Honeywell Enraf

CALIBRON® Small Volume Prover
Operation & Installation Manual

CALIBRON®

SMALL VOLUME PROVER
OPERATION & INSTALLATION MANUAL

FOR

MODEL 05, 15, 25, 35, 50, 85, 120

U.S. PATENT #5,052,211

23rd Edition
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Table of Contents

LIST OF FIGURES

LIST OF TABLES

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Safety instructions for installation, commissioning, operation and maintenance

Preface

The Calibron® SVP (Small Volume Prover) is a high precision instrument for verification of calibration of flow metering equipment.

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

Refer to Honeywell Enraf installation manual 44103445M for additional information.

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.

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.

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 are factory wired. No unauthorized changes are allowed as these would invalidate the approval.

There are no intrinsically safe connections that need wiring and thus no verification of Intrinsic Safety (entity parameter compatibility) applies.

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 cover is 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 lines.

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 Calibron® SVP can be used for its intended purpose.

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)

Certificates and standards :

CE Directive	Certificate number	Standards applied
94/9/EC ATEX electrical	LCIE 05 ATEX 6068X	EN 60079-0:2006, EN 60079-1:2004, EN 60079-11:2007
94/9/EC ATEX mechanical	Honeywell Enraf declared	EN 13463-1:2009, EN 13463-5:2003
2006/42/EC Machinery Directive	Honeywell Enraf declared	EN 60204-1:2006, EN 953: 1998 + A1: 2009
97/23/EC Pressure Equipment Directive	60330-2009-CE-HOU-DNV	

Environmental conditions:

Ambient pressure	:	atmospheric
Relative humidity	:	5 – 95 %
Ambient temperature	:	ATEX Approval -29˚C to +40˚C (-20˚ F to +104˚F) and CSA Approval -29˚C to +50˚C (-20˚ F to +122˚F)

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INSTALLATION PROCEDURE

Warning

Please read this section carefully before installing, using, or maintaining your CALIBRON® 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 CALIBRON® 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 CALIBRON® small volume prover for this purpose.

1. *Before* performing *any* operations with the CALIBRON® small volume prover read this operation manual *completely!* Also read API MPMS 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 CALIBRON® 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 CALIBRON® 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 CALIBRON® small volume prover has been designed to be used as either a portable or stationary mounted flow prover. The CALIBRON® small volume prover may be installed upstream or downstream of the meter under test, as the displaced volumes are equal.

6. The CALIBRON® 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 7, page 2-5). 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 6 page 2-4).
8. When installing the CALIBRON® 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 6 page 11. 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.
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 5, page 2-3).
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 CALIBRON® 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 CALIBRON® small volume prover, especially in hazardous area locations. The CALIBRON® 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

    LCIE ATEX certified for II 2 G EEx d ia [ia] IIB T4 and II 2 G c IIB T4

    It is the responsibility of the user to satisfy the relevant electrical code requirements on connections made to the CALIBRON® 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 CALIBRON® 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 CALIBRON® small volume prover users:

It is mandatory that all CALIBRON® 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 CALIBRON® 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 CALIBRON® small volume prover manufactured by Honeywell Enraf Americas, Inc.

The CALIBRON® 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 (5×10^{-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 CALIBRON® 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 contents of this manual provide general information and operational characteristics for the CALIBRON® small volume prover. This manual does not include information regarding auxiliary equipment for unique applications, nor does it provide complete instructions for maintenance and repairs of the unit. Please read the CALIBRON® small volume prover maintenance manual or 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.

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 CALIBRON® small volume prover design specifications

Environmental Configuration: CALIBRON® small volume prover can be installed and used in different configurations as specified in the Table 1 below.

Operating process temperature range: -40 °C to 80 °C (-40 °F to 176 °F).

Standard ambient temperature range: -29 °C to 40 °C (-20 °F to 104 °F). For ambient temperatures below -29 °C (-20 °F), please consult factory.

Environmental Configuration (Position 1)	
O	Offshore marine coastal, platform, & ship applications (Wetted Parts “E” only)
P	Portable Applications (O or S unit trailer mounted)
S	Standard stationary product design

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)										
Prover Model	Maximum Flow		Displaced Volume		Maximum Flow		Displaced Volume	Displaced Volume	Shipping Weight	Shipping Weight
	PD, Turbine Meters	Coriolis, Ultrasonic Meters	PD, Turbine Meters	Coriolis, Ultrasonic Meters	PD, Turbine Meters	Coriolis, Ultrasonic Meters	Gallons	Liters	LB	KG
	BPH	BPH	GPM	GPM	m^3/h	m^3/h				
0 5	715	715	500	500	114	114	5	18.9	1,200	544
1 5	2,140	1,719	1,498	1,203	340	273	20	75.7	3,500	1,588
2 5	3,570	1,719	2,499	1,203	568	273	20	75.7	4,350	1,973
3 5	5,000	4,671	3,500	3,270	795	743	25	94.6	5,250	2,381
5 0	7,200	5,783	5,040	4,048	1,145	919	40	151.4	7,850	3,561
8 5	12,500	11,267	8,750	7,887	1,987	1,791	75	283.9	12,500	5,670
1 2 0	17,500	15,922	12,249	11,145	2,782	2,531	120	454.2	14,500	6,577

Table 2: Prover Flow Range

Wetted Parts: CALIBRON® small volume provers can be supplied with wetted parts from 304 or 316 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, end flanges & shafts.
E	316 Stainless Steel flow tube with chrome plated bore. 316SS piston, flanges, & shafts. (Required for 'O' Models)

Table 3: Wetted Parts

Operating pressure range: CALIBRON® small volume provers comply with ANSI 16.5 regulations depending on the prover flange rating and operating temperature. (**Note:** Standard pressure rating calculated between -29 °C to 37.8 °C (-20 °F to 100 °F) any operating temperature limits outside the standard listed may require de-rating of maximum allowable pressure.)

ANSI B16.5 Flange Rating (Position 6)	
1	Class 150 RF connection flanges (05 Not Available)
2	Class 300 RF connection flanges (05 Not Available)
3	Class 600 RF connection flanges (15 & 120 Not Available).
4	Class 900 RF connection flanges (15 & 120 Not Available).
5	Class 900 RJ connection flanges (15 & 120 Not Available).

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6	Class 150 RJ connection flanges (05 Not Available).	
7	Class 300 RJ connection flanges (05 Not Available).	
8	Class 600 RJ connection flanges (15 & 120 Not Available).	
9	Class 1500 RF connection flanges (15 & 120 Not Available).	
↓	**Operating Pressure Rating (Position 7)**	
↓	A	275 psi Pressure rating (For use with Flange Rating 1 & 6)
↓	B	720 psi Pressure rating (For use with Flange Rating 2 & 7)
↓	C	1440 psi Pressure rating (For use with Flange Rating 3 & 8)
↓	D	2160 psi Pressure rating (For use with Flange Rating 4 & 5)
↓	E	3600 psi Pressure rating (For use with Flange Rating 9)

Table 4: Pressure Condition Ranges

Inlet and Outlet Configuration: For easy installation and connection to the end user's piping system CALIBRON® 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.
1 1	Inlet flange on top & Outlet on right.
1 2	Flanges at 90°, Inlet on right side Outlet on top..
1 3	Inlet on right, Outlet on left, Outlet on top

Table 5: Inlet and Outlet Configuration

Motor Voltage Supply Options: The SVP motor sizes have been established to satisfy the industry needs globally for all possible facility needs. (**Note:** The DC power was designed for use with our portable provers for the P05 to the P35 sizes only.)

Motor Voltage Supply (Position 10)		
D	24 VDC	(Portable 05 -35 Only)
A	120 VAC, 60 Hz	(05 -35 Only)
G	120 VAC, 50 Hz	(05 -35 Only)
B	220 VAC, 60 Hz , 1 Phase	(05 -35 Only)
C	220 VAC, 50 Hz, 1 Phase	(05 -35 Only)

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H	220/240 VAC, 60 Hz, 3 phase	(Required 50-120 Sizes)
N	220/240 VAC, 50 Hz, 3 phase	(Required 50-120 Sizes)
R	380/400/415 VAC, 60 Hz, 3 phase	(Required 50-120 Sizes)
L	380/400/415 VAC, 50 Hz, 3 phase	(Required 50-120 Sizes)
E	460/480 VAC, 60 Hz, 3 phase	(Required 50-120 Sizes)
O	460/480 VAC, 50 Hz, 3 phase	(Required 50-120 Sizes)

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 1011011 (LR 84500)]
4	CSA/UL Class 1 Division 1 Group C T3B [CSA 1011011 (LR 84500)]
5	ATEX LCIE CE II 2 G EExd ia [ia] IIC T4 [LCIE 05 ATEX6068 X]

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

Transmitter Manufacturer: The Calibron SVP comes with one each Honeywell Pressure transmitter, and two each Honeywell Temperature Transmitter. (**Note:** Only one of the temperature transmitters comes with the local display. Other manufactures can be supplied as option.)

Transmitters (Position 13)	
H	Honeywell Pressure and Temperature Transmitter
R	Rosemount Pressure and Temperature Transmitter
Y	Yokagowa Pressure and Temperature Transmitter

Table 9: Transmitters

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 4.

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

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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

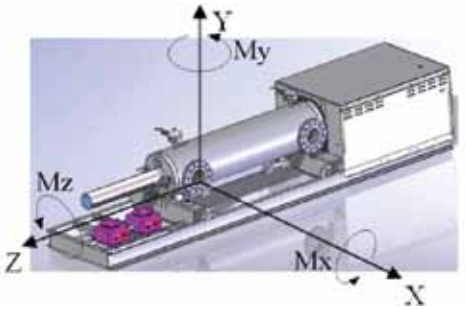
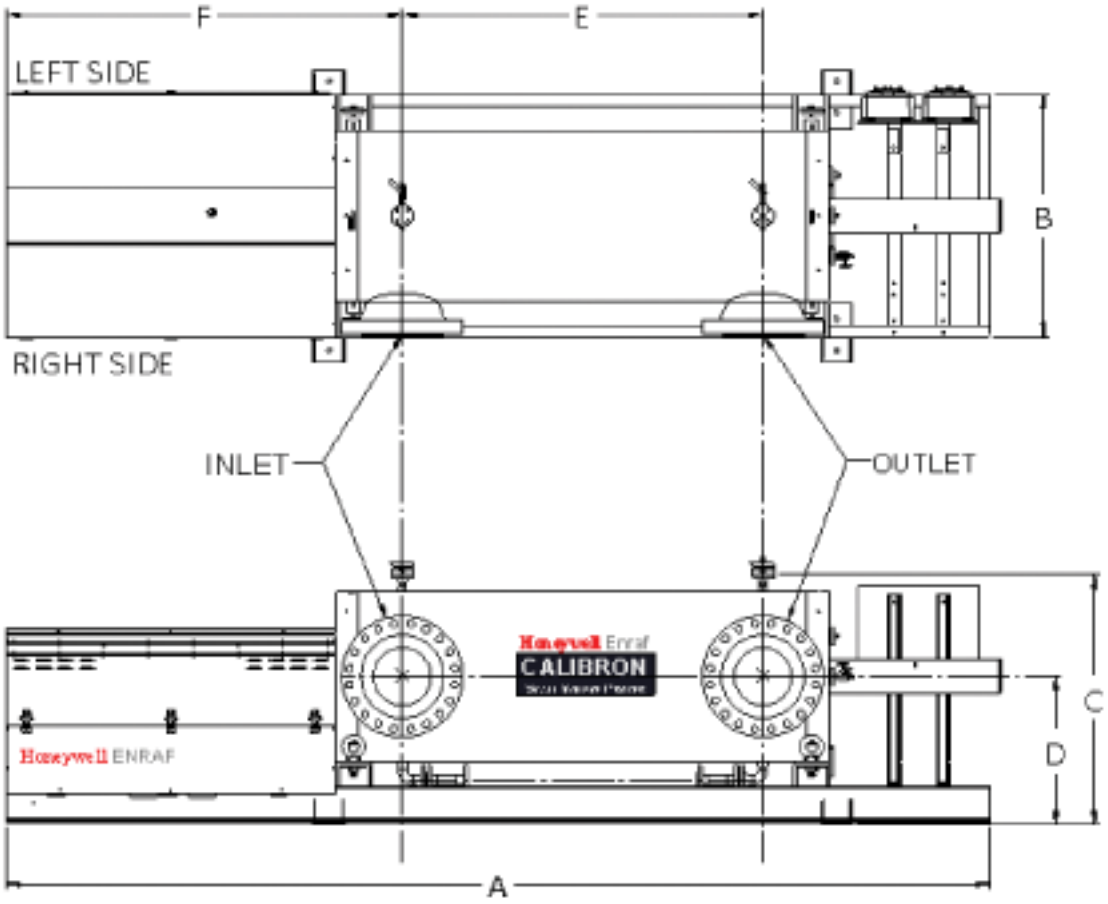


Table 10: Maximum allowable inlet and outlet flange loads

Prover critical dimensions: See prover's critical dimensions provided in the Figure 1 below.



MODEL #/ DIMENSIONS	05	15	25	35	50	85	120
A	2438 (96)	4060 (160)	4060(160)	4060 (160)	4500 (177)	5230 (206)	5590 (220)
B	610 (24)	914 (36)	914 (36)	914 (36)	1070 (42)	1270 (50)	1370 (54)
C	686 (27)	828 (32.6)	848 (33.4)	925 (36.4)	1170 (45.9)	1230 (48.5)	1380 (54.5)
D	427 (16.8)	523 (20.6)	523 (20.6)	541 (21.3)	673 (26.5)	762 (30)	833 (32.8)
E	777 (30.6)	1370 (53.9)	1370 (53.9)	1310 (51.4)	1470 (58)	1930 (76)	2040 (80.5)
F	930 (36.6)	1500 (59)	1500 (59)	1530 (60.3)	1870 (73.8)	2110 (83)	2250 (88.4)
FLANGE SIZES	3 inch	6 inch	6 inch	8 inch	8 inch	12 inch	16 inch

NOTES:
1. All dimensions are in mm (inches)
2. Dimensions ‘C’ and ‘F’ may vary according to model type/configuration
3. All dimensions vary according to pressure rating
4. All dimensions are subject to change

Figure 1: Prover Dimensions

Pressure drop: Pressure drop measured between inlet and outlet of the prover is specified in the Table 11 (see below). The drop is obtained at maximum flow rate using water as a fluid.

