SYNCROTRAK®

Liquid Flow Prover
Operation Manual

For
Models 05, 15, 25, 35, 50, 85, 120
U.S. Patent #5,052,211

21st Edition
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WARNINGS

Please read this section carefully before installing, using, or maintaining your SYNCROTRAK® flow 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 operation procedure.

1. **Before** performing any operations with the SYNCROTRAK® flow 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. 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 torqued to the correct specifications.
   d. No foreign bodies, i.e.: weld slag, will be introduced into the prover.

3. Pressurize system slowly to avoid shock which could result in damage to prover, personnel, and/or lines.

4. Be certain that ALL applicable electrical codes are met when connecting and using the SYNCROTRAK® flow prover, especially in hazardous area locations. The SYNCROTRAK® prover is certified by one of the following:
   - CSA/US certified for Class 1 Group D T2C
   - CSA/US certified for Class 1 Group C T3B
   - ATEX certified for EEx d [ia] ia IIA T4
   It is the responsibility of the user to satisfy the relevant electrical code requirements on connections made to the SYNCROTRAK® flow prover.

5. Covers must be in place on all explosion-proof electrical conduit and fittings at all times when the prover is energized. If it is necessary to troubleshoot electrical components, it must be done in a “safe” area following site procedure.

6. All drive covers **must** be in place during operation or anytime electrical power is applied to the prover to avoid personal injury.

7. Do not alter or modify the SYNCROTRAK® flow 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.

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

9. Prover vent and drain lines must be plumbed to drain/collection sump. Do not vent directly from bleed valves as personal injury may occur.

10. Prover frame must be correctly earth grounded prior to electrical service connection.

11. Follow all hazardous warning stickers! Pinch and crush points are present on this equipment in addition to electrical shock hazards.
Important Notice to ALL SYNCROTRAK® flow prover users:

It is mandatory that all SYNCROTRAK® flow 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 system. Due to the fact that each installation will require a different pressure relief valve (based upon system pressure, fluid properties, flow rate, etc.), the following equation should be used to size the appropriate relief valve. This equation has been taken from API 520 Section 3.8:

\[
A = \frac{Q}{38K_dK_wK_vK_p}\sqrt{\frac{G}{p_1-p_2}}
\]

API 520, Section 3.8, Equation 3.9

where:

- \(A\) = required effective discharge area, \(\text{in}^2\)
- \(Q\) = flow rate, U.S. gpm
- \(K_d\) = rated coefficient of discharge that should be obtained from the valve manufacturer. For a preliminary sizing, an effective discharge coefficient can be used as follows:
  - = 0.65 when a pressure relief valve is installed with or without a rupture disk in combination,
  - = 0.62 when a pressure relief valve is not installed and sizing is for a rupture disk in accordance with API 520, Section 3.11.1.2
- \(K_w\) = correction factor due to back pressure. If the back pressure is atmospheric, use a value for \(K_w\) of 1.0. Balanced bellows valves in back pressure service will require the correction factor determined from API 520 Figure 31. Conventional and pilot operated valves require no special correction, See API 520 Section 3.3
- \(K_c\) = combination correction factor for installations with a rupture disk upstream of the pressure relief valve (see API 520 Section 3.11.2).
  - = 1.0 when a rupture disk is not installed,
  - = 0.9 when a rupture disk is installed in combination with a pressure relief valve and the combination does not have a published value.
- \(K_v\) = correction factor due to viscosity as determined from API 520 Figure 36 or from the following equation:

\[
= \left(0.9935 + \frac{2.878}{R^{0.5}} + \frac{34.2}{R^{1.5}}\right)^{-1.0}
\]

- \(G\) = specific gravity of the liquid at the flowing temperature referred to water at standard conditions.
- \(p_1\) = upstream relieving pressure, psig. This is the set pressure plus allowable overpressure (typically 10%).
- \(p_2\) = back pressure, psig.

The above equation will allow the user to determine the appropriate pressure relief valve; however, it is strongly advisable that a relief valve manufacturer be contacted, as their sizing methods may differ from that shown here.
The pressure rating of the relief valve is calculated by taking the maximum operating pressure and adding 10% for a momentary overpressurization or line surge of the system. This value is the same as \( p_1 \) in the above equation. If more information is needed on the sizing, rating, type, etc. of pressure relief valves, Honeywell Enraf recommends contacting the relief valve manufacturers directly.

IMPORTANT: WATCH DISCHARGE FROM RELIEVING DEVICES!

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

As with all pressure containing equipment, it is essential to protect your SYNCROTRAK® Flow 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. Please remember to place permanent structures of any type outside the required Service Clearance area detailed in Figure A. 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.

