

FX Tester

Testing Mechanical Leak Detectors



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Introduction

FXT Description 1
 U.S. Environmental Protection Agency (EPA) Information 1
 Safety Precautions 2
 Warnings and Instructions 3
 IMPORTANT SAFETY INFORMATION 3
 PRELIMINARY PRECAUTIONS 3
 REQUIREMENTS FOR USE 4
 OPERATING PRECAUTIONS 4
 Applications 5
 Static Head Pressure on Mechanical Leak Detector 5

Testing Procedures

Tester Setup with FX2 Series Models 7
 Hose Connections 7
 Use of Extender Hoses 7
 Simulated Leak Test - 4 Step Test 7
 Observation of Leak Detector Opening Time 10
 Operating Test - Pressure Relief 11
 Pump Operation 11
 Thermal Contraction 12
 Vacuum Test 12
 To Perform A Vacuum Test 13
 Resiliency Test 13
 Using the FX Tester for Testing at the Impact Valve 13
 Installation of the FX Tester at the Impact Valve 14
 Manifolder Pumps with Leak Detectors 15

The FX Leak Detector 3-Step Test 16

Parts Description & Replacement Parts List

Scale Changing Instructions 19
 Variable Area Flow Meter 19
 Cleaning the Flow Meter 19
 To Disassemble 19
 Cleaning 20
 Assembly 20

Evaluation Charts 22

Figures

Figure 1.	Static head	5
Figure 2.	Example FX tester connection to the Standard pump	7
Figure 3.	Example FX tester connection to the Red Jacket pump	8
Figure 4.	FXT selector valve	9
Figure 5.	Installing Snap Tap at shear valve	14
Figure 6.	Discharge fluid height limit example	15
Figure 7.	FX Tester operating positions	16
Figure 8.	Flow meter exploded view	20

Tables

Table 1.	Test Leak Rate Selections	9
Table 2.	Red Jacket Pump Operating Pressures	11
Table 3.	FX Tester Parts List	18

Introduction

The FX Tester (FXT) has been specially designed to work with mechanical leak detectors to offer quick, clean, easily performed, functional checks. Unique, secondarily contained dry break fittings, called Snap Tap Connectors, attach to FX2V, and FX2DV (FX2 Series) leak detectors and the tank test port of the submersible pump, or at the shear valve under the dispenser.

The FX2 Series allows the FXT to be connected to the piping system and perform a leak detector functionality test without shutting down the submersible pump. Product spillage that occurs when installing other leak detector testing equipment is avoided. Because the FXT system returns product to the tank during the test period, direct handling of product used to simulate a leak is eliminated.

FXT Description

This report provides the procedure for functional testing of V-R mechanical leak detectors utilizing the FXT. In addition to establishing that the unit is functioning, it provides for a demonstration of the leak detectable by subject system under current conditions. The characteristics of the pumping system in which the line leak detector (LLD) is installed will affect its performance. This procedure provides some evaluation of the pumping system as well as the LLD. It can be utilized for further evaluation of the pumping system. **Please note that the performance of the procedures set forth in Section II, A and B is intended to satisfy functionality check requirements for annual inspection of leak detectors. Section IV of Option A (RJ-21) and Section V-VI of option (RJ-20) are also intended to satisfy the minimum requirement.** For information on this as well as reference information on the LLD and the pumping system in which it is installed, including symptoms, probable causes, suggested action, see Red Jacket Mechanical Leak Detector Manual, #5191, and/or 5190

Option A, utilizing the Apparatus to Verify Operation (AVO) will provide a more basic, less extensive approach to evaluating the V-R LLD. See Form RJ-21 for this basic procedure. Option B, utilizing the Field Test Apparatus (FTA) offers a finite testing method, See Form RJ-20.