CALIBRON SVP MODEL	FLOW RATE (BPH)	PRESSURE DROP
S05	785	69 kPa (10.0 psig)
S15	2,140	28 kPa (4.0 psig)
S25	3,750	52 kPa (7.5 psig)
S35	5,000	55 kPa (8.0 psig)
S50	8,000	69 kPa (10.0 psig)
S85	12,500	38 kPa (5.5 psig)
S120	17,500	48 kPa (7.0 psig)

Table 11: Maximum pressure drop per prover size

1.4 Tests and Certifications

The CALIBRON® 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 CALIBRON® 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

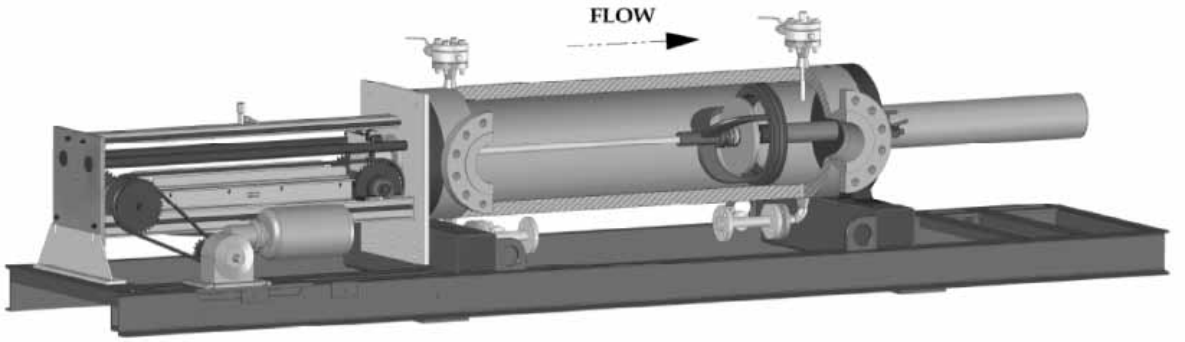


Figure 2: Prover in Stand-By Mode

In the stand-by mode the piston is down-stream and stationary, see Figure 2. 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 3. 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.

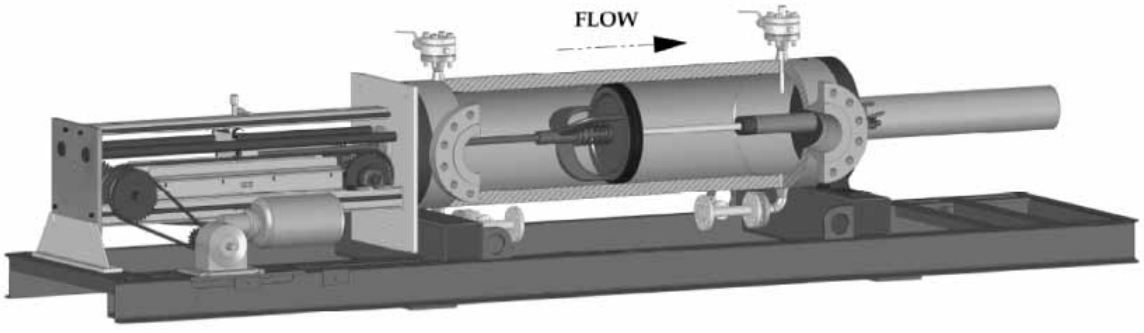


Figure 3: Prover During Prove Run - Mid-Run

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.

CHAPTER 2 INSTALLATION

2.1 Receipt of Equipment

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

When installing the CALIBRON® 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 4 (Process Connections and General Arrangement) for connecting the CALIBRON® 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.

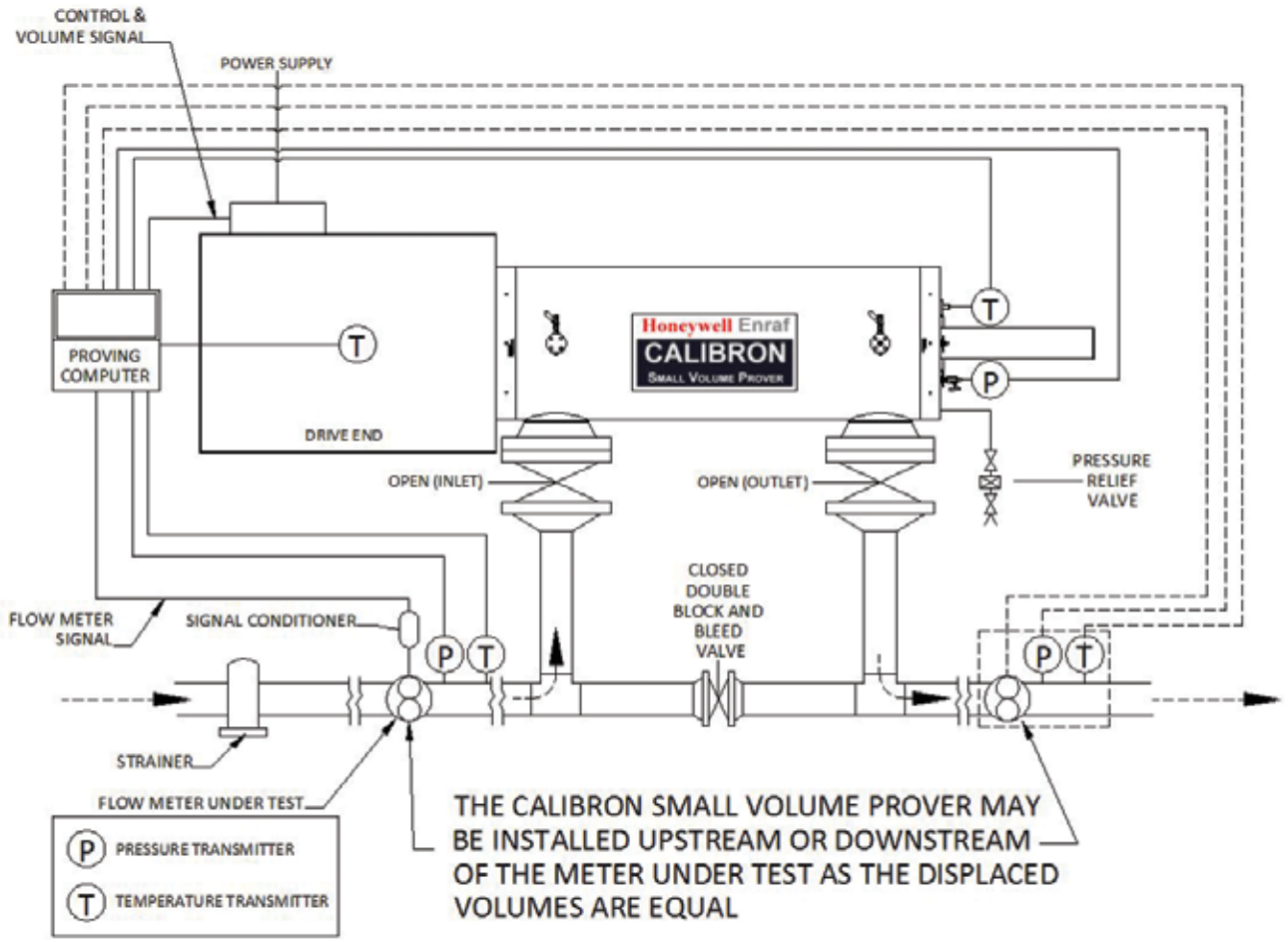


Figure 4: Process Connections and General Arrangement

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 CALIBRON® 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.

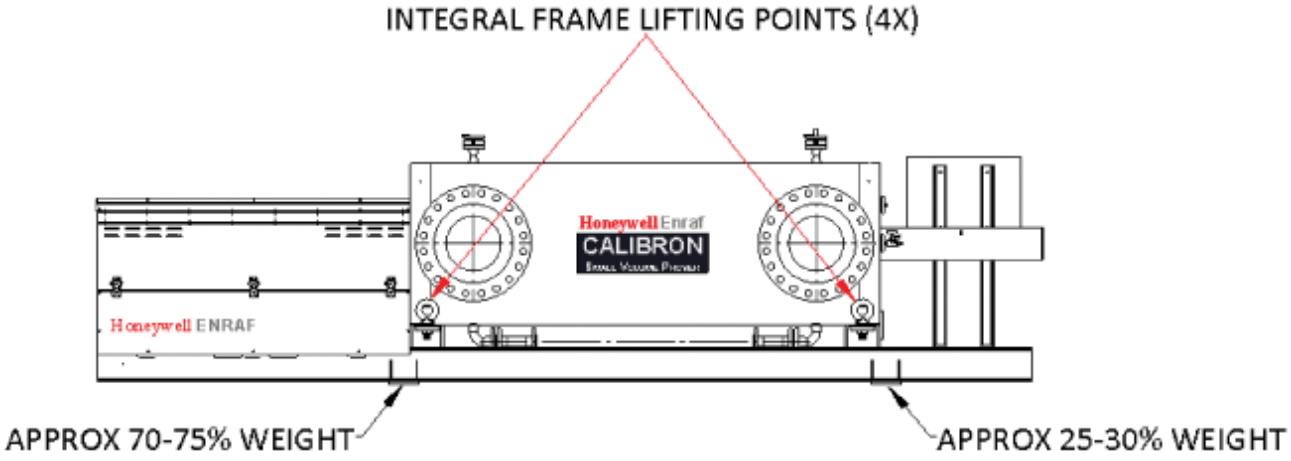
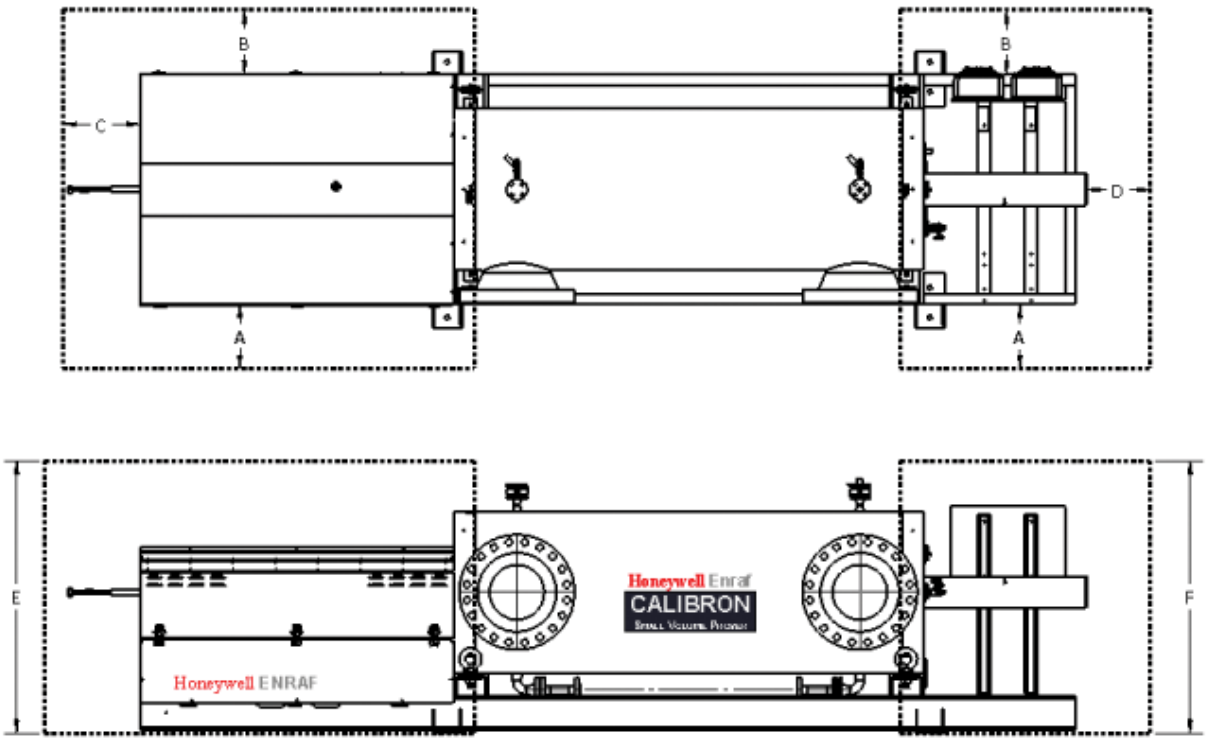


Figure 5: Prover Lifting Diagram

As with all pressure containing equipment, it is essential to protect your CALIBRON® 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 6.



MODEL	A	B	C	D	E	F
05	610 (2)	610 (2)	610 (2)	1220 (4)	1520 (5)	1520 (5)
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)

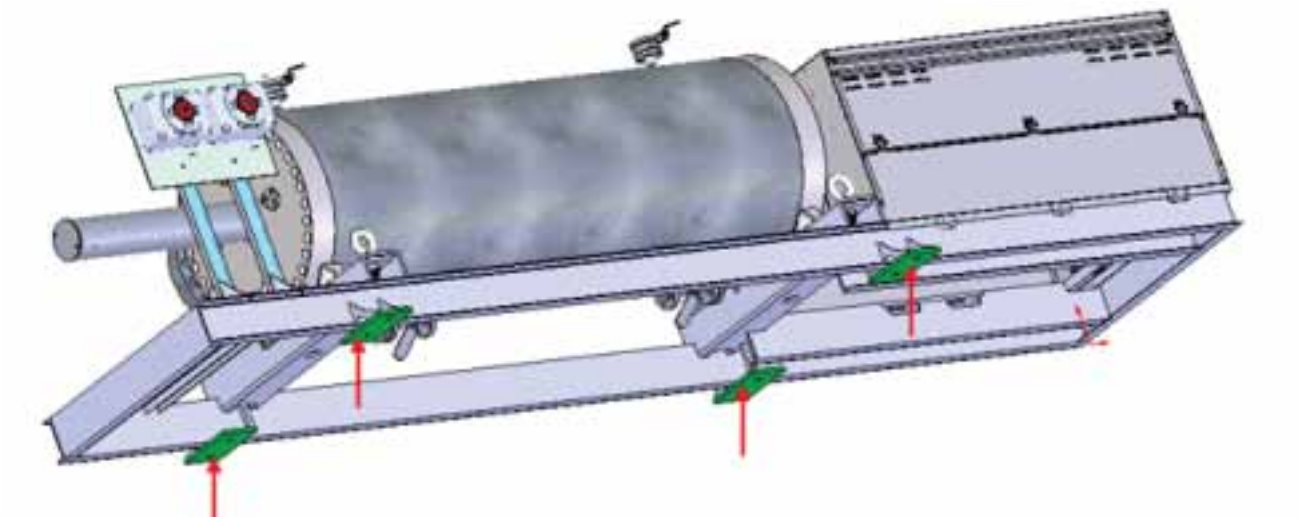
NOTES:

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 6: Prover Service Clearance Diagram

The CALIBRON® 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 7). 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.



Figures 7: Designated anchor points (plates) located on the bottom side of the prover frame.

The CALIBRON® 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 CALIBRON® small volume prover is certified by one of the following agencies:

CSA/US certified for Class 1 Group D T2C

CSA/US certified for Class 1 Group C T3B

LCIE ATEX certified for II 2 G EEx d ia [ia] IIB T4 and II 2 G c IIB T4

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

Refer to Section 5 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 CALIBRON® small volume prover must be correctly earth grounded prior to electrical service connection.

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CHAPTER 3 CALIBRATION

3.1 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 4.3.7.1, 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 CALIBRON® 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. CALIBRON® 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.

3.2 Static Leak Detection

The CALIBRON® 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.

3.2.1 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 8.

3.2.2 Static Leak Detection Procedure

1. Block all inlet and outlet ports on the prover (including drains).
2. Refer to Figure 8, 9 &11 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 CALIBRON® 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 10.
10. Rotate the adjustment screw (3) Figure 11 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 12.