Figure A: Prover Service Clearance Diagram
INTRODUCTION

1.1 Overview

This manual provides the necessary information and procedures for the proper operation of the SYNCROTRAK® Flow Prover manufactured by Honeywell Enraf Americas, Inc.

The SYNCROTRAK® Flow Prover uses a wear and corrosion resistant precision honed 12 RMS finish flow tube. Contained within the flow tube is the piston/bypass valve arrangement. Proof runs are made with minimal disturbance to the flow. 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 unlatched from the return mechanism, allowing the poppet valve to close and the flowing fluid to move the piston through the measurement cylinder.

Slotted precision optical switches are utilized to define volume displaced. These switches are reliable, fast (5 X 10 -6 sec), 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 SYNCROTRAK® are filled TFE. 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.

The contents of this manual provide general information and operational characteristics for the SYNCROTRAK® flow 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 consult the SYNCROTRAK® Prover Maintenance manual or consult your factory approved service center for this information.

1.2 General Description

- 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.
- Low consumables design reduces operating cost.
• Quickest and easiest seal change of any small volume prover. 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 Design Constraints

SYNCROTRAK® FLOW PROVER DESIGN SPECIFICATIONS:

Operating temperature range: -40 degrees F to 176 degrees F (-28.8 degrees C to 80 degrees C)

Operating pressure range: Dependent on Prover flange rating, see Table 1 below.

Table 1: Prover Operating Pressure Ratings

<table>
<thead>
<tr>
<th>ANSI B16.5 FLANGE RATING</th>
<th>SELECT ONLY 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>150# Raised face connection flanges.</td>
</tr>
<tr>
<td>2</td>
<td>300# Raised face connection flanges.</td>
</tr>
<tr>
<td>3</td>
<td>600# Raised face connection flanges (S15 &amp; S120 Not Available).</td>
</tr>
<tr>
<td>4</td>
<td>900# Raised face connection flanges (S15, S65 &amp; S120 Not Available).</td>
</tr>
<tr>
<td>5</td>
<td>600# Ring joint connection flanges (S15, S65 &amp; S120 Not Available).</td>
</tr>
<tr>
<td>6</td>
<td>150# Ring joint connection flanges.</td>
</tr>
<tr>
<td>7</td>
<td>300# Ring joint connection flanges.</td>
</tr>
<tr>
<td>8</td>
<td>600# Ring joint connection flanges (S15 &amp; S120 Not Available).</td>
</tr>
<tr>
<td>9</td>
<td>1500# Ring joint connection flanges (S15 &amp; S120 Not Available).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OPERATING PRESSURE RATING</th>
<th>SELECT ONLY 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>275 PSI Pressure rating (For use with Table IV 1 &amp; 6).</td>
</tr>
<tr>
<td>B</td>
<td>720 PSI Pressure rating (For use with Table IV 2 &amp; 7).</td>
</tr>
<tr>
<td>C</td>
<td>1440 PSI Pressure rating (For use with Table IV 3 &amp; 8).</td>
</tr>
<tr>
<td>D</td>
<td>2160 PSI Pressure rating (For use with Table IV 4 &amp; 5).</td>
</tr>
<tr>
<td>E</td>
<td>3600 PSI Pressure rating (For use with Table IV 9).</td>
</tr>
</tbody>
</table>

Prover dimensions: See information Figure 1 below.

Figure 1: Prover Dimensions
Flow rate specifications: See Table 2 below.

### Table 2: Prover Flow Rate Capabilities

<table>
<thead>
<tr>
<th>Flow Rate (BPH)</th>
<th>Maximum Flow (GPM)</th>
<th>Maximum Flow (M³/hr)</th>
<th>Displaced Volume (GALLONS)</th>
<th>Displaced Volume (LITERS)</th>
<th>Approximate Shipping Weight (LB)</th>
<th>Approximate Shipping Weight (KG)</th>
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<tr>
<td>05</td>
<td>7.15</td>
<td>497</td>
<td>113</td>
<td>19</td>
<td>1,200</td>
<td>545</td>
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<td>15</td>
<td>2,140</td>
<td>1,728</td>
<td>346</td>
<td>76</td>
<td>4,150</td>
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<tr>
<td>25</td>
<td>3,570</td>
<td>2,455</td>
<td>567</td>
<td>76</td>
<td>4,350</td>
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<tr>
<td>35</td>
<td>5,000</td>
<td>3,297</td>
<td>795</td>
<td>95</td>
<td>5,250</td>
<td>2,386</td>
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<tr>
<td>60</td>
<td>7,220</td>
<td>4,059</td>
<td>1,146</td>
<td>151</td>
<td>7,850</td>
<td>3,540</td>
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<tr>
<td>85</td>
<td>12,600</td>
<td>7,784</td>
<td>1,988</td>
<td>284</td>
<td>12,500</td>
<td>5,590</td>
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<tr>
<td>120</td>
<td>17,600</td>
<td>11,413</td>
<td>2,784</td>
<td>454</td>
<td>14,500</td>
<td>6,590</td>
</tr>
</tbody>
</table>

### 1.4 Tests and Certifications

The SYNCROTRAK® Flow Prover has been factory calibrated using NIST traceable test equipment. The water draw was performed by the gravimetric method using the Honeywell Enraf dual-valve water draw 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 other customer requirements). Before using the SYNCROTRAK® Flow Prover, be certain that the setup information in the flow computer, as given by the certification sheet for the prover, is correct.