U.S. Environmental Protection Agency (EPA) Information

Under 40CFR280.44(a), EPA has:

1. Defined laboratory performance standards for automatic LLDs (out-of-the-box) prior to installation. V-R mechanical leak detectors have been constructed to meet the EPA requirements as outlined in 40CFR280.44(a). A copy of our third-party certification is available upon request.
2. Stated that an annual test of the operation of the LLD must be conducted in accordance with the manufacturer's requirements.

The EPA requires "...that the LLDs be tested annually to insure that they are properly installed and maintained and have not been tampered with and are operating in accordance with the manufacturer's requirements". In addition, to assure maintenance of LLD capability, V-R requires that operation of the mechanical leak detector be verified upon start-up and that testing of the LLD be performed routinely - at least annually. Section IV of Option A (RJ-21) or Sections V and VI of Option B (RJ-20) or section II of this manual, are intended to meet the minimum requirement for verifying the functionality of the LLD.

NOTE This report, as well as reports RJ-21 and RJ-20, provide the manufacturer's requirements for testing V-R mechanical LLDs. The procedures covered in this form and reports RJ-21 and RJ-20, supersede previously issued procedures for testing V-R LLDs.

Competent mechanical leak detector evaluation requires A) that testing be performed by trained, qualified personnel and B) consistent, proper procedures involving good maintenance and quality control of equipment are utilized.

Education on this and all technical aspects of V-R petroleum submersible pumping and monitoring systems is available.

It has been established that the obligation of compliance with the appropriate regulations covering USTs is the owners, with the following guidelines in place in reference to LLDs.

EPA regulations require that the LLD be installed and operating, capable of detecting a catastrophic leak and tested annually in accordance with the manufacturer's requirements. The manufacturer's requirements and procedures for annual testing of V-R LLDs are covered in Option A, Form RJ-21, Option B, Form RJ-20 and this publication 051-272-1. While some regulatory bodies have, the EPA has not issued guidelines as to when LLDs are to be replaced based on quantitative performance. They state that annual quantitative performance tests of LLDs installed in the field are not required by EPA standards. It is suggested you check with state and local authorities for any requirements that may be different from those of the U.S. EPA.

Based on the above and other pertinent factors, it is our opinion that the UST owner is the best equipped to assess their situations and therefore to make the decision as to when subject LLD is to be replaced. We do not consider it prudent as the manufacturer to make that determination.

We do urge that if after evaluating the pumping system the subject LLD is not demonstrating the capability of reacting to a leak at the rate of or equivalent to 5 gph at 10 psi (19 lph at 69 kPa) or greater, serious assessment should be made of the entire pumping system and of replacement of the LLD versus continued use.

NOTE We have no control, influence or participation with reference to the design, operation or quality of any mechanical leak detectors other than those manufactured and marketed by V-R/Red Jacket petroleum equipment identification. We, therefore, do not advise or condone use of the information, procedures or equipment covered in this or any other publication issued by V-R for any equipment other than V-R petroleum equipment.

For additional assistance with regard to the above or any V-R petroleum equipment, contact Technical Support at 1-800-323-1799.

Safety Precautions

The following safety symbols are used throughout this manual to alert you to important safety hazards and precautions.

 <p>EXPLOSIVE Fuels and their vapors are extremely explosive if ignited.</p>	 <p>FLAMMABLE Fuels and their vapors are extremely flammable.</p>
 <p>ELECTRICITY High voltage exists in, and is supplied to, the device. A potential shock hazard exists.</p>	 <p>TURN POWER OFF Live power to a device creates a potential shock hazard. Turn Off power to the device and associated accessories when servicing the unit.</p>
 <p>WARNING Heed the adjacent instructions to avoid equipment damage or personal injury.</p>	 <p>READ ALL RELATED MANUALS Knowledge of all related procedures before you begin work is important. Read and understand all manuals thoroughly. If you do not understand a procedure, ask someone who does.</p>
 <p>WEAR EYE PROTECTION Wear eye protection when working with pressurized fuel lines to avoid possible eye injury.</p>	 <p>APPROVED CONTAINERS Use metal, clearly marked containers, suitable for collecting and transporting hazardous fuels during service.</p>