Figure 8: Static Leak Detection Set-up

Figure 9: Gauge with HI & LOW markings

Figure 10: Differential pressure creator inserted in drive end plate.

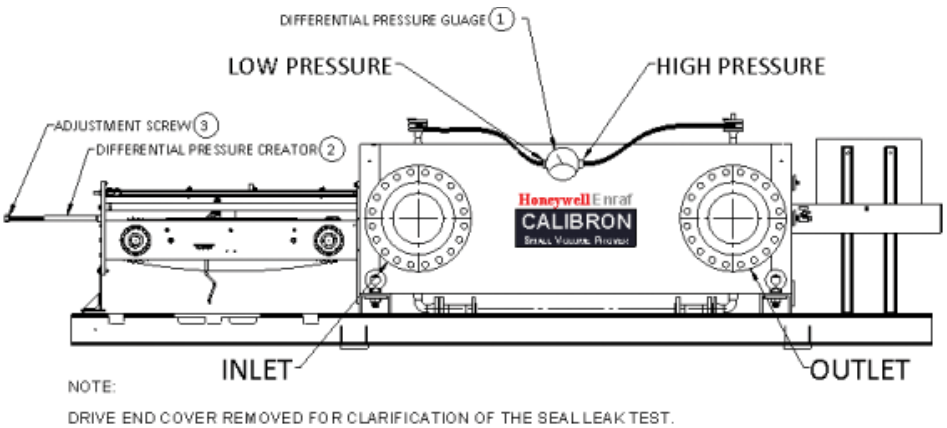


Figure 11: Static Leak Detection set-up overview

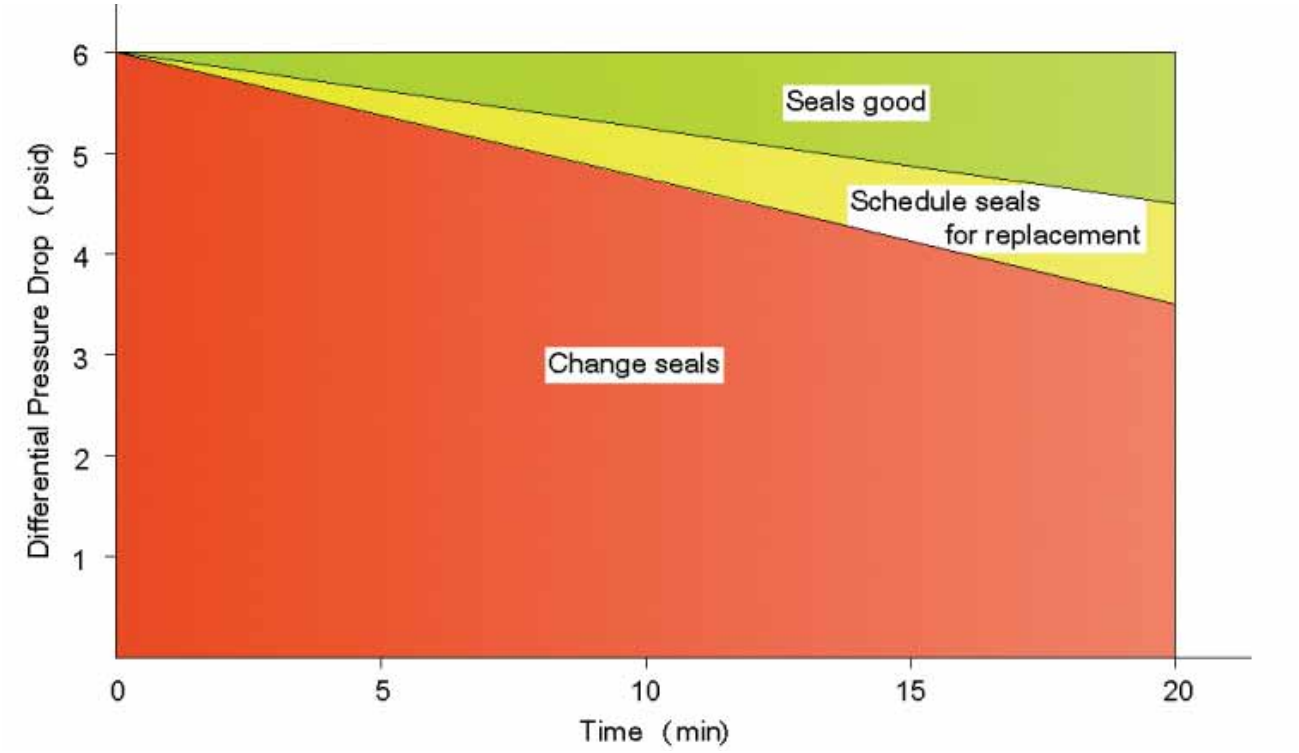


Figure 12: Recommendation for seal change

3.3 Volume Water Draw

Equipment

1. Water draw kit: Contact Honeywell Enraf representative or factory directly to obtain a water draw kit, (see Figure 13).
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 (see Figure 14)
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.

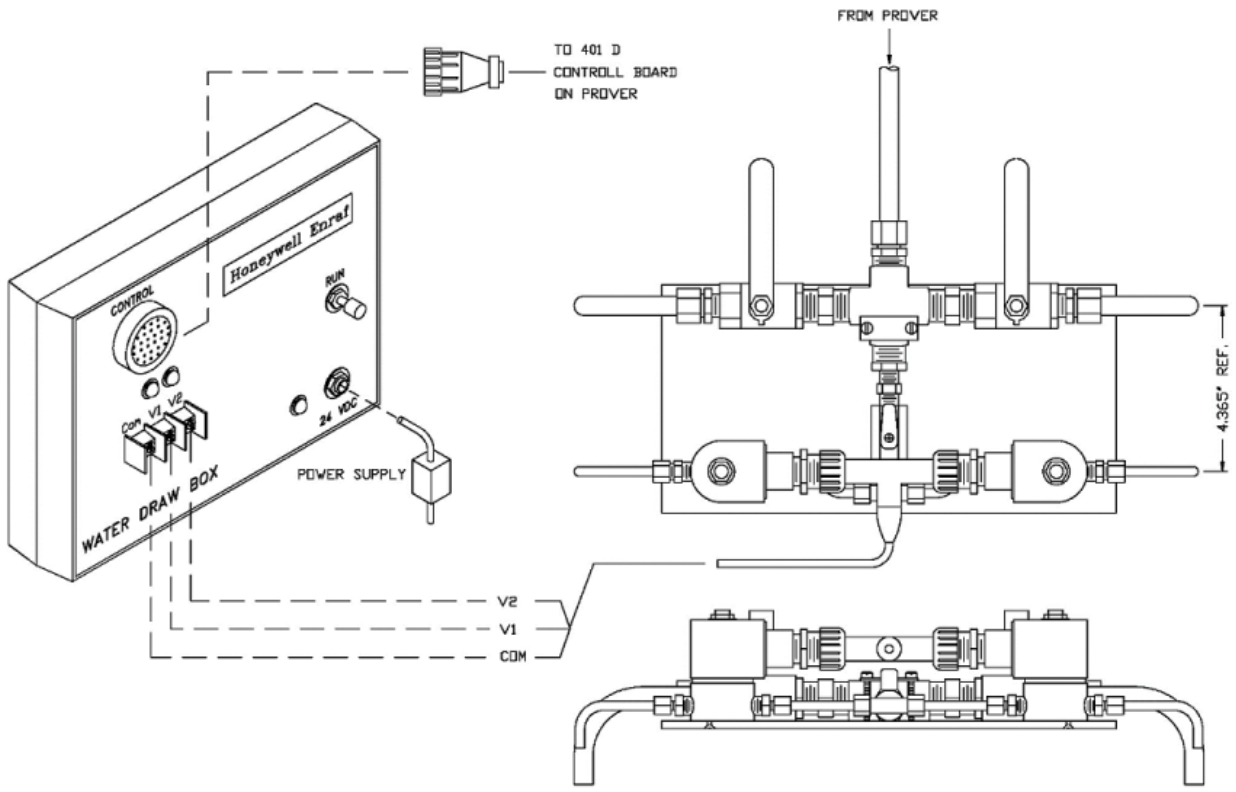


Figure 13: Water Draw Kit

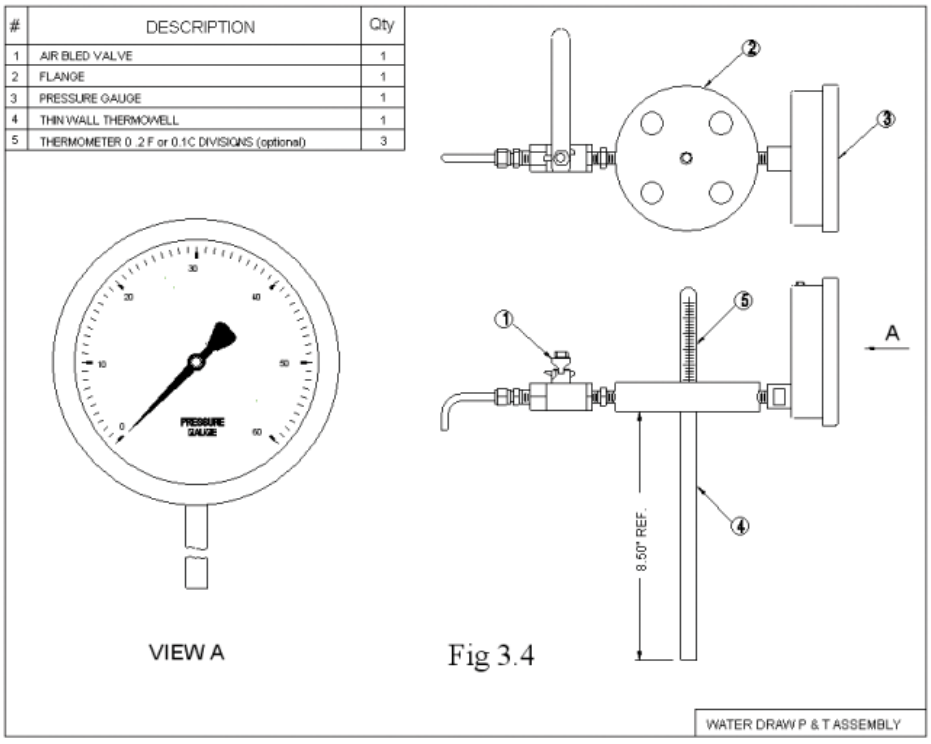


Figure 14: Water Draw P&T Kit

Procedure

Water draw notes:

Perform steps 9-16 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 3.2. 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 CALIBRON® water draw configuration, Figure 15, and install Honeywell Enraf available water draw kit, see Figure 13 and Figure 14. 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 P&T kit to it. Have available, Table 8 to record data from prover calibration (volumetric water draw data sheet).
4. Connect water supply to prover, (refer to Figure 15).
5. Connect prover control cable to water draw valve controller, (refer to Figure 13).
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.
8. Apply power to the water draw circuit. One of the valves will switch on immediately. Note which valve switches on, and mark it as the overboard or bypass valve. The other valve is the draw valve and will be on only when the piston is in the measurement area of the flow tube. Also, apply electrical power to the prover.
9. Place properly wetted & drained test measure under the water draw valves.
10. To start water draw depress the switch on the controller. This will cause the prover piston to be returned to upstream position and start the draw sequence.

11. Water should now be draining into the wastewater container until the flag reaches the first optical (volume) switch. The optical (volume) switch will send the signal to the controller to switch the valves and start the water flowing into the test measure.
12. Record the prover pressure (Pp) at P1 while only the water draw valve is open. Valves V5, and V6, must be closed while recording this pressure, which is the pressure at the start and the end of volume switching.
13. 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.
14. Record fluid temperature (Tp) at T1.
15. When the flag reaches the second optical (volume) switch, the signal will be sent to water draw valve to close. Carefully record scale reading (SR) and test measure temperature (Ttm).
16. After all data is collected, drain the test measure.
17. Repeat steps 10 through 16 as necessary to obtain the required number of runs (including one run at 25% flow rate variance).
18. Calculate prover volume per Section 3.5.

A copy of Table 12 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 volumetric method.

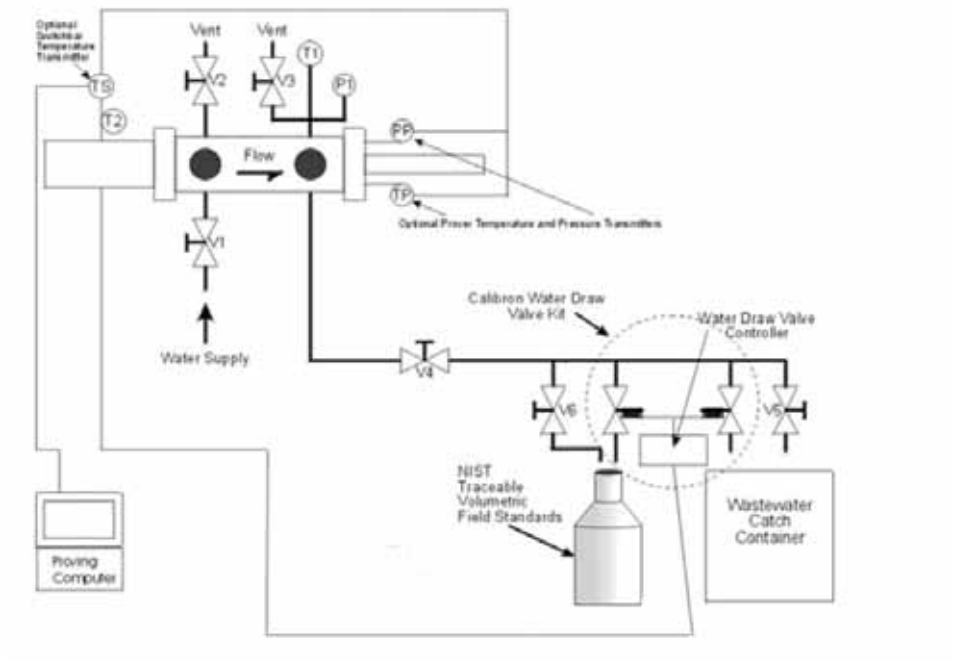


Figure 15: Water Draw Plumbing Diagram

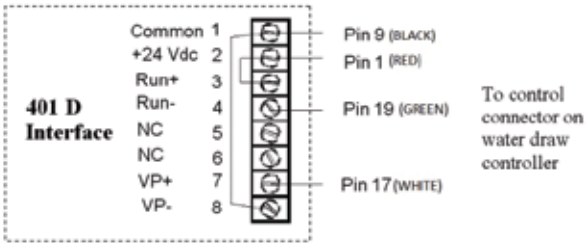


Figure 16: 401D Interface for Water Draw Controller Connection

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 12: Volumetric Water Draw Data Sheet

3.4 Gravimetric Water Draw

Equipment

1. Water draw kit: Contact Honeywell Enraf representative or factory directly to obtain a water draw kit, Figure 13.
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 2 equivalent or better.
4. Source of air-free or deaerated deionized or distilled water with approximately 19 Lpm at 172-690 kPag (5 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 pressure gauge: 0 - 690 kPag (100 psig)
7. Three traceable thermometers with 0.1°C (0.2°F) graduations (see Figure 14).
8. Water draw data sheet, Table 12.
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.