### 1.5 Principle of Operation

![Figure 2: Prover in Stand-By Mode](image)

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.
2 INSTALLATION

2.1 Receipt of Equipment

The SYNCROTRAK® Flow Prover is pressure 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. Be sure to have the serial number and sales order number of your order available to help expedite any needed assistance.

2.2 Mechanical Installation

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

When installing the SYNCROTRAK®, 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 Figure 5 for connecting the SYNCROTRAK® 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.

**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 SYNCROTRAK® flow prover is equipped with integral lifting points. Figure 4 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 4: Prover Lifting Diagram**
2.3 Electrical Connection

The SYNCROTRAK® prover is certified by one of the following:

- CSA/US certified for Class 1 Group D T2C
- CSA/US certified for Class 1 Group C T3B
- ATEX certified for EEx d [ia] ia IIA T4

Be certain to conform to all applicable national and local electrical codes when making electrical connections to the SYNCROTRAK® 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.
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, 11.2.3, 12.2.1, 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 11.2.3.5, Wagenbreth equation is the API standard used for the density determination of water.

The displaced volume has been calibrated as described in the MPMS chapters 4.3.7.1, 11.2.3, 12.2.1, 12.2.4, 4.9.1, 4.9.2, and 4.9.4.

The SYNCROTRAK® 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. SYNCROTRAK® 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 SYNCROTRAK® 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. 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 0-10 psid 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 6.
3.2.2 Procedure

1. Refer to Figure 6 below and install the differential pressure gauge (1) between the inlet and outlet ends of the prover.
2. Block off inlet and outlet with flanges or blocking valves.
3. Fill the prover with liquid and vent off all air from the system.
4. Power up the proving computer and the SYNCROTRAK®.
5. From the proving computer, initiate a proving run to pull the piston upstream.
6. Remove the plug from the drive cover end panel.
7. Install the differential pressure creator (2) in the threaded hole provided in the drive system end plate and hand tighten, refer to Figure 6.
8. Rotate the adjustment screw (3) Figure 6 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 5 psid has been created.
9. Look the prover over for any obvious external leaks.
10. Observe the differential pressure gauge for a period of 15 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.

Figure 6: Static Leak Detection Set-up
3.3 Volumetric Water Draw

**Equipment**

1. Water draw kit: Contact Honeywell Enraf representative or factory directly to obtain a water draw kit, Figure 7.

2. Source of clean, potable water, capable of approximately 10 gpm at 25-100 psi. Pump or water supply must have steady, non-pulsating pressure.

3. Certified volume test measures (conforming to API chapter 4 section 7) traceable to the U.S. NIST (or other certifying agency if outside U.S.). Ideally the test measure will 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 20-gallon test measure.

4. Certified high resolution pressure gauge: 0-100 psig

5. Three traceable thermometers with 0.2 degree graduations, see Figure 8.

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, see Figure 8.

![Figure 7: Water Draw Kit](image-url)
Figure 8: Water Draw P&T Kit

Procedure

Water draw notes:

Perform steps 9-19 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 flange or double block and bleed valve.
3. Refer to SYNCROTRAK® water draw configuration, Figure 9, and install Honeywell Enraf available water draw kit, see Figure 7 and Figure 8. 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 downstream prover bleed valve and install P&T kit.

4. Connect water supply to prover, refer to Figure 9.

5. Connect prover control cable to water draw valve controller, see Figure 5 and Figure 10.

6. Turn water supply on, and open valves V1, V2, and V3. After all air is bled off, close V2 and V3. Open V4 and V5 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 test measures under the water draw valves.

10. 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.

11. 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. At the first volume switch the controller will signal the valves to switch, and start water flowing into the test measure.

12. Record the pressure \( P \) 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. Allow test measure to fill. If one can is used which is the same as the displaced volume of the prover, one may open valve V6 to speed up the flow until the can is nearly filled, then close off V6 & allow the calibration valve to switch back into the wastewater container.