⚠ WARNING	
	<p>This product operates in the highly combustible atmosphere of a gasoline storage tank. FAILURE TO COMPLY WITH THE FOLLOWING WARNINGS AND SAFETY PRECAUTIONS COULD CAUSE DAMAGE TO PROPERTY, ENVIRONMENT, RESULTING IN SERIOUS INJURY OR DEATH.</p> <ol style="list-style-type: none"> 1. All installation work must comply with the latest issue of the National Electrical Code (NFPA 70), the Code for Motor Fuel Dispensing Facilities and Repair Garages (NFPA 30A), and any European, national, state, and local code requirements that apply. 2. Turn off, tag, and lockout power to the STP before connecting or servicing the STP. 3. Before installing pipe threads apply an adequate amount of fresh, UL classified for petroleum, non-setting thread sealant. 4. When servicing unit, use non-sparking tools and use caution when removing or installing equipment to avoid generating a spark. 5. To protect yourself and others from serious injury, death, or substantial property damage, carefully read and follow all warnings and instructions in this manual.

In addition to the specified torque values noted in this manual, when properly tightened, all flanged fittings should have metal-to-metal contact.

Warnings and Instructions

IMPORTANT SAFETY INFORMATION

This section introduces the hazards and safety precautions associated with installing, inspecting, maintaining or servicing this product. Before performing any task on this product, read this safety information and the applicable sections in this manual, where additional hazards and safety precautions for your task will be found. Fire, explosion, electrical shock or pressure release could occur and cause death or serious injury, if these safe service procedures are not followed.

PRELIMINARY PRECAUTIONS

You are working in a potentially dangerous environment of flammable fuels, vapors, and high voltage or pressures. Only trained or authorized individuals knowledgeable in the related procedures should install, inspect, maintain or service this equipment.

Read the Manual

Read, understand and follow this manual and any other labels or related materials supplied with this equipment. If you do not understand a procedure, call 1-800-323-1719 to locate a qualified technician. It is imperative to your safety and the safety of others to understand the procedures before beginning work. **Make sure your employees and any service contractors read and follow the instructions.**

Follow the Regulations

Applicable information is available in National Fire Protection Association (NFPA) 30A; *Code for Motor Field Dispensing Facilities and Repair Garages*, NFPA 70; *National Electrical Code* (NEC), Occupational Safety and Hazard Association (OSHA) regulations and federal, state, and local codes. All these regulations must be followed. Failure to install, inspect, maintain or service this equipment in accordance with these codes, regulations and standards may lead to legal citations with penalties or affect the safe use and operation of the equipment.

Prevent Explosions and Fires

Fuels and their vapors will explode or burn, if ignited. Spilled or leaking fuels cause vapors. Even filling customer tanks will cause potentially dangerous vapors in the vicinity of the dispenser or island.

Working Alone

It is highly recommended that someone who is capable of rendering first aid be present during servicing. Familiarize yourself with Cardiopulmonary Resuscitation (CPR) methods, if you work with or around high voltages. This information is available from the American Red Cross. Always advise the station personnel about where you will be working, and caution them not to activate power while you are working on the equipment. Use the OSHA Lockout/Tagout procedures. If you are not familiar with this requirement, refer to OSHA documentation.

Working With Electricity Safely

Ensure that you use safe and established practices in working with electrical devices. Poorly wired devices may cause a fire, explosion or electrical shock. Ensure that grounding connections are properly made. Ensure that you do not pinch wires when replacing covers. Follow OSHA Lockout/Tagout requirements. Station employees and service contractors need to understand and comply with this program completely to ensure safety while the equipment is down. Before you start work, know the location of the Emergency Power Cutoff Switch (the E-STOP). This switch cuts off power to all fueling equipment and submerged turbine pumps and is to be used in the event of an emergency. The buttons on the console at the cashier's station WILL NOT shut off electrical power to the pump/dispenser. This means that even if you press a button on the console labeled EMERGENCY STOP, ALL STOP, PUMP STOP, or something similar, fuel may continue to flow uncontrolled.