Procedure

Water draw notes:
Perform steps 10-17 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 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 3.2. 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 flange or double block and bleed valve.
3. Refer to CALIBRON® water draw configuration, Figure 15, and install Honeywell Enraf available water draw kit, (Figure 13 and Figure 14). 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 P&T kit to the opening in it. Have available, Table 9 to record data from prover calibration (water draw).
4. Calibrate the scale as specified in API 4.9.4.
5. Connect water supply to prover, (refer to Figure 15)
6. Connect prover control cable to water draw valve controller, (Figure 13.)
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. Open V2 slightly to allow just a very small stream of water to flow, which will bleed off air which may be in the water supply.
9. Apply power to the water draw circuit. One of the valves will switch on immediately. Note which valve switches on, and mark it as the overboard or bypass valve. The other valve is the draw valve and will only be on during the two volume switches. Also apply electrical power to the prover.
10. Calibrate scales with test weights totaling +/- 10% of draw weight per API 4.9.4.
11. With volume catch container on the scales and under water draw valve, tare scales.
12. To make a water draw, depress the switch on the controller, this will cause the prover piston to be returned to upstream position and start the draw sequence.
13. Water should now be draining into the wastewater container, and will drain into the wastewater container until the first volume switch has been reached. 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. The controller will now signal the valves to switch, and start flow into the volume catch container.
14. The draw can be sped up by opening valve V6 after the valves have switched to flowing into the container located on the scale. Record the pressure at P1 while the draw is being conducted while only the water draw solenoid valve is open — not while V6 is open. Again close V6 at least 13mm or 2L (1/2” or 1/2 gal) gal prior to solenoid draw valve switching.
15. Record ambient temperature (T_a)

16. Record temperature (T_d) at T2, which is detector temperature, by opening drive cover and placing thermometer midway between volume switches, which is in the location of the switch bar temperature transmitter thermowell.
17. Record fluid temperature (T_p) at T1 (at prover).
18. Allow catch container to fill until valve switches.
19. Record scale reading (W_w). Drain container and tare scales.
20. Repeat above procedure, 10 through 17, until the desired # of draws are attained. (Usually 5 consecutive draws within the desired tolerance).
21. Calculate results per Section 3.5.

A copy of Table 4 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.

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 (ρ*A*) =					

Continued on next page

Continued from previous page

Calculated Density of Water (ρ*w*) =					
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 13: Gravimetric Water Draw Data Sheet

3.5 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:

$\rho A = 0.001223068*(1-(0.032 \times h/1000))*(519.67/(Tf + 459.67))$

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)

$CBW= \{[1-(0.0012/ \rho TWr)] / [1- (0.0012/ \rho TWf)]\} * \{[1-(\rho A/ \rho TWf)] / [1- (\rho A/ \rho Ftp)]\}$

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)

CHAPTER 4 OPERATIONS AND TROUBLESHOOTING

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 CALIBRON® 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 4.
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 4, slowly to divert the flow through the prover.
5. The CALIBRON® 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.

4.2 Optical Switch and 401D Board Troubleshooting Procedure

The following procedure will allow the user to troubleshoot both the optical switches and 401D for possible failure.

1. If flow computer is not receiving a flow meter signal install a signal generator to produce a signal in place of the flow meter.
2. Check that the piston is completely downstream, if not check for reasons why and correct the problem.
3. Instruct the Flow Computer to take a proving cycle and do the following:
   a. Take a business card or anything similar and swipe it through the downstream optic switch, the one closet to the flow tube.
   b. Next, swipe the card through the upstream optic switch.
   c. Trip the motor stop micro switch located on the switch bar.
   d. Swipe the card through the upstream optic switch.
   e. After performing steps a. through d. check to see if the computer is receiving flow meter pulses.
   f. Lastly, swipe the card through the downstream optic switch and the pulses should stop.

Steps a. through c. above simulates the piston being pulled from a downstream stand by position to an upstream position. Step d. simulates

the piston being released by the puller and starting a proving run. Steps e. and f. simulate the piston completing its proving run and returning to the downstream stand by position.

If you do not receive pulses when you trip the upstream optical switch check the 401D board and see if the light is on and flashing, if so replace the upstream optical switch and run test again. If the pulses now start at the upstream switch, you can trip the downstream switch and the pulses should stop.

If the pulse did not stop when you swiped the downstream switch and the light is flashing on the 401D board, replace the downstream optical switch.

If you check the 401D board and the LED light is not on, check the input power (24 VDC). If you have power to the board and no LED light, replace 401D and run through the above sequence again.

4.3 Trouble Shooting Chart

Prover does not cycle when proving pass is initiated	
No AC power to CALIBRON® small volume prover.	Check for continuity of power to prover, see Section 5.
Interface cable between CIU or flow computer and CALIBRON® small volume prover is not properly connected	Check connections and integrity of cables, see Section 5 and flow computer manual.
Above checks do not resolve problem	See Section 5 for location of 401D interface 1. Remove CALIBRON® drive cover panel 2. Remove explosion proof interface box cover 3. Check 401D status indicator light
No light on 401D	401D failure or no power to 401D
1 flash and a pause	Indicates failure of downstream volume switch
2 flashes and a pause	Indicates failure of upstream volume switch
3 flashes and a pause	Indicates a failure of both switches
4 flashes and a pause	Indicates a motor, drive, or motor relay failure
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 14: CALIBRON® Troubleshooting Chart

CHAPTER 5 ELECTRICAL SCHEMATICS & DRAWINGS

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

5.1 Customer Electrical Connections

Figure 17 details the customer electrical connections for a prover with one electrical box (assuming that the power to the motor will be supplied to the motor directly.

Figure 18 details this same connection for provers equipped with two electrical boxes.

Figure 19 details this same connection for provers equipped with three electrical boxes.

Each of these electrical connection drawings makes reference to Note 1 and Note 2; these notes can be found on page 41.

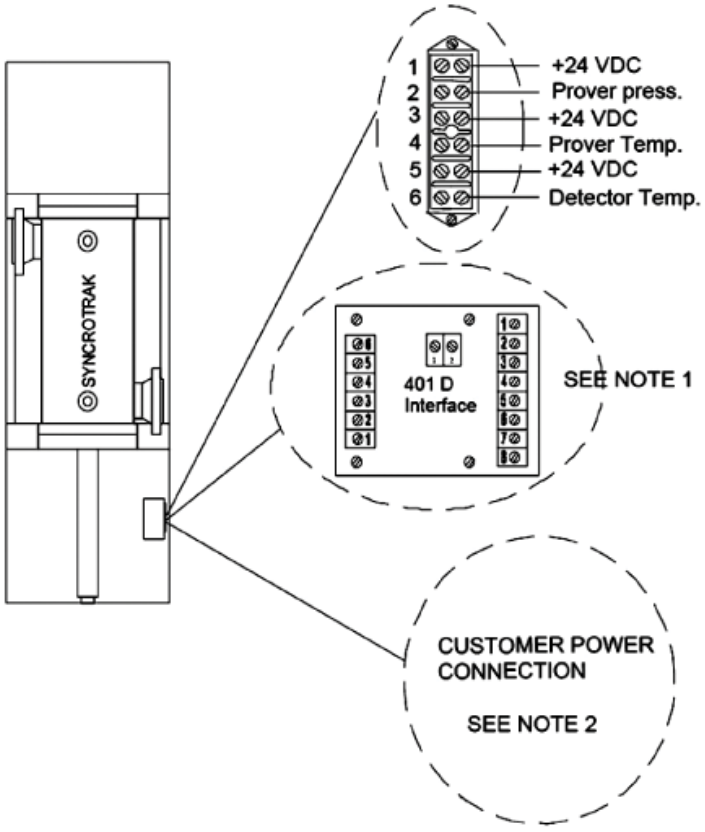


Figure 17: Customer Electrical Connections One Box

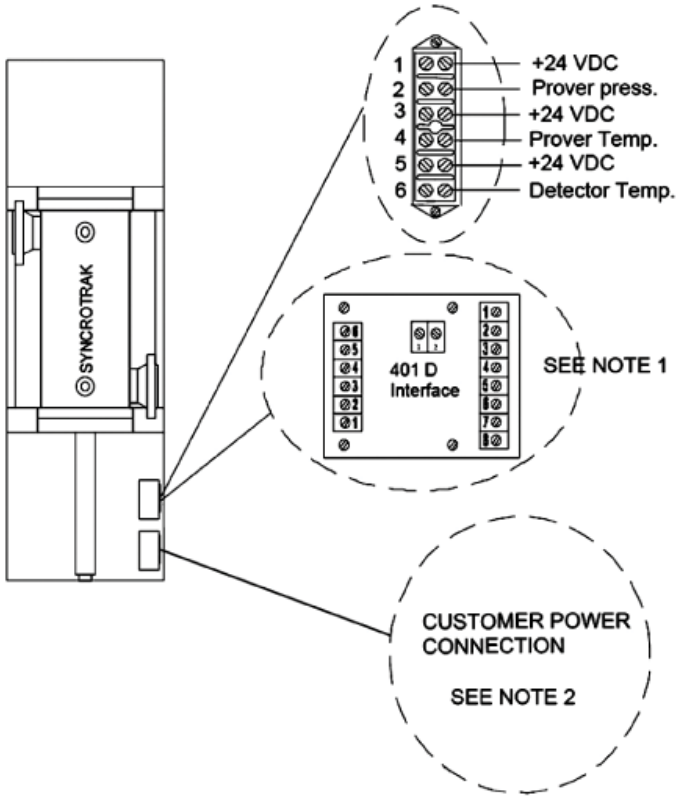


Figure 18: Customer Electrical Connections Two Box Models

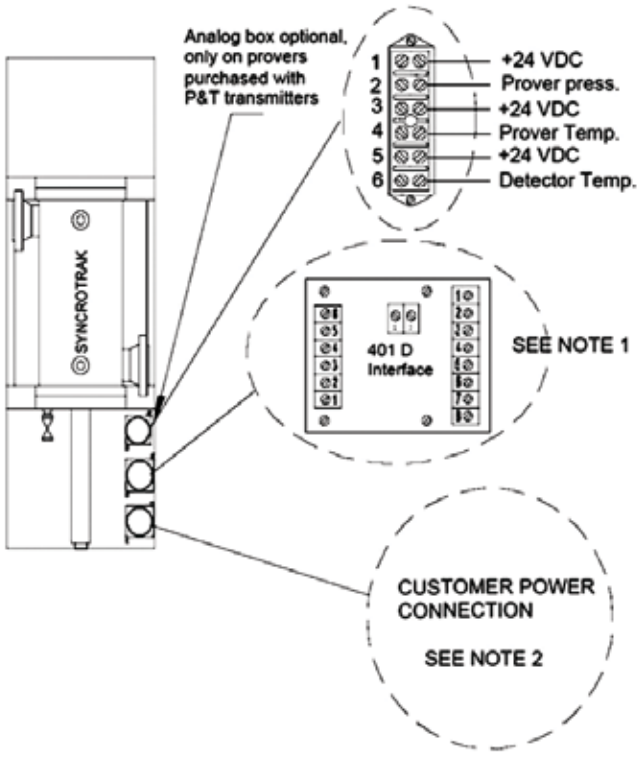


Figure 19: Customer Electrical Connections Three Box Models

Note 1: See appropriate wiring diagram and information for connection to your proving computer in Section 5.2.

Note 2: See Figure 18 for single phase AC power, Figure 19 for 3 phase AC Power, and Figure 20 for DC power.

5.2 CALIBRON® Wiring Diagrams

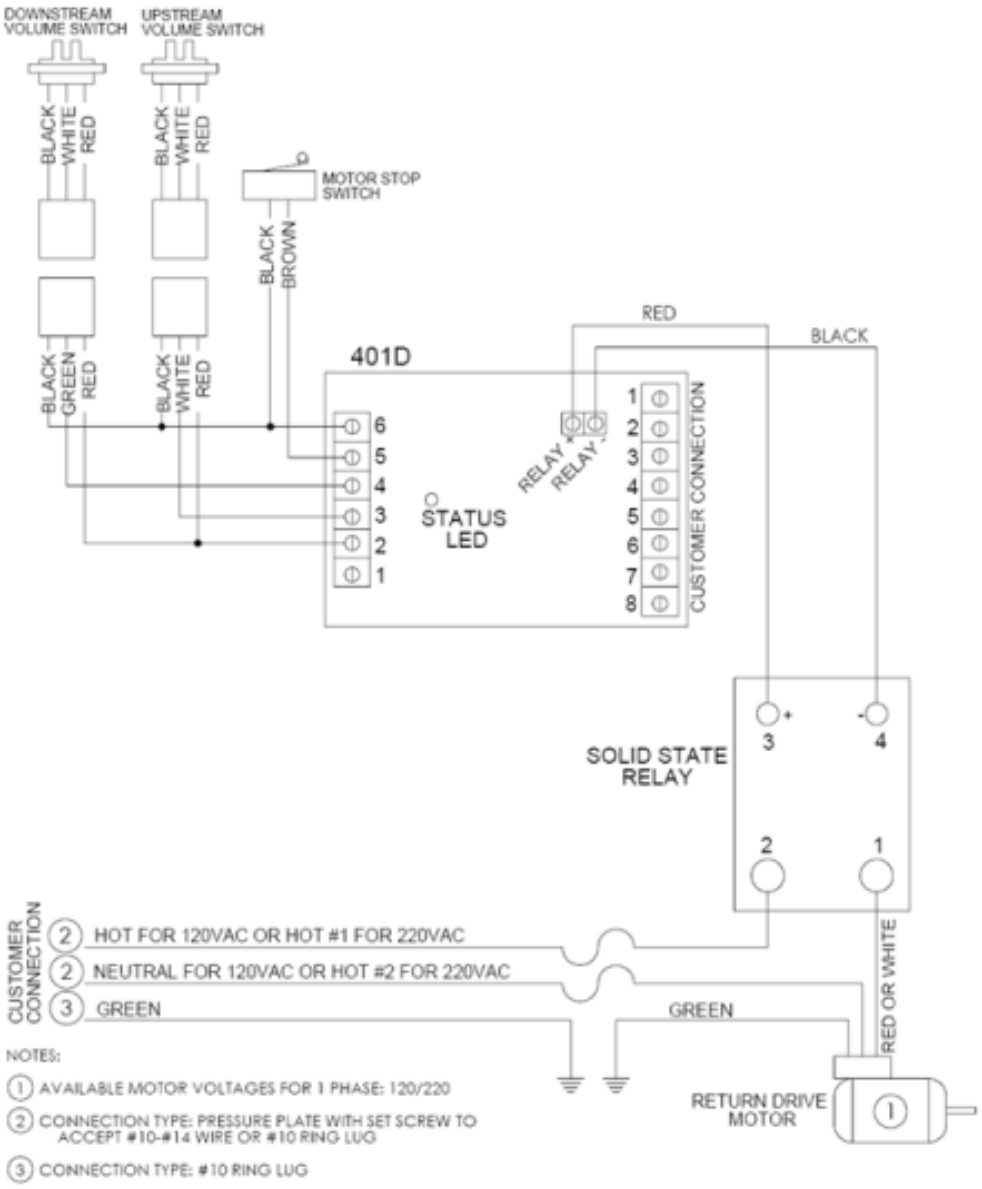


Figure 20: Wiring Diagram for Single Phase Models

Please Note: Exercise extreme caution when wiring 401D module. The 401D module is a very sensitive electronic device and if wired incorrectly will be rendered useless.