14. Record temperature \( T_\text{d} \) at T2, which is 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.

15. Record fluid temperature \( T_\text{p} \) at T1.

16. If multiple cans are used, close valve V4, check level, measure temperature, and record data.

17. Repeat above if more test measures are to be used to contain displaced volume.

18. To fill last can, which must be under the solenoid valve and V6, open V6 until can is nearly full, then close V6 to allow water draw valve to perform shut off at end of volume. Carefully record can level \( V \) and temperature of contents \( T_\text{tm} \).
19. Repeat steps 9 through 19 as necessary to obtain the required number of runs.

20. Calculate prover volume per Section 3.5.

A copy of Table 3 can be used to enter water draw data. A Lotus 1-2-3 or Excel readable file is available from Honeywell Enraf which will calculate the corrected prover volume using the gravimetric method.

Figure 9: Water Draw Plumbing Diagram
### Table 3: Volumetric Water Draw Data Sheet

<table>
<thead>
<tr>
<th>Volumetric Water Draw Data Sheet</th>
<th>Fill 1</th>
<th>Fill 2</th>
<th>Fill 3</th>
<th>Fill 4</th>
<th>Fill 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prover Serial Number:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prover Model Number:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Report Number:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base Temperature ($T_b$):</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base Measure Volume—from calibration cert. ($BMV$):</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume Measure Thermal Coefficient ($Gc$):</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compressibility Factor (water) ($CPL$):</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flow Tube Area Thermal Expansion Coefficient ($Ga$):</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Detector Linear Thermal Expansion Coefficient ($Gl$):</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Modulus of Elasticity of flow tube ($E$):</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flow Tube Inside Diameter (inches) ($ID$):</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flow Tube Wall Thickness (inches) ($WT$):</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fill Time (minutes) =</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flow Rate (Nominal Volume/Fill Time) =</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature Prover ($T_p$) =</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature Detector ($T_d$) =</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prover Pressure ($P_p$) =</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scale Reading on Volume Measure ($SR$) =</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume of Water adjusted for $SR$ ($BMVa$) =</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test Measure Temperature ($T_{tm}$) =</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correction for Temp. Differential ($C_{tdw}$) =</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effect of Temp. on Test Measure ($CTS_{tm}$) =</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effect of Temperature on Prover ($CTS_{p}$) =</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combined effect of $CTS_{M}$ &amp; $CTS_{P}$ ($CCT_{s}$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume Waterdraw ($WD$) =</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effect of Pressure on Flow Tube ($CPS_{p}$) =</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compressibility of water in prover ($CPL_{p}$) =</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Water Drawn Volume ($WD_{zb}$) =</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.4 Gravimetric Water Draw

Equipment

1. Water draw kit: Contact Honeywell Enraf representative or factory directly to obtain a water draw kit, Figure 7.

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 200 lb. and +/- 0.01 lb. resolution. (1 part out of 20,000 or better resolution)

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 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: 0-100 psig

7. Three traceable thermometers with 0.2 degree graduations, see Figure 8.

8. Water draw data sheet, Table 4.

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, see Figure 8.

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 SYNCROTRAK® water draw configuration, Figure 9, and install Honeywell Enraf available water draw kit, see Figure 7 and Figure 8. 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 downstream prover bleed valve and install P&T kit.

4. Connect water supply to prover, refer to Figure 9.

5. Connect prover control cable to water draw valve controller, see Figure 5 and Figure 10.

6. Turn water supply on, and open valves V1, V2, V3. After all air is bled off, close V2 and V3. Open V4 and V5 and allow water to circulate until the temperature has stabilized and is not changing.

7. 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.

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 only be on during the two volume switches. Also apply electrical power to the prover.

9. Calibrate scales with test weights totaling +/- 10% of draw weight per API 4.9.4.

10. With volume catch container on the scales and under water draw valve, tare scales.

11. 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.

12. 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.

13. The draw can be sped up by opening valve V6 after the valves have switched to flowing into the volume catch container. 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 1/2" or 1/2 gal prior to solenoid draw valve switching.

14. Record ambient temperature ($T_a$)

15. 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.

16. Record fluid temperature ($T_p$) at T1 (at prover).

17. Allow catch container to fill until valve switches.

18. Record scale reading ($W_w$). Drain container and tare scales.

19. Repeat above procedure, 10 through 17, until the desired # of draws are attained. (Usually 5 consecutive draws within the desired tolerance).

