guide blocks. The guide block for S35 prover has additional two cam followers.*

8.11 After Sales Support.

Honeywell GTS (Global Technical Services) support the Honeywell Enraf provers globally.

All after sales support enquiries should be channeled to GTS in the first instance.

Honeywell Enraf have strategically positioned global service partners in USA, Europe & Asia to support Honeywell Enraf provers worldwide.

In order to analyze the problem the following information is required:

- Serial number of prover
- Model number
- Point of contact
- Contact details
- Location of prover
- Process conditions when problems occurred (flow rate, viscosity, product, temperature, number of prover runs)
- Historic information about prover (date installed, repair history)
- Pictures of damage

Honeywell Enraf can offer;

- Commissioning & start-up (including replacement of the transit seals).
- A periodic maintenance service which normally consists of changing seals, checking alignment of drive end and changing optical switches and a differential pressure test to check for seal leakage. (Recommended annually)
- Water draw is (Recommended every 2 years)
- Small Volume Prover Inspection and Refurbishment
- Project consultation

Honeywell GTS:
Email - HFS-TAC-Support@Honeywell.com
Call: 1-800-423-9883

8.12 Frequently asked questions.

What type of prover is the Honeywell Enraf?	The Honeywell Enraf prover is classified as a **Small Volume Unidirectional Piston Displacement Prover.**
Why is the Honeywell Enraf prover considered to be small volume when it can hold up to 350 gallons of fluid?	The small volume classification is based on the volume displaced in relationship to the number of flow meter pulses collected. A large volume prover requires greater than 10,000 meter pulses be collected to generate a meter factor (typically a pipe prover). A small volume prover in conjunction with 'Double chronometry' can generate a meter factor in less than 10,000 meter pulses.
How can the Honeywell Enraf flow prover be used on Corriolis and UltraSonic meters?	By slowing the prover down to allow for longer run up time, the flow disturbance caused by the internal valve closure will have had enough time to stabilize and generate accurate repeatable readings.
What is 'Run up time'?	The run up time is the time it takes from the release of the piston to reach the start measurement switch. (1st Optical Switch)
Why is the upstream and downstream volume the same?	The Honeywell Enraf flow Prover has a piston shaft on both sides of piston body therefore the displaced volume is the same.
How does the flow prover measure volume pulses?	The Honeywell Enraf prover does not measure anything. It is a very accurate, but simple instrument that waits for a start signal from the flow computer and sends back the pulses as it passes the volume switches.
Can the fluid flow through the prover all the time?	Yes, many Honeywell Enraf provers are installed in "Standby Mode", but it is recommended to consider the more durable elastomer option when operating a prover in this way. This is the best practice for fluids that are at temperatures higher or lower than ambient continuous to allow for faster warm up time.
How much pressure drop does the Honeywell Enraf Flow Prover Have?	Under normal operating conditions the prover will generate 28 - 69 kPa (4 – 10 psi) pressure drop at maximum flow rate. This is based on water and is applicable to refined products such as diesel, jet, gasoline, etc. Products such as heavy crude oil can generate pressure drops of up to 20psi in some cases.
What motor sizes are used on Honeywell Enraf provers?	It depends on the prover model but in general an 05 uses 0.5hp/.35kW electric motor; 15, 25, 35, & 50 use a 1hp/.75kW electric motor; 85 uses a 2hp/1.5kW electric motor; 120 uses 5hp/3.7kW electric motor.
What are the installation considerations for a Honeywell Enraf prover?	Correct installation of the Honeywell Enraf prover is vital to a long and trouble-free operation. Critical elements include suitable foundations, pipe stress and load analysis on provers inlet and outlet ports, adequate upstream filtration and thermal pressure relief. If you have any questions, please consult the factory.
How is the installed base of Honeywell Enraf provers supported?	Honeywell Global Technical Support (GTS) is the focal point for all Honeywell Enraf related after-sales support questions and GTS is supported by a network of Honeywell service centers and strategically positioned service partners.
How can I receive information and support for the Honeywell Enraf prover?	Contact your local sales specialist. There is a Honeywell Enraf specialist located in each global region (Americas, Asia Pacific and Europe Middle-East & Africa - EMEA).

Table 28: Frequently Asked Questions.

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