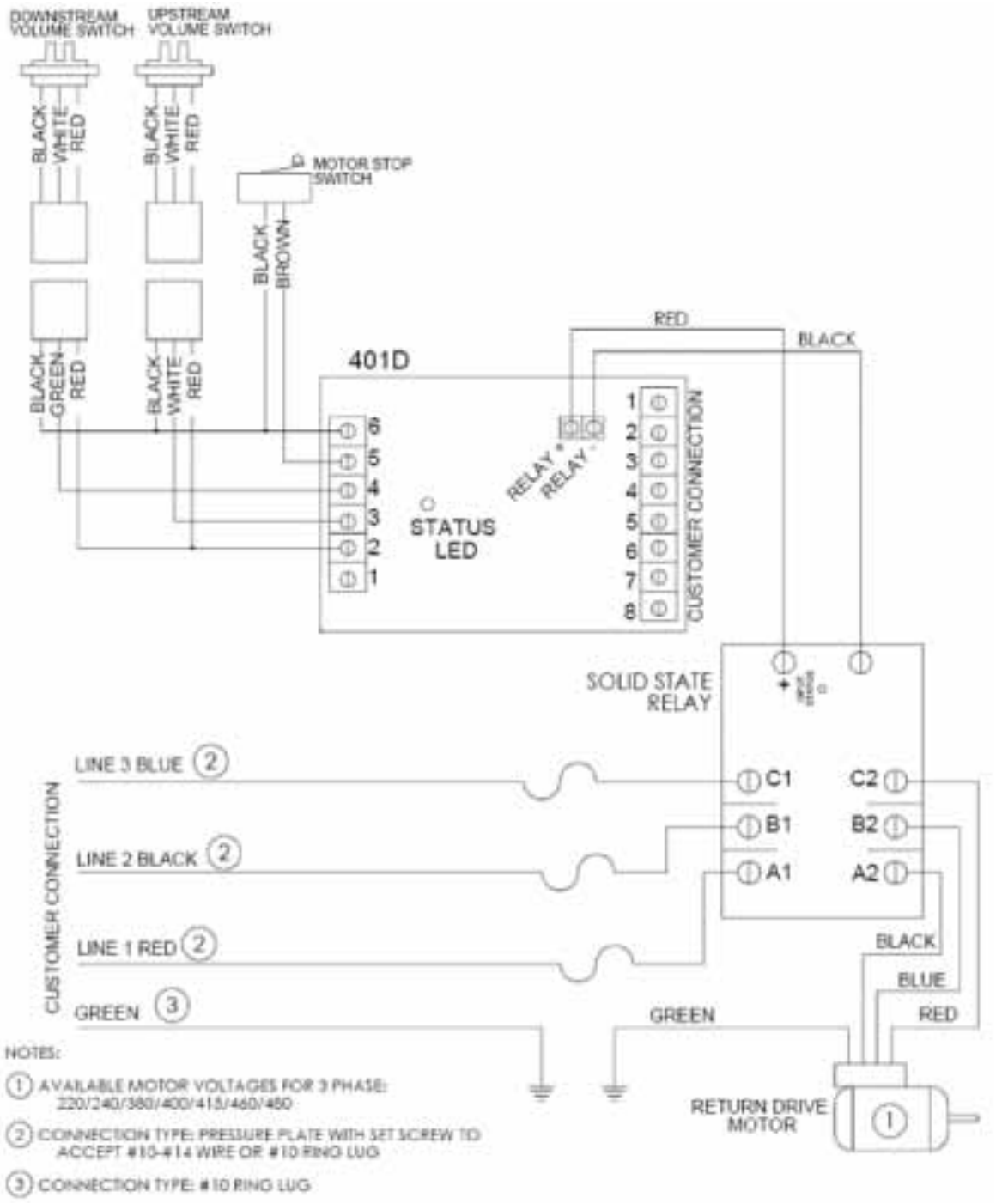


Figure 21: Wiring Diagram for 3 Phase Models

Please Note: Exercise extreme caution when wiring 401D module. The 401D module is a very sensitive electronic device and if wired incorrectly will be rendered useless.

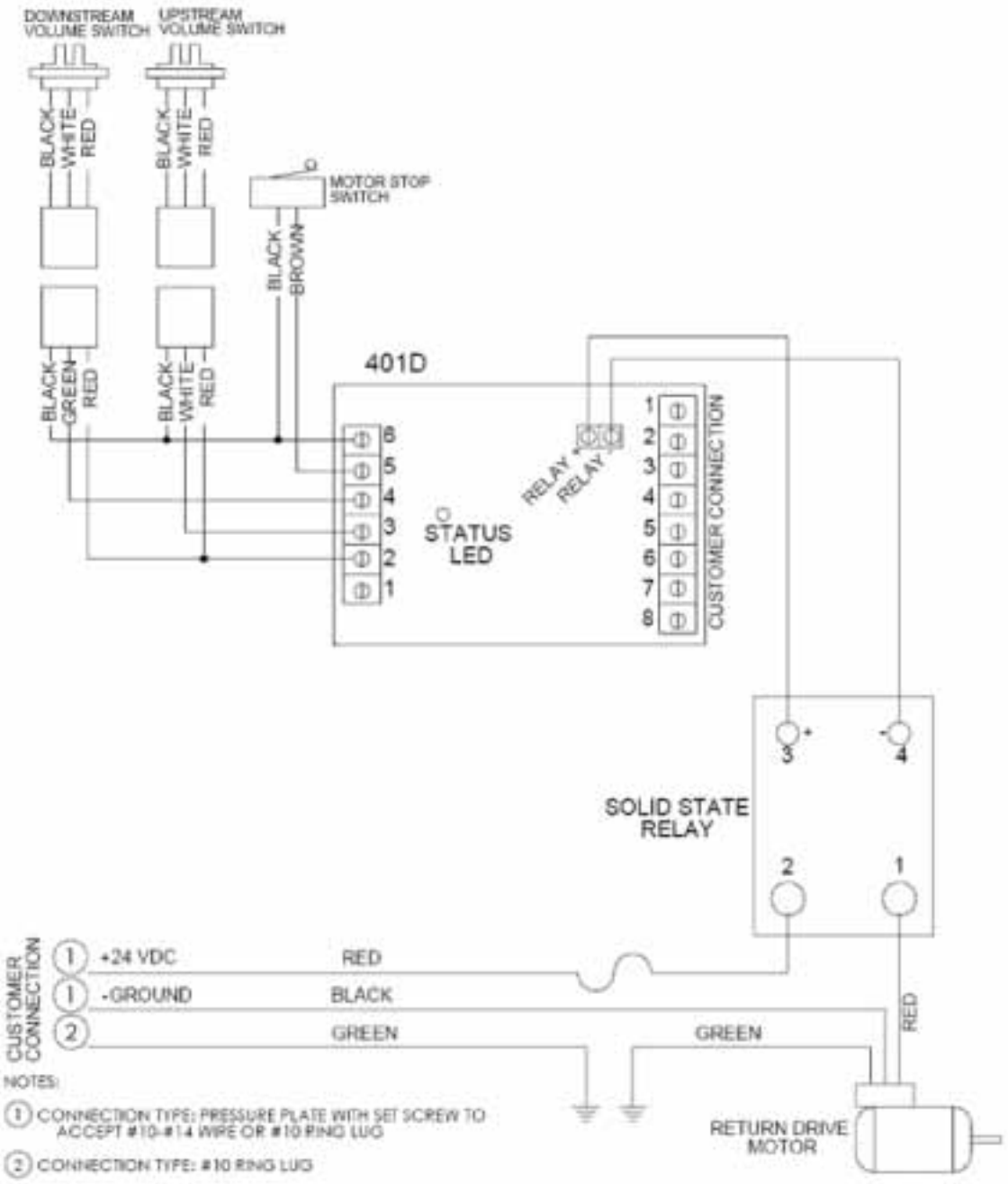


Figure 22: Wiring Diagram for 24 VDC Models

Please Note: Exercise extreme caution when wiring 401D module. The 401D module is a very sensitive electronic device and if wired incorrectly will be rendered useless.

5.3 401D Wiring Diagrams

401D to OMNI Flow Computer wiring and setup

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. The switch output *VP+ (Point #7of the 401D) connects to the prover detector input of the E Combo Card. The prover detector inputs on the Omni are between Pin #7 and Pin #10, usually Pin #7. The prover run command (Run+, Point #3 of the 401D) 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 resistor between 1000 to 5000 ohms (4000 to 5000 ohms preferred) must be installed between the ground (Point #1 of 401D) and the Run- (Point #4 of the 401D) 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. The DC- and DC+ (Points #1 & #2 of the 401D) connect to the Omni power supply or any other supply that is common to the Omni. A jumper must be connect between the ground (Point #1 of 401D) and *VP- (Point #8 of the 401D board).

Please read the Omni's Operator's manual prior to connection and or operation of the CALIBRON® small volume prover.

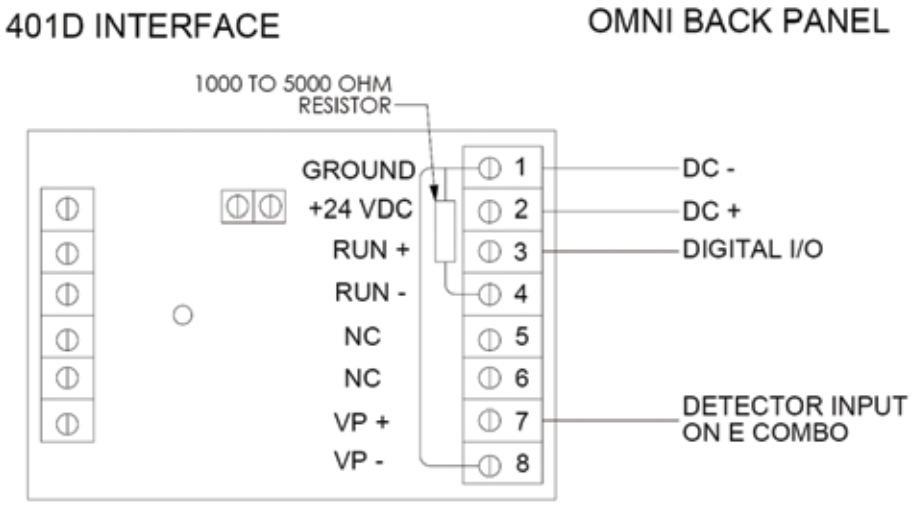


Figure 23: 401D to OMNI Wiring

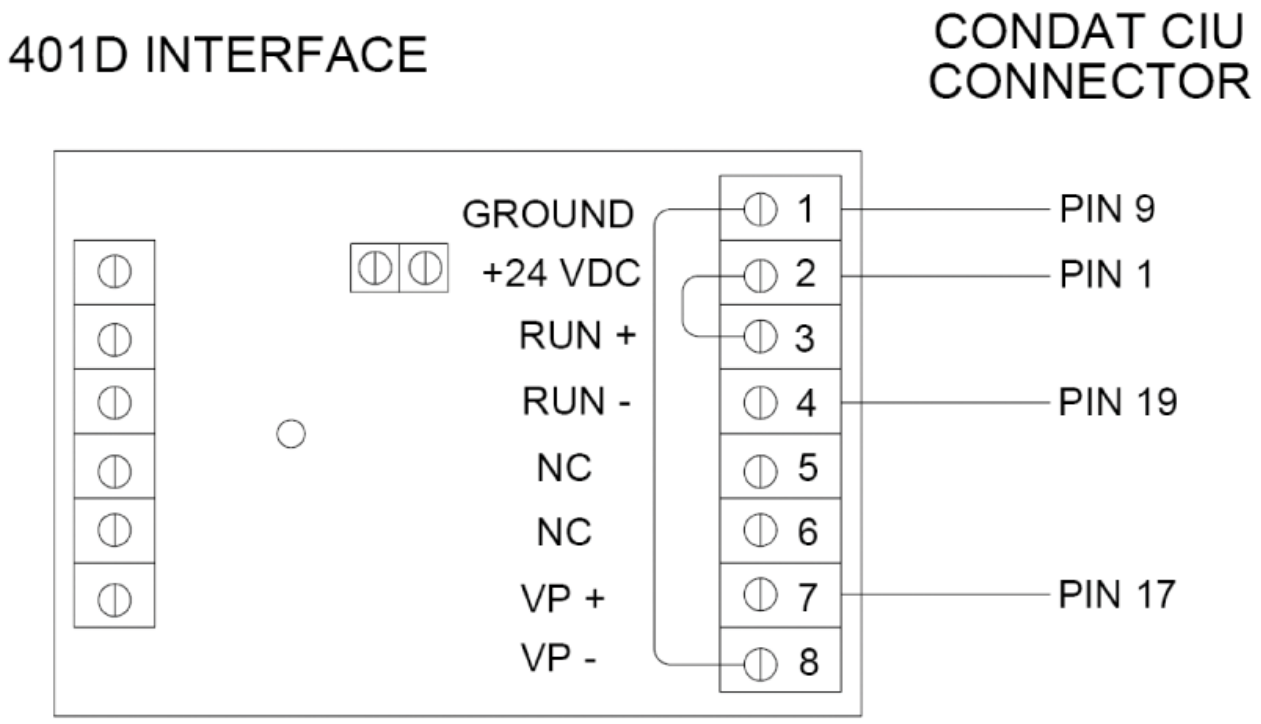


Figure 24: 401D to CONDAT Wiring

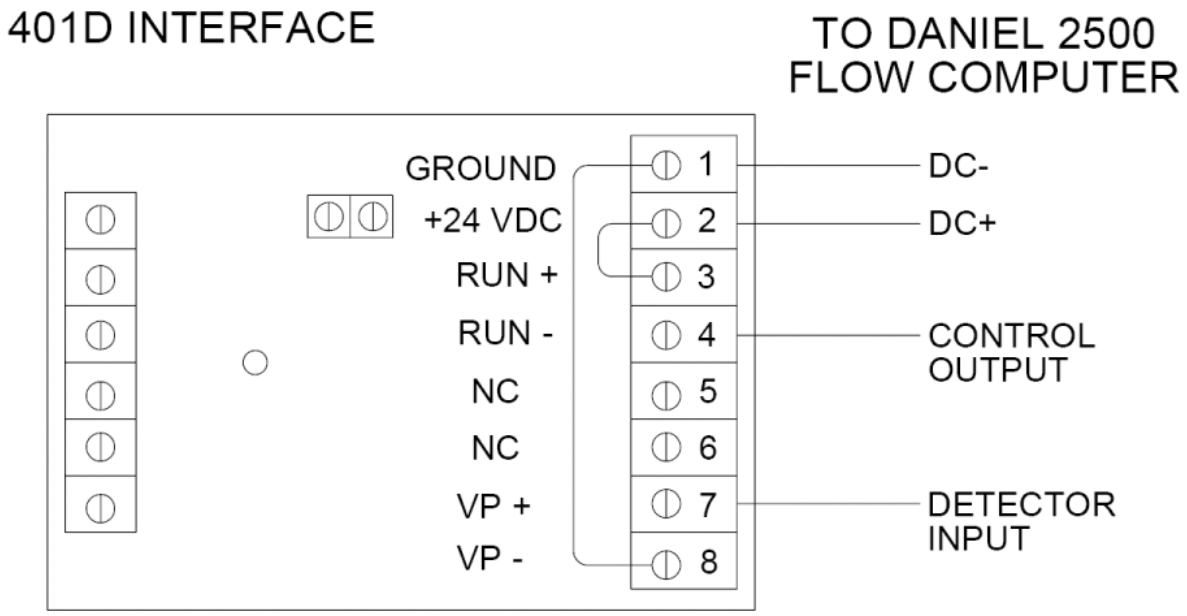


Figure 25: 401D to Daniel 2500 Flow Computer Wiring

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.