20. Calculate results per Section 3.5.

A copy of Table 4 can be used to enter water draw data. A Lotus 1-2-3 readable file is available from Honeywell Enraf which will calculate the corrected prover volume using the gravimetric method.
Table 4: Gravimetric Water Draw Data Sheet

<table>
<thead>
<tr>
<th>Gravimetric Water Draw Data Sheet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>$T_a$ = Detector bar temperature =</td>
</tr>
<tr>
<td>$T_p$ = Prover temperature =</td>
</tr>
<tr>
<td>$T_s$ = Ambient air temperature =</td>
</tr>
<tr>
<td>$P_p$ = Prover pressure =</td>
</tr>
<tr>
<td>$W_w$ = Weight of Water =</td>
</tr>
<tr>
<td>$G_l$ = Coefficient of linear expansion = (switchbar)</td>
</tr>
<tr>
<td>$Ga$ = Coefficient of flow tube area thermal expansion =</td>
</tr>
<tr>
<td>$DENtw$ = Density of test weights =</td>
</tr>
<tr>
<td>$E$ = Modulus of elasticity (flow tube) =</td>
</tr>
<tr>
<td>$WT$ = Wall Thickness of flow tube =</td>
</tr>
<tr>
<td>$ID$ = Inside Diameter of flow tube =</td>
</tr>
<tr>
<td>$T_{ac} = (T_a - 32) \times 5 ÷ 9 =$</td>
</tr>
<tr>
<td>$T_{pc} = (T_p - 32) \times 5 ÷ 9 =$</td>
</tr>
<tr>
<td>$DENa = 0.0012*(1-(0.032*\bar{h}/1000))*(520/(T_a+460))$</td>
</tr>
<tr>
<td>$RHO_w = \text{Per API 11.2.3}$</td>
</tr>
<tr>
<td>$M_w = (W_w \times (1 - (Da÷Dtw))) + (1-(Da÷RHO))$</td>
</tr>
<tr>
<td>$V_w = M_w ÷ RHO_w =$</td>
</tr>
<tr>
<td>$CPLp = 1 + (Pp * 0.0000322) =$</td>
</tr>
<tr>
<td>$CTSp = (1+((Tp-Tb)*Ga)*1+((Td-Tb)*Gf))$</td>
</tr>
<tr>
<td>$CPSp = 1 + ((Pp \times ID) ÷ (E \times WT)) =$</td>
</tr>
<tr>
<td>$CCF = CPLp<em>CTSp</em>CPSp =$</td>
</tr>
<tr>
<td>$V_{60} = V_w ÷ CCF =$</td>
</tr>
</tbody>
</table>
3.5 Calculations

Volumetric Water Draw Calculations

Water draw volume corrections taken from API Manual of Petroleum Measurement Standards 12.1.11.2.1, 12.1.11.2.2, 12.1, 4.9.1, 4.9.2 and Appendix B.4 F2.a, 11.2.3.5

Symbols and Calculations from API 12.2.4:

Given:

\( RHO_{tm} \) = Density of liquid (water) in test measure. (API 11.2.3)
\( RHOp \) = Density of liquid (water) in prover. (API 11.2.3)
\( CPL \) = Correction for the compressibility of liquid. (For water 3.2E-6)
\( T_b \) = Base calibration temperature. (60 deg. F. in US)
\( Ga \) = Area coefficient of expansion for flow tube. (API 12.2.1.11.2.1)
\( Gi \) = Linear coefficient of expansion for detector. (API 12.2.1.11.2.1)
\( Gc \) = Coefficient of expansion for the test measure (from calibration certificate)
\( E \) = Modulus of elasticity for flow tube material (from API 12.2 Appendix A)

Calculate:

\( BMVa \) = Base Measured Volume adjusted for scale reading.
\[ = BMV + SR \]
\( CTDW \) = Correction for prover/test measure liquid temperature difference.
\[ = \frac{RHO_{tm}}{RHOp} \]
\( CTStm \) = Correction for effect of temperature on test measure.
\[ = 1 + (Ttm - 60) \times (Gc) \]
\( CTSp \) = Correction for effect of temperature on prover.
\[ = \{(1+[(Tp-Tb)\times Ga]) \times (1+[(Td-Tb)\times Gl])\} \]
\( CCTs \) = Correction for prover/test measure steel temperature difference
\[ = \frac{CTStm}{CTSp} \]
\( WD \) = Adjusted Base Volume of Draw
\[ = BMVa\times CTDW\times CCTs \]
\( CPSp \) = Correction for the effect of pressure on prover
\[ = 1 + \frac{(Pp*ID)/(E*WT)}{1-(0.0000032*Pp)} \]
\( CPLp \) = Correction for effect of pressure on liquid (water)
\[ = 1 / \left[ 1-(0.0000032*Pp) \right] \]
\( WDz \) = Average of all WD's
\[ = \frac{\text{[\sum (WDz Fill 1..WDz Fill5)]}}{n} \]
\( WDzb \) = Volume of Prover at 60 deg F and 1 atm
\[ = \frac{WDz}{(CPSp \times CPLp)} \]
Gravimetric Water Draw Calculations

Water draw volume corrections are based on the API Manual of Petroleum Measurement Standards 11.2.3, 12.2.1, 12.2.4, and 14.6.18.2.1.