Hazardous Materials

Some materials may present a health hazard if not handled correctly. Ensure that you clean hands after handling equipment. Do not place any equipment in the mouth.

WARNING! FAILURE TO COMPLY WITH THE FOLLOWING WARNINGS AND SAFETY PRECAUTIONS COULD RESULT IN PROPERTY DAMAGE, INJURY OR DEATH.

FIRE HAZARD! Do **NOT** use **power tools** (Class I Division I and Class I Division II) during the installation or maintenance of equipment. Sparking could ignite fuel or vapors, resulting in fire.

CHEMICAL EXPOSURE HAZARD! Wear appropriate **safety equipment** during installation or maintenance of equipment. Avoid exposure to fuel and vapors. Prolonged exposure to fuel may cause severe skin irritations and possible burns.

REQUIREMENTS FOR USE

- The Red Jacket submersible pumps are designed for use only at facilities dispensing motor fuels.
- The application of Red Jacket submersible pumps must be consistent with NFPA Code 30A, OSHA regulations, and federal, state and local fire codes, and other applicable local regulations.
- The selection of any Veeder-Root product must be based upon physical specifications and limitations and the product's compatibility with the materials to be handled. Veeder-Root makes no warranty of fitness for a particular purpose.
- All Veeder-Root products should be used in accordance with applicable federal, state and local laws, ordinances and regulations.

OPERATING PRECAUTIONS

- **NO SMOKING.** Extinguish all open flames and pilot lights, such as on RV appliances.
- **TURN OFF** cell phones and other electronic devices to avoid distractions while fueling.
- **GASOLINE CAN BE HARMFUL OR FATAL IF SWALLOWED.** Long-term exposure may cause cancer. Keep eyes and skin away from liquid gasoline and gasoline vapors. Avoid prolonged breathing of gasoline vapors.



WARNING! Before installing leak detector, review the application section in leak detector manual #5191 for limitations or restrictions on usage.

NOTICE! This instruction sheet should be kept with the end user of the leak detector for reference.

When using 117-182 Big-Flo Diaphragm Valve, refer to installation instructions #042-108-1 included with the valve. When using an FXV model leak detector with adapter housing #038-072-5, refer to installation instructions #041-415-1 included with the housing. FXV Leak Detectors are for use with all UL-listed 4-inch Red Jacket models containing a “P” or “AG” prefix; FE Petro UL-listed 4-inch “STP” models; Tokheim UL-listed 4-inch models – 585A-34 and 585A-150.



WARNING! Tampering with the screws or seals on this leak detector may inhibit operation and will void warranty.



DO NOT wire submersible pumps to run continuously. Red Jacket line leak detectors will not perform leak tests on pumping systems that run continuously.

NOTICE! ALL AIR MUST BE OUT OF THE SYSTEM FOR THE LEAK DETECTOR TO WORK PROPERLY. Before installing leak detector in the pump, fill the system with product by running the pump and delivering product from each dispenser (starting with the farthest from the pump and working to the pump) until all air is removed from system.

Certain regulatory bodies require that leak detectors remain in the system after the lines have been installed. The lines may be purged of air by back-pressuring the lines with an inert gas, such as helium or nitrogen, to a pressure of 25 psi (172 kPa). This may be done at the impact valve under the dispenser. When this pressure has been reached, the leak detector will be in the open position. By turning on the pump and gradually bleeding the gas from the line through a valve at the impact valve of the farthest dispenser, the line may be purged of air.

Applications

Static Head Pressure on Mechanical Leak Detector

The FX Leak Detector is designed to operate when installed into systems which impose a static head on 11 (eleven) feet or less.

When installing a mechanical leak detector in an underground submersible pumping system, the installer must be aware of the static head that will be placed on the leak detector when in operation (see 'A' in Figure 1). The static discharge head is the vertical elevation from the leak detector body to the point of free discharge.