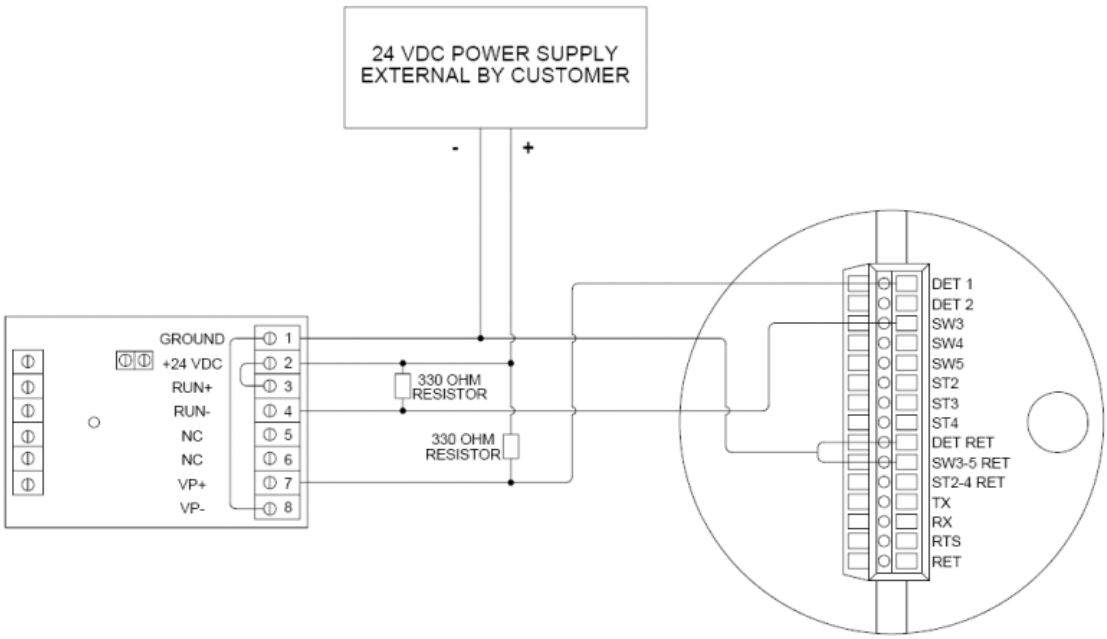


Figure 26: 401D to DYNAMIC Flow Computer Wiring

CHAPTER 6 PROVER MAINTENANCE

6.1 General Prover Maintenance Information

Preventative Maintenance

CALIBRON® 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.

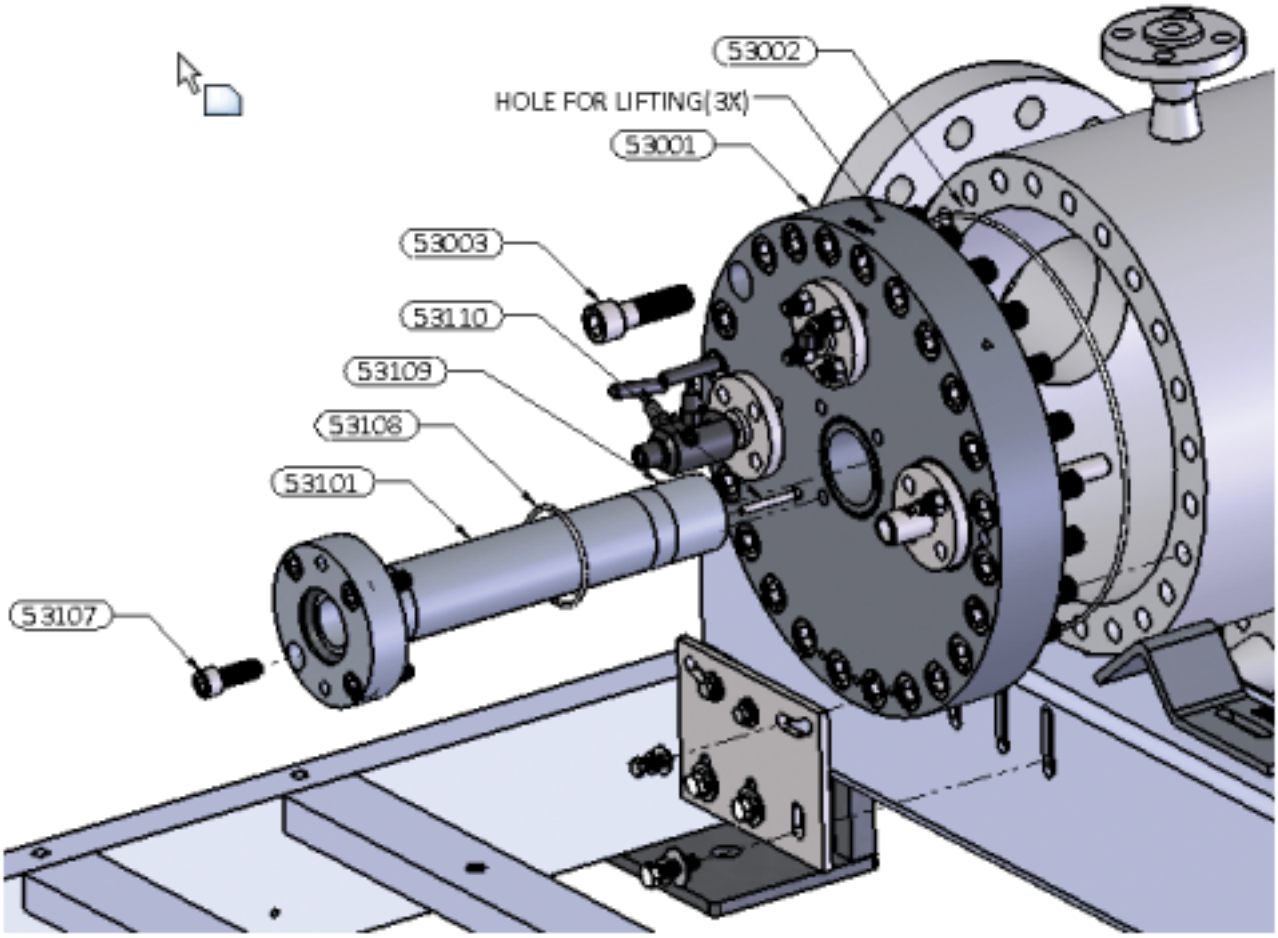
This maintenance section covers most of the routine maintenance procedures to be performed on your prover. Trouble shooting information is contained in Section 4 while wiring diagrams and schematics common to all CALIBRON® small volume models are found in Section 5.

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

6.2 Prover Piston Seal Replacement

Please Note: When referring to an item # in the following instructions, please refer to Figure 27 through Figure 34.

1. Move the piston to the downstream position.
2. Disconnect power from prover.
3. Disconnect prover from line, or block off from line, and drain completely.
4. Disassemble prover drive hood by removing the ¼-20 hex head bolts, starting with the side panels, then the top panel, outer end panel, and inner panel.
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 27 #53101.
6. Remove the 4 bolts, Figure 27 #53107, holding the downstream stop and the seal retainer to the end flange and remove the downstream stop, Figure 27 #53101.
7. Remove the bracket securing the flow tube and downstream flange to the frame.
8. Remove the hex socket bolts, Figure 27 #53003, securing the downstream end flange Figure 27 #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 flange. Remove the last hex socket bolt, and using the hoist to support the flange, remove it from the flow tube.
9. Remove the hex socket bolts, Figure 27 #53110 in order to disasamble downstream seal retainer #53109 from the downstream stop, Figure 27 #53101.

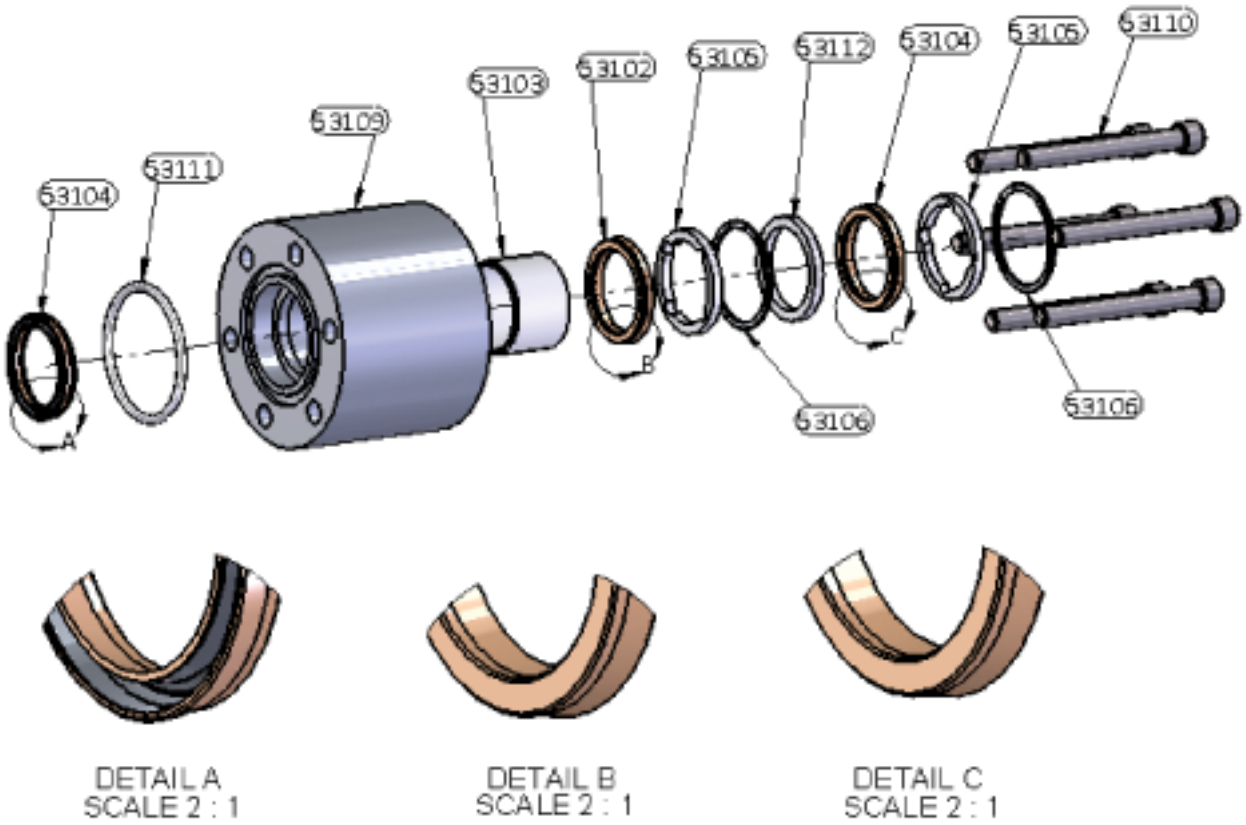


ITEM NO.	DESCRIPTION
53001	DOWNSTREAM FLANGE
53002	O-RING SEAL DOWN STREAM FLANGE
53003	FLANGE RETAINING BOLT
53101	DOWNSTREAM STOP
53107	DOWN STREAM STOP RETAINING BOLT
53108	O-RING SEAL DOWN STREAM STOP
53109	DOWN STREAM SEAL RETAINER
53110	DOWN STREAM SEAL RETAINER BOLT

Figure 27: Downstream Side Exploded View

10. Remove downstream stop and remove seal retainer, Figure 28 #53109.
11. Remove the retaining rings, seals and washers from the downstream seal retainer.
12. Clean and inspect seal retainer.

13. Check seal surfaces for scratches and a surface finish of 12rms. If necessary, polish the seal surfaces.
14. Install new seals and washers in proper orientation (see Figure 28 for correct installation). Note the direction of the seal lips for correctly installing of the new seals. The washers may be cracked or broken; if this is the case make sure they are replaced when new seals are installed. Prepare the downstream seal retainer for reassembly.



ITEM NO.	DESCRIPTION
53102	SHAFT SEAL
53103	IGUS BUSHING
53104	SHAFT SEAL
53105	NOTCHED RYTON WASHER
53109	DOWNSTREAM SEAL RETAINER
53110	SOCKET HEAD CAP SCREW
53111	O-RING SEAL
53112	RYTON WASHER
53106	RETAINING RING

Figure 28: 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.