Corrections and representations:

Given:

\[ T_d = \text{Temperature of detector bar. (deg F)} \]
\[ T_p = \text{Temperature of prover. (deg F)} \]
\[ T_a = \text{Temperature of ambient air. (deg F)} \]
\[ P_p = \text{Pressure in prover. (psig)} \]
\[ W_w = \text{Weight of water. (grams)} \]
\[ h = \text{Elevation above sea level. (feet)} \]
\[ D_{tw} = \text{Density of test weights. (gm/cc)} \]
\[ G_a = \text{Area coefficient of expansion for flow tube. (API 12.2.1.11.2.1)} \]
\[ G_l = \text{Linear coefficient of expansion for detector. (API 12.2.1.11.2.1)} \]
\[ E = \text{Modulus of elasticity for flow tube material. (API 12.2 Appendix A)} \]
\[ W_T = \text{Thickness of flow tube wall. (inches)} \]
\[ I_D = \text{Diameter of flow tube. (inches)} \]

Calculate:

\[ D E N_a = \text{Density of air (gm/cc) (Per API 14.6.18.2.1)} \]
\[ = 0.0012(1-(0.032 \times h/1000))*(520/(T_a + 460)) \]

\[ R H O_w = \text{Density of water (gm/cc) (From API 11.2.3 or calculate by algorithm)} \]
\[ = ((9.998395639 \times 10^2) + (6.798299989 \times 10^2) \times T_p - 
(9.106025564 \times 10^3) \times T_p^2 + (1.005272999 \times 10^4) \times T_p^3 - 
(1.126713526 \times 10^6) \times T_p^3 + (6.591795606 \times 10^9) \times T_p^5) / 1000 \]

\[ M_w = \text{True mass of water (gm)} \]
\[ = (W_w \times (1 - (D_a/\text{Dt}_w))) / (1-(D_a/\text{RHO})) \]

\[ V_w = \text{Volume of water dispensed (cc)} \]
\[ = M_w \div \text{RHO} \]

\[ C P L_p = \text{Correction for the effect of pressure on water} \]
\[ = 1 + (P_p \times 0.0000032) \]

\[ C T S_p = \text{Correction for effect of temperature on prover} \]
\[ = (1+[\text{(Tp-Tb)}G_a])*(1+[\text{(Td-Tb)}G_l]) \]

\[ C P S_p = \text{Correction for effect of pressure} \]
\[ = 1 + ((P_p \times I_D) / (E \times W_T)) \]

\[ C C F = \text{Combined correction factor} \]
\[ = C_{t_k} \times C_{ps} \times C_{pl} \]

\[ V_{60} = \text{Volume of prover at 60 deg F and 1 atm} \]
\[ = V_w \div C C F \]
4 OPERATIONS AND TROUBLESHOOTING

4.1 Operating Instructions

1. First open fluid inlet valve slowly. After the inlet valve is completely open, open fluid outlet valve, connecting the prover to the process line, Figure 5.

2. Vent trapped air from the prover by opening the vent valves located at the top of the prover flow tube.

3. Close process diverter valve, Figure 5, slowly to divert the flow through the prover.

4. The SYNCROTRAK® flow prover is now ready for meter proving. Refer to the appropriate proving computer manual for procedures for performing meter proving runs.

5. 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 closest 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. After performing steps a. through d. check to see if the computer is receiving flow meter pulses.
   e. 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 prove run. Step e. simulates the piston completing its prove 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