15. Remove the securing nut and the standard nut, (1) Figure 29, from the guide block (2).

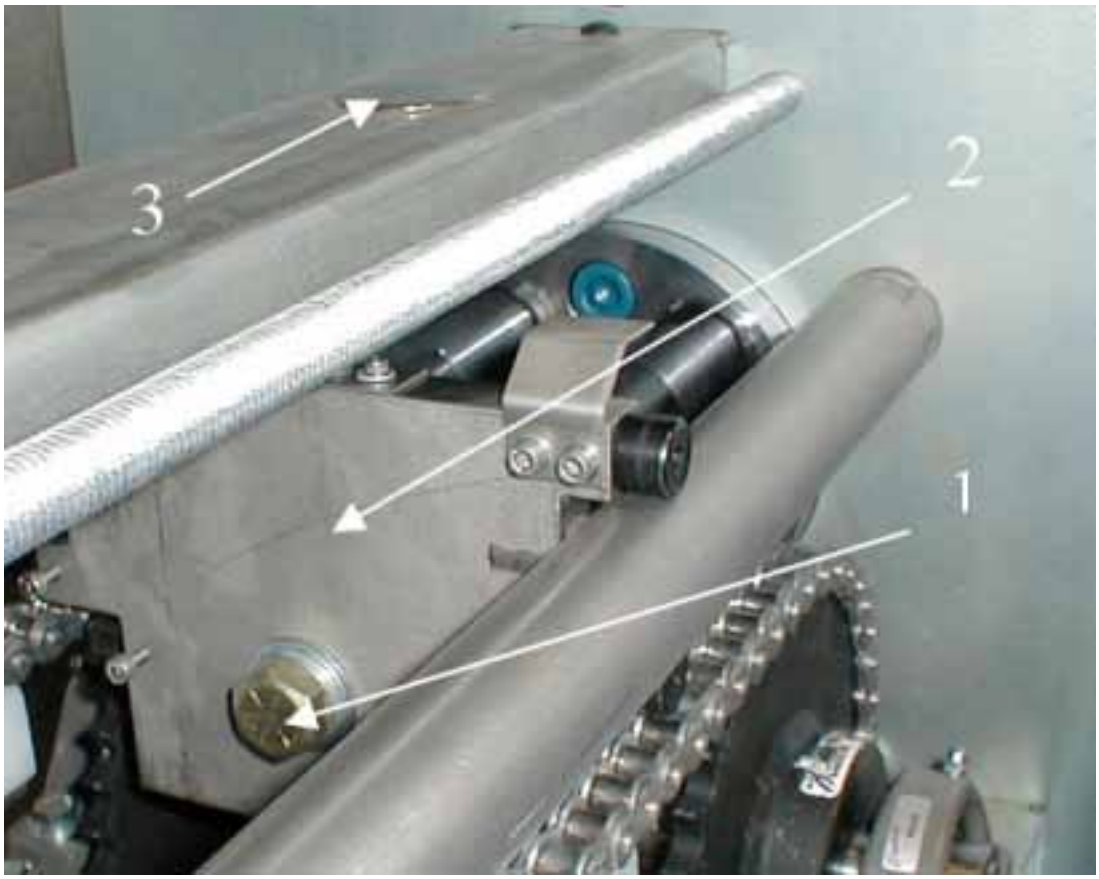
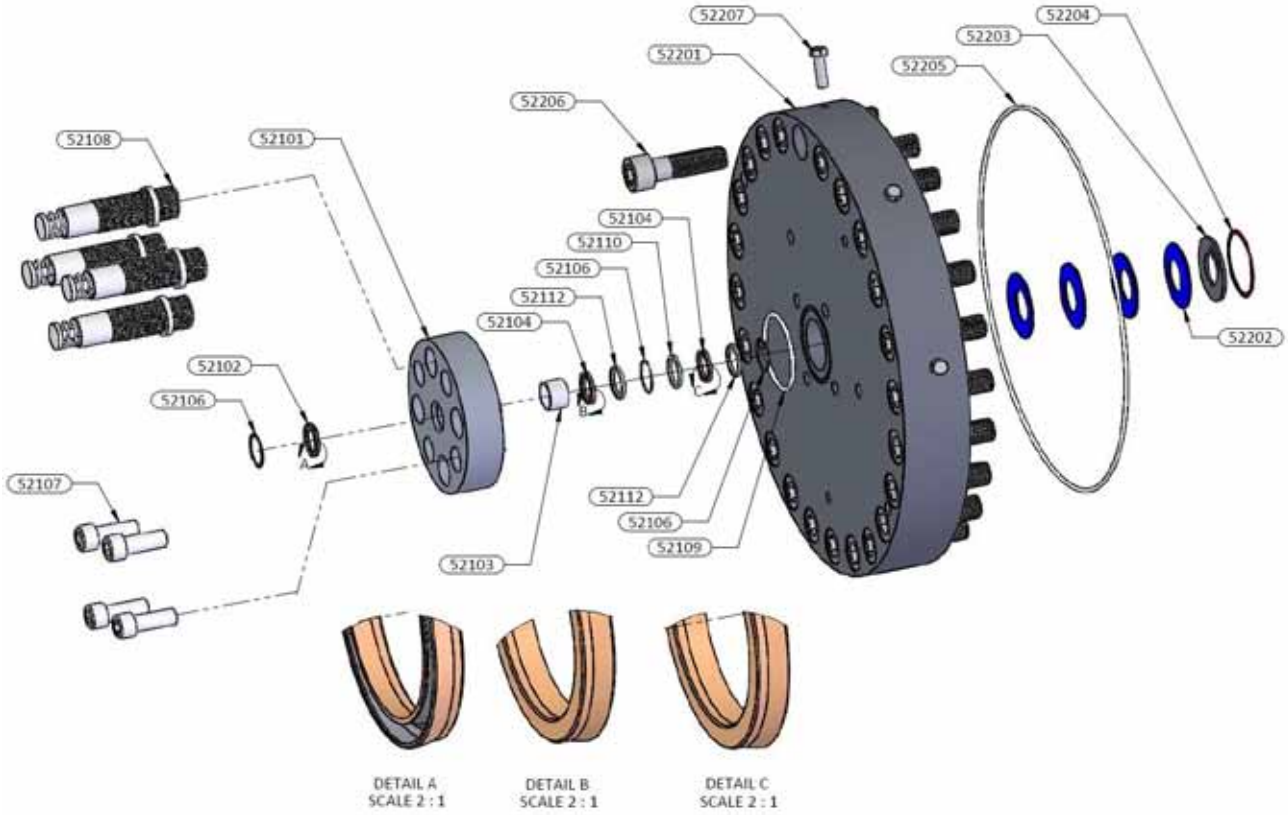


Figure 29: Guide Block Assembly

16. Remove the upstream seal retainer assembly, Figure 30 #52101, from the upstream flange by first removing the shock absorbers, Figure 30 #52108, and then removing the hex socket cap screws, Figure 30 #52107 holding the seal retainer to the end flange. Then remove the seal retainer assembly.
17. Remove the retaining rings, seals and washers from the upstream seal retainer.
18. Clean and inspect seal retainer.
19. Check seal surfaces for scratches and a surface finish of 12rms. If necessary, polish the seal surfaces.
20. Install new seals and washers in proper orientation (see Figure 30 for correct installation). Note the direction of the seal lips for correctly installing of the new seals. The washers may be cracked or broken; if this is the case make sure they are replaced when new seals are installed. Prepare the upstream seal retainer for reassembly.



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
52112	NOTCHED RYTON WASHER

Figure 30: 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.

21. With sufficient personnel and/or a hoist or crane at the downstream end of the prover to lift the piston assembly, pull the piston assembly out of the flow tube. 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, see Figure 31.

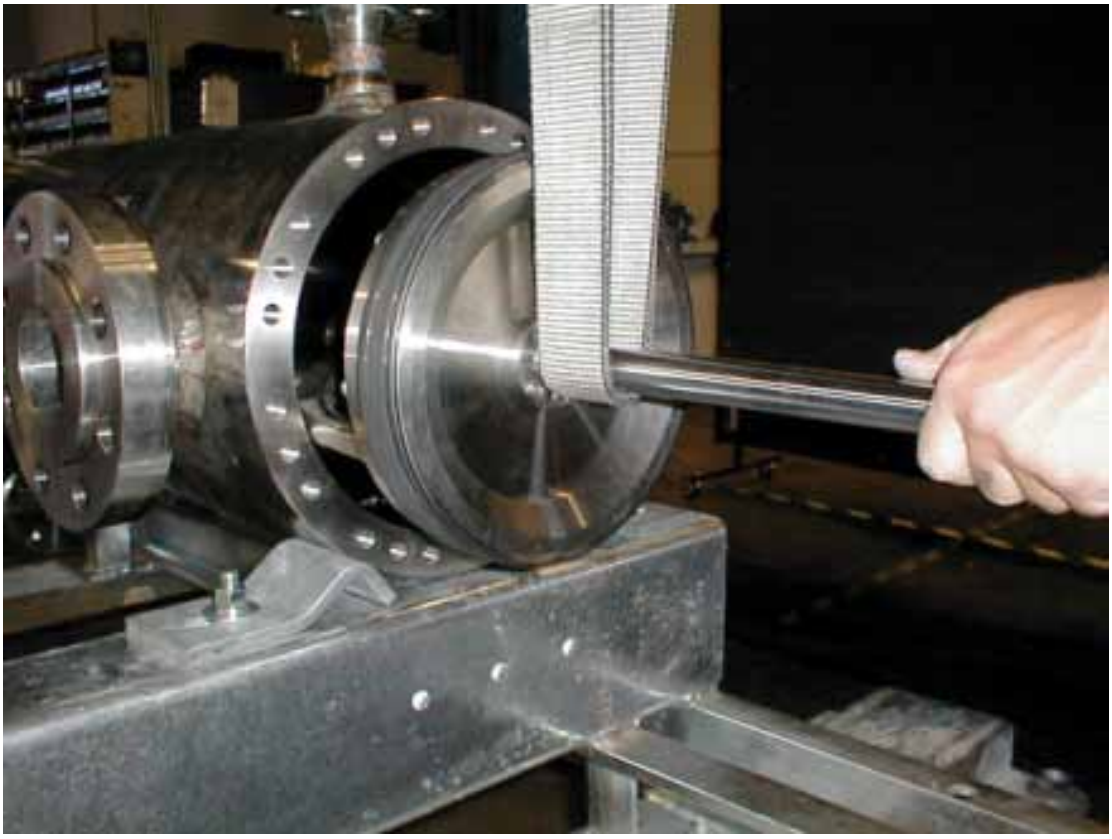


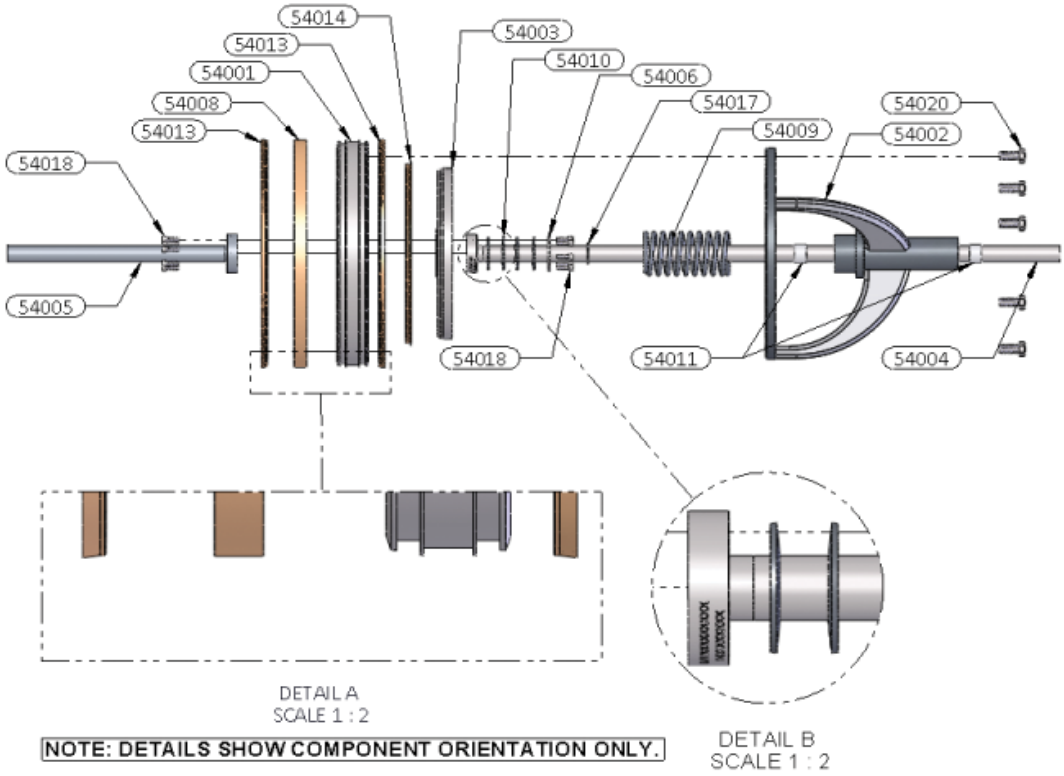
Figure 31: Piston Removal

22. For piston disassembly on most models, use procedure 11a, for older models, use 11b.

11a. Referring to Figure 32, disassemble the piston, by first removing the downstream shaft #54005 from the poppet valve. 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.

11b. Referring to Figure 32, disassemble the piston, by first removing the downstream shaft #54005 from the poppet valve. 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.



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
54009	PISTON SPRING
54010	PISTON BELLEVILLE SPRING
54011	IGUS BUSHING
54013	PISTON SEAL (QUANTITY MAY VARY BASED ON PROVER MODEL)
54014	POPPET SEAL
54017	BELLEVILLE RETAINER SEAL
54018	SOCKET HEAD CAP SCREW
54020	HEX HEAD BOLT

Figure 32: Piston Assembly Exploded View

23. Reassemble the piston by reversing the disassembly procedure and use new seals in all locations, refer to Figure 32. 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: 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.

24. 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 33. 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.

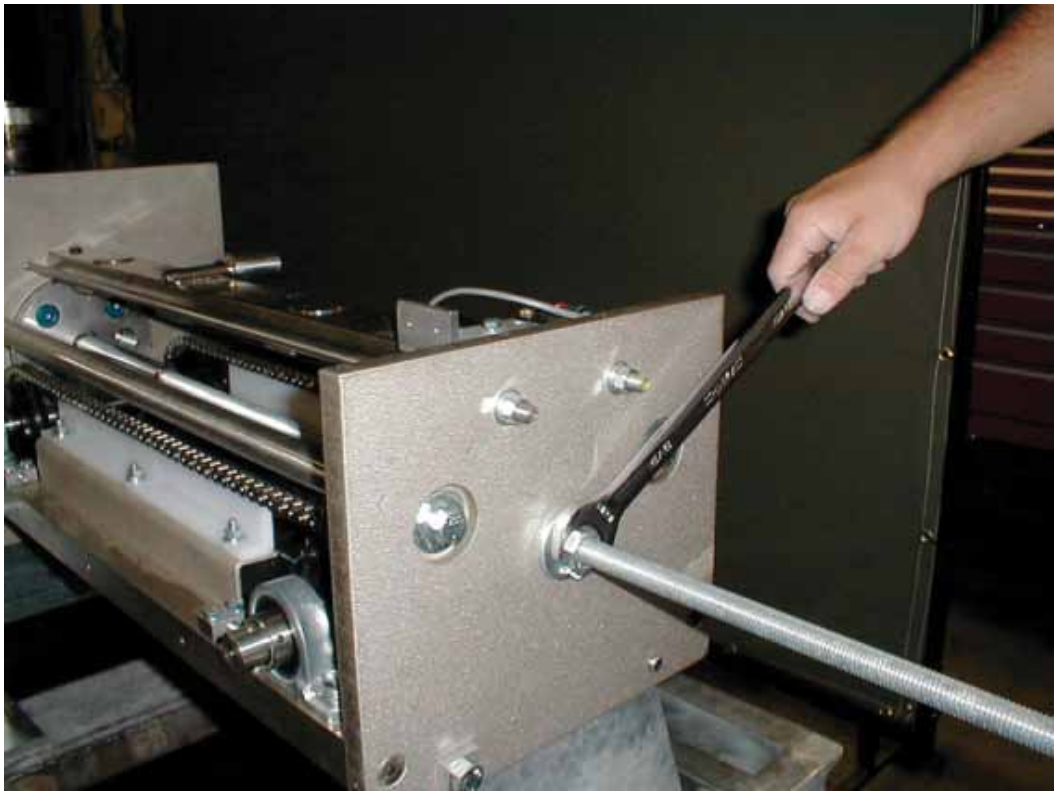


Figure 33: Piston Insertion into Flow Tube – Pulling MethodNote: Refer to Table 15 for bolt torque values for assembling flow prover

25. Put a new o-ring seal, Figure 27 #53002, onto downstream flange, Figure 27 #53001, carefully re-install flange into flow tube. Re-install hex socket bolts, Figure 25 #53003, securing the downstream end flange, Figure 27 #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 4 for bolt torque specifications, and carefully tighten bolts evenly, using a cross pattern, and moving in increments to the full torque value.
26. Assemble the downstream seal retainer, Figure 27 #53109, to the downstream stop, Figure 27 #53101, using hex socket bolts, Figure 27 #53110. Make sure that the O-ring seal, Figure 28 #53111, is in place before the seal retainer is assembled to the downstream stop.
27. Finish re-assembly of the downstream side of the prover using the reverse of the procedure from # 1 through # 9 skipping #4.
28. Install the upstream seal retainer housing, Figure 30 #52101, in the upstream flange, Figure 30 #52001, torque the hex head cap screws to value found in Table 11, and re-install the shock absorbers.
29. Install guide block, washer, and nut onto the stud in the piston shaft; be sure to clean the threads on the stud and be careful not to damage the optic switches. If prover has only a bolt in the piston shaft, it is recommended that it be replaced with a B7 stud and 2H nut. Any prover found using a standard nut in place of the 2H needs to have it replaced with a 2H nut.