Table 5: SYNCROTRAK® Troubleshooting Chart

<table>
<thead>
<tr>
<th>Issue</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prover does not cycle when proving pass is initiated</td>
<td></td>
</tr>
<tr>
<td>No AC power to SYNCROTRAK®</td>
<td>Check for continuity of power to prover, see Section 5.</td>
</tr>
<tr>
<td>Interface cable between CIU or flow computer and SYNCROTRAK®</td>
<td>Check connections and integrity of cables, see Section 5 and flow computer manual.</td>
</tr>
<tr>
<td>Above checks do not resolve problem</td>
<td>See Section 5 for location of 401D interface</td>
</tr>
<tr>
<td>1. Remove SYNCROTRAK® drive cover panel</td>
<td>2. Remove explosion proof interface box cover</td>
</tr>
<tr>
<td>3. Check 401D status indicator light</td>
<td>4. Check 401D status indicator light</td>
</tr>
<tr>
<td>No light on 401D</td>
<td>401D failure or no power to 401D</td>
</tr>
<tr>
<td>1 flash and a pause</td>
<td>Indicates failure of downstream volume switch</td>
</tr>
<tr>
<td>2 flashes and a pause</td>
<td>Indicates failure of upstream volume switch</td>
</tr>
<tr>
<td>3 flashes and a pause</td>
<td>Indicates a failure of both switches</td>
</tr>
<tr>
<td>4 flashes and a pause</td>
<td>Indicates a motor, drive, or motor relay failure</td>
</tr>
<tr>
<td>Unsteady or absence of pulse from flow meter</td>
<td></td>
</tr>
<tr>
<td>Defective flow meter signal cable or connection</td>
<td>Refer to applicable proving computer manual and check cables and connections.</td>
</tr>
<tr>
<td>Defective pickup or pulser</td>
<td>Check for electrical or mechanical failure</td>
</tr>
<tr>
<td>Defective flow meter</td>
<td>Observe for pulse width variation and possible noise from meter (repair or replace flow meter)</td>
</tr>
<tr>
<td>Defective flow meter signal</td>
<td>Test input and output signals preamplifier with an oscilloscope</td>
</tr>
<tr>
<td>Defective CONDAT® interface unit or signal conditioners, if using CONDAT® prover control</td>
<td>Input a frequency signal with a signal generator and check for signal at computer or output of signal conditioner with an oscilloscope.</td>
</tr>
<tr>
<td>If using flow computer of other manufacture</td>
<td>Check flow computer's operation manual for possible solution to problem</td>
</tr>
</tbody>
</table>
5 ELECTRICAL SCHEMATICS & DRAWINGS

This section contains various electrical schematics and drawings for the SYNCROTRAK® flow 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 11 details the customer electrical connections for a prover with one electrical box. Figure 12 details this same connection for provers equipped with two electrical boxes. Figure 13 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 30.
Figure 11: Customer Electrical Connections One Box Models
Figure 12: Customer Electrical Connections Two Box Models

1. +24 VDC
2. Prover press.
3. +24 VDC
5. +24 VDC

SEE NOTE 1

CUSTOMER POWER CONNECTION

SEE NOTE 2
Figure 13: 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 14 for single phase AC power, Figure 15 for 3 phase AC Power, and Figure 16 for DC power.
5.2 SYNCROTRAK® Wiring Diagrams

Figure 14: Wiring Diagram for Single Phase Models

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

NOTES:
1. AVAILABLE MOTOR VOLTAGES FOR 1 PHASE: 120/220
2. CONNECTION TYPE: PRESSURE PLATE WITH SET SCREW TO ACCEPT #10-#14 WIRE OR #10 RING LUG
3. CONNECTION TYPE: #10 RING LUG
Excise extreme caution when wiring 401D module. The 401D module is a very sensitive electronic device and if wired incorrectly will be rendered useless.

Figure 15: Wiring Diagram for 3 Phase Models

NOTES:
1. AVAILABLE MOTOR VOLTAGES FOR 3 PHASE: 220/240/380/400/415/460/480
2. CONNECTION TYPE: PRESSURE PLATE WITH SET SCREW TO ACCEPT #10-#14 WIRE OR #10 RING LUG
3. CONNECTION TYPE: #10 RING LUG
Figure 16: Wiring Diagram for 24 VDC Models

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

NOTES:
1. CONNECTION TYPE: PRESSURE PLATE WITH SET SCREW TO ACCEPT #10-#14 WIRE OR #10 RING LUG
2. CONNECTION TYPE: #10 RING LUG

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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 #7 of 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 SYNCROTRACK® flow prover.

![Diagram of 401D to OMNI Wiring](image)

**Figure 17: 401D to OMNI 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 20: 401D to DYNAMIC Flow Computer Wiring
6 PROVER MAINTENANCE

6.1 General Prover Maintenance Information

Preventative Maintenance

SYNCROTRAK® Flow 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.
6.2 Prover Seal Replacement

Please Note: When referring to an item # in the following instructions, please refer to Figure 21 through Figure 27.

1. Disconnect power from prover.

2. Disconnect prover from line, or block off from line, and drain completely.

3. Disassemble prover drive hood by removing the 1/4-20 hex head bolts, starting with the side panels, then the top panel, outer end panel, and inner panel.

4. Remove downstream shaft cover by removing outer support, carefully sliding tube cover from the shaft, and unscrew the threaded rod from the downstream seal retainer, Figure 21 #53101.

5. Remove the 4 bolts, Figure 21 #53107, holding the stop and seal retainer to the end flange and remove the stop, Figure 21 #53101.

6. Remove the bracket securing the flow tube and downstream flange to the frame.

7. Remove the hex socket bolts, Figure 21 #53003, securing the downstream end flange Figure 21 #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.
8. Remove the nut, (1) Figure 21, holding the guide block (2) to the upstream shaft.