NOTE: Upstream flange to flow tube seal does not usually need replacement during normal maintenance, nor is it necessary to remove upstream flange, Figure 30 #52001.

6.3 Bolt Torque Specifications

	Item#	Item#	Item#	Item#	Item#	Item#	Item#	Item#
Model #	52006	52107	53003	53107	53110	54018	54020	See Note 1
05X3C	120 lbf•ft	150 lbf•ft	120 lbf•ft	150 lbf•ft	75 lbf•ft	75 lbf•ft	19 lbf•ft	150 lbf•ft
15X1A	120 lbf•ft	150 lbf•ft	120 lbf•ft	150 lbf•ft	75 lbf•ft	75 lbf•ft	45 lbf•ft	150 lbf•ft
15X2B	120 lbf•ft	150 lbf•ft	120 lbf•ft	150 lbf•ft	75 lbf•ft	75 lbf•ft	45 lbf•ft	150 lbf•ft
25X1A	120 lbf•ft	150 lbf•ft	120 lbf•ft	150 lbf•ft	75 lbf•ft	75 lbf•ft	45 lbf•ft	150 lbf•ft
25X2B	120 lbf•ft	150 lbf•ft	120 lbf•ft	150 lbf•ft	75 lbf•ft	75 lbf•ft	45 lbf•ft	150 lbf•ft
25X3C	500 lbf•ft	150 lbf•ft	500 lbf•ft	150 lbf•ft	75 lbf•ft	75 lbf•ft	45 lbf•ft	150 lbf•ft
25X4 and 5	500 lbf•ft	150 lbf•ft	500 lbf•ft	150 lbf•ft	75 lbf•ft	75 lbf•ft	45 lbf•ft	150 lbf•ft
35X1 thru 5	500 lbf•ft	150 lbf•ft	500 lbf•ft	150 lbf•ft	75 lbf•ft	75 lbf•ft	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

Continued on next page

Continued from previous page

85X1A	295 lbf•ft	150 lbf•ft	295 lbf•ft	150 lbf•ft	75 lbf•ft	11 lbf•ft	170 lbf•ft	250 lbf•ft
85X2B	295 lbf•ft	150 lbf•ft	295 lbf•ft	150 lbf•ft	75 lbf•ft	11 lbf•ft	170 lbf•ft	250 lbf•ft
85X3C	1200 lbf•ft	150 lbf•ft	1200 lbf•ft	150 lbf•ft	75 lbf•ft	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

	Item#	**Item#**	**Item#**	**Item#**	**Item#**	**Item#**	**Item#**	**Item#**
Model #	52006	52107	53003	53107	53110	54018	54020	See Note 1
05X3C	163 Nm	203 Nm	163 Nm	203 Nm	102 Nm	102 Nm	26 Nm	203 Nm
15X1A	163 Nm	203 Nm	163 Nm	203 Nm	102 Nm	102 Nm	61 Nm	203 Nm
15X2B	163 Nm	203 Nm	163 Nm	203 Nm	102 Nm	102 Nm	61 Nm	203 Nm
25X1A	163 Nm	203 Nm	163 Nm	203 Nm	102 Nm	102 Nm	61 Nm	203 Nm
25X2B	163 Nm	203 Nm	163 Nm	203 Nm	102 Nm	102 Nm	61 Nm	203 Nm
25X3C	678 Nm	203 Nm	678 Nm	203 Nm	102 Nm	102 Nm	61 Nm	203 Nm
25X4 and 5	678 Nm	203 Nm	678 Nm	203 Nm	102 Nm	102 Nm	61 Nm	203 Nm
35X1 thru 5	678 Nm	203 Nm	678 Nm	203 Nm	102 Nm	102 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	102 Nm	15 Nm	230 Nm	340 Nm
85X2B	400 Nm	203 Nm	400 Nm	203 Nm	102 Nm	15 Nm	230 Nm	340 Nm
85X3C	1630 Nm	203 Nm	1630 Nm	203 Nm	102 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 15: Bolt Torque Specifications

Note 1: Hex nut, (1) Figure 22, holding guide block, (2) Figure 22, to upstream shaft.

<table>
<tr><th colspan="6">Torque ratings for guide block components</th><th></th></tr>
<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><td>24006</td><td>24012</td><td>24018</td><td>24002</td><td>24019</td></tr>
<tr><td>Screw</td><td>Screw</td><td>Screw</td><td>Cam follower</td><td>Cam follower</td></tr>
<tr><td>5</td><td rowspan="6">13 Nm
9.6 lbf•ft</td><td rowspan="6">26.8 Nm
19.8 lbf•ft</td><td rowspan="6">31.7 Nm
43.0 lbf•ft</td><td colspan="2">47.5 Nm 35 lbf•ft</td><td>5</td></tr>
<tr><td>15</td><td colspan="2" rowspan="3">129 Nm
95 lbf•ft</td><td>15</td></tr>
<tr><td>25</td><td>25</td></tr>
<tr><td>35</td><td>35</td></tr>
<tr><td>50</td><td>340 Nm
250 lbf•ft</td><td>881 Nm
650 lbf•ft</td><td>50</td></tr>
<tr><td>85</td><td>85</td></tr>
<tr><td>120</td><td colspan="2">1700 Nm
1250 lbf•ft</td><td>120</td></tr>
</table>

Table 16: Guide Block Bolt Torque Specifications

Note: See Figure 34 for items referenced in Table 16.

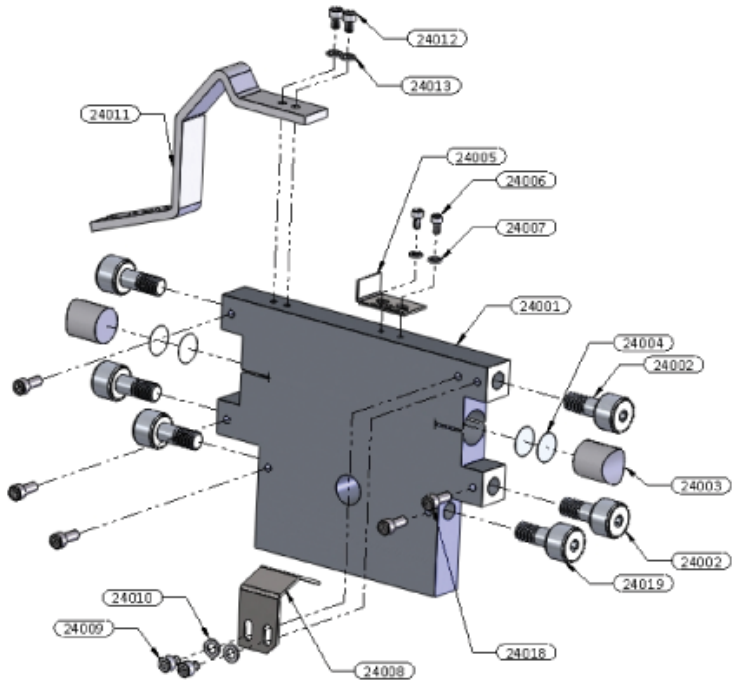


Figure 34: Guide Block Exploded View

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

6.4 Replacement of Upstream Shaft Seals

1. Refer to Section 6.2. Follow steps 1 through 4, step 15 through 18, then steps 19, 20, 28, 29 and then reverse steps 4 through 1 for final re-assembly of unit.

6.5 Replacement of Downstream Shaft Seals

1. Refer to Section 6.2. Follow steps 1 through 3, then steps 5, 6, 9, 10, 11, 12, 13, 14 and 26, and then reverse steps 3 through 1 for final re-assembly of unit.

6.6 Drive System Maintenance

The CALIBRON® 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 33. Gearbox was filled at the factory with **Mobil SHC 626 gear oil (ISO viscosity 68).** If the oil level is low, drain the remaining oil and refill the reducer to the correct level - do not mix types of oil.

NOTE: Mobil SHC 626 is satisfactory for temperatures from -40°C to 66°C (-40°F to 150°F).

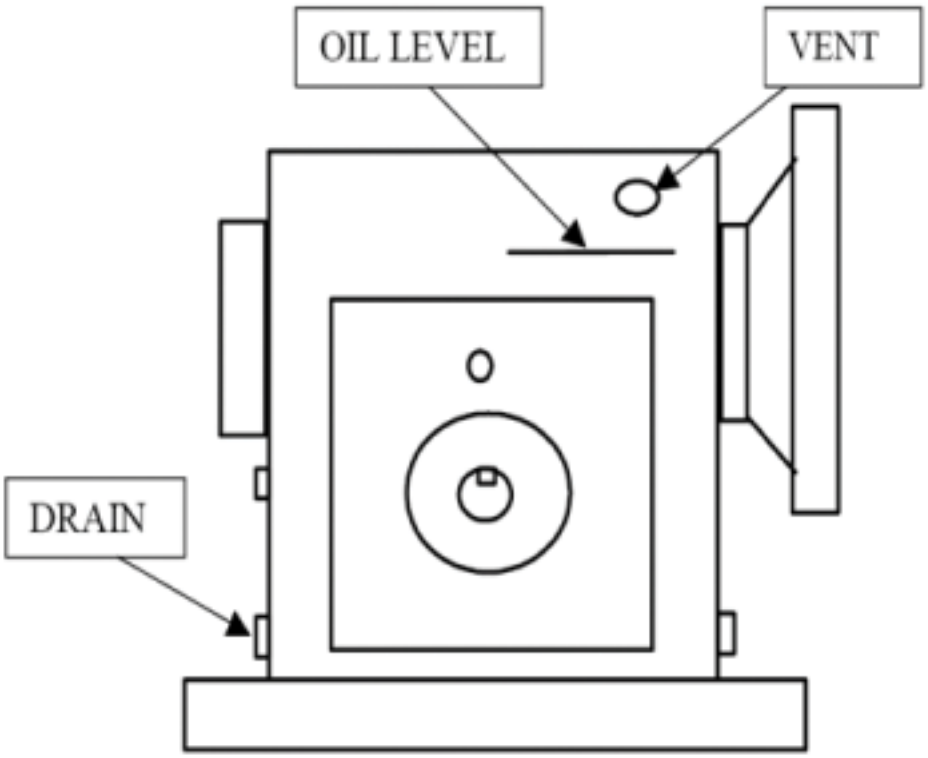


Figure 35: Gearbox Lubrication Diagram

6.7 Volume Switch Replacement

If optical volume switch replacement is necessary, as determined by trouble shooting procedures found in Section 4, follow steps 1 through 5.

1. Remove (3) as shown in Figure 29 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 CALIBRON® 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 36 and 37 below illustrate a correct optical switch installation.

Figure 36: Correct Optical Switch Installation Bottom View

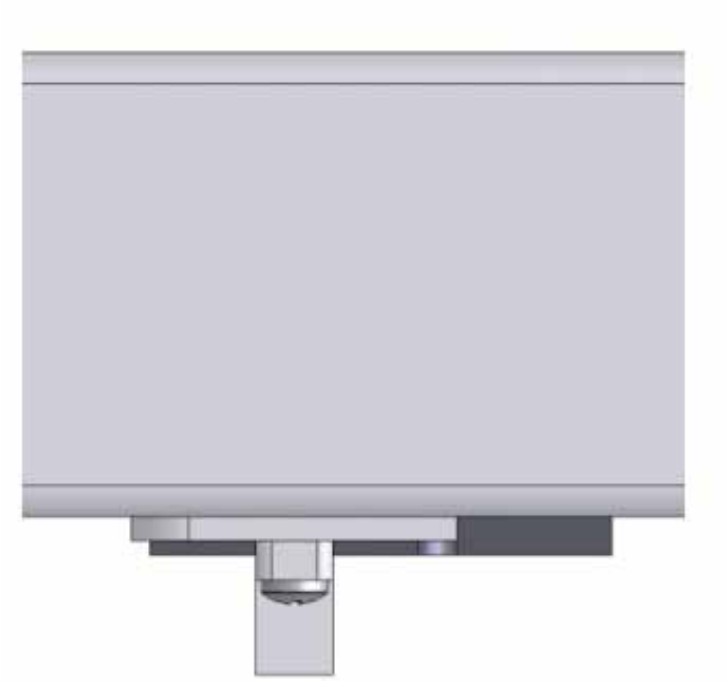


Figure 37: Correct Optical Switch Installation Side View

Figure 38, Figure 39, and Figure 40 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 38: Improper Optical Switch Installation Bottom View 1

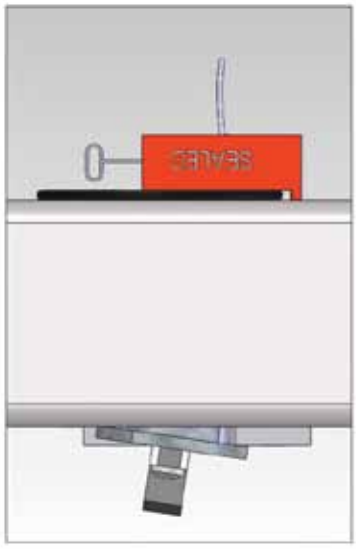


Figure 39: Improper Optical Switch Installation Side View

Figure 40: Improper Optical Switch Installation Bottom View 2

6.8 After Sales Support.

Honeywell GTS (Global Technical Services) support the Calibron® 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 CALIBRON® 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

6.9 Frequently asked questions.

What type of prover is the CALIBRON®?	The CALIBRON® prover is classified as a **Small Volume Unidirectional Piston Displacement Prover.**
Why is the CALIBRON® 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 CALIBRON® 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 CALIBRON® 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 CALIBRON® 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 CALIBRON® 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 CALIBRON® 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 CALIBRON® 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 CALIBRON® prover?	Correct installation of the CALIBRON® 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 CALIBRON® provers supported?	Honeywell Global Technical Support (GTS) is the focal point for all CALIBRON® 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 CALIBRON® prover?	Contact your local sales specialist. There is a CALIBRON® specialist located in each global region (Americas, Asia Pacific and Europe Middle-East & Africa - EMEA).

Table 17: Frequently Asked Questions.

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Roswell, GA 30076-4908
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www.honeywellenraf.com

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Honeywell Enraf