Figure 21: Downstream Exploded View

Figure 22: Guide Block Assembly
9. Remove the upstream seal retainer assembly, Figure 23 #52101, from the upstream flange by first removing the shock absorbers, Figure 23 #52108, and then removing the hex socket cap screws, Figure 23 #52107 holding the seal retainer to the end flange. Then remove the seal retainer assembly.

Figure 23: Upstream Exploded View
10. 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 24.

![Figure 24: Piston Removal](image)

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

11a. Referring to Figure 25, 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 25, 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.

12. Reassemble the piston by reversing the disassembly procedure and use new seals in all locations, refer to Figure 25. To assist in installing the riders and main piston seals, put them in hot water (140-150 degrees 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.

Figure 25: Piston Assembly Exploded View

13. 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, 5/8” all thread, inserted through the hole in the drive end plate where the static leak detector is inserted, refer to Figure 26. Screw the threaded rod into the piston shaft. A piece of 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.
Note: Refer to Table 6 for bolt torque values for assembling flow prover

14. Put a new o-ring seal, Figure 21 #53002, onto downstream flange, Figure 21 #53001, carefully re-install flange into flow tube. Re-install hex socket bolts, Figure 21 #53003, securing the downstream end flange, Figure 21 #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.

15. Refer to Figure 21, and remove the shaft seal housing #53109 from the downstream stop #53101 by removing the hex socket bolts #53110. Remove the retaining ring, seals and washer from the housing. Note the direction of the seal lips for correctly installing the new seals

16. Refer to Figure 27 to remove the retaining rings, washers, and seals from the upstream seal retainer housing. Note the direction of the seal lips for correctly installing 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.

17. Reassemble the seal retainer assemblies in the same sequence that the parts were removed, using new seals, refer to Figure 21, Figure 23, and Figure 27.

18. Install the upstream seal retainer housing, Figure 23 #52101, in the upstream flange, Figure 23 #52001, torque the hex head cap screws to value found in Table 6, and re-install the shock absorbers.

19. Finish re-assembly using the reverse of the procedure from # 9 through # 1.

NOTE:
Upstream flange to flow tube seal does not usually need replacement during normal maintenance, nor is it necessary to remove upstream flange, Figure 23 #52001.
6.3 Bolt Torque Specifications

Table 6: Bolt Torque Specifications

<table>
<thead>
<tr>
<th>Model #</th>
<th>Item#</th>
<th>Item#</th>
<th>Item#</th>
<th>Item#</th>
<th>Item#</th>
<th>Item#</th>
<th>Item#</th>
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<td>05X3C</td>
<td>52006</td>
<td>52107</td>
<td>53003</td>
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<td>54018</td>
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<td>500 ft lb</td>
<td>150 ft lb</td>
<td>11 ft lb</td>
<td>11 ft lb</td>
<td>170 ft lb</td>
<td>250 ft lb</td>
</tr>
</tbody>
</table>

Note 1: Hex nut, (1) Figure 22, holding guide block, (2) Figure 22, to upstream shaft.
Table 7: Guide Block Bolt Torque Specifications

<table>
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<tr>
<th>Item#</th>
<th>Item#</th>
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<td>24019</td>
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<td>Screw</td>
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Torque ratings for guide block components

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<td>9.6 in lb</td>
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<td>650 in lb</td>
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</table>

See Figure 28 for items referenced in Table 7.

Figure 28: Guide Block Exploded View

6.4 Replacement of Upstream Shaft Seals

1. Refer to Section 6.2. Follow steps 1 through 3, step 9, then steps 16, 17, 18, and then reverse steps 1 through 3 for final re-assembly of unit.
6.5 Replacement of Downstream Shaft Seals

1. Refer to Section 6.2. Follow steps 1 through 5, then steps 15 and 17, and then reverse steps 5 through 1 for final re-assembly of unit.

6.6 Drive System Maintenance

The SYNCROTRAK® 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 TFE filled chain lube for bicycles and motorcycles.

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 1/2" below vent port for horizontally mounted provers, see Figure 29. 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° to 150° F.

---

**Figure 29: 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 22 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 SYNCROTRAK® FLOW PROVER USERS:
The following pictures detail our new optical switch shape. As seen below, the radii at the corners of the optical switch will now be placed toward the inside corner of the switch bar L-bracket. You will also note that the switch is now reversible. Additionally, the new switch style is calibrated on both sides, so the user does not have to worry about improper installation due to switch orientation. Figures 30 and 31 below illustrate a correct optical switch installation.
Figure 30: Correct Optical Switch Installation Bottom View

Figure 31: Correct Optical Switch Installation Side View

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