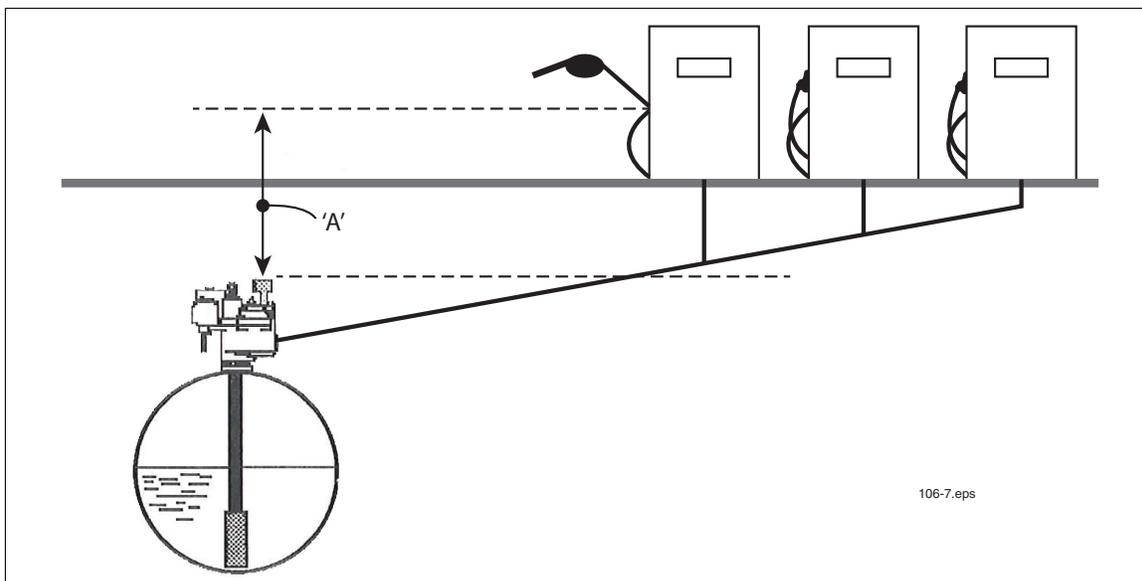


Figure 1. Static head

The term 'head' is usually expressed in feet whereas pressure is usually expressed in pounds-per-square-inch. The formula for converting these factors follows:

$$\begin{aligned} \text{Pressure (Lbs./Sq. In.)} &= \frac{\text{Head (feet)} \times \text{Specific Gravity}}{2.31} \\ \text{Head (feet)} &= \frac{\text{Pressure (psi)} \times 2.31}{\text{Specific Gravity}} \end{aligned}$$

(A rough equation is 3 feet of gasoline head equals 1 psi).

The history of industry practice concerning location of the submersible pump in relation to the dispenser indicates that static head is not normally a problem. The general operating parameters for the leak detector dictate that it will trip or reset at approximately 3.5 to 4 psi or below, and the approximate 11 feet of liquid head or excess of 3.5 to 4 psi is not usually experienced by the leak detector. Typically, FX model leak detectors will overcome static heads of 3.5 to 4 psi.

However, if the static head and subsequent pressure experienced by the leak detector is in excess of the threshold, the leak detector may not operate. (see the three-step test).

Important Points to Remember:

1. Leaks occurring at a height above the leak detector that exert more fluid pressure than the threshold value will keep the leak detector from entering the leak sensing position. Such leaks will not be detected.
2. The threshold value for the reset pressure is a result of varying mechanical characteristics in the leak detector and may vary. Our experience shows that it is possible to encounter leak detectors that will work in a given situation when others won't because they have a slightly higher threshold.

The effect of excessive static pressure can be observed when a simulated leak is placed into the line above the threshold height and then closed before the pump is turned on. Under normal operations, the leak detector will hesitate at the metering pressure for several seconds before opening up to full pump pressure. With excessive static head present, the pressure will increase immediately to full pump pressure. If under these conditions a leak is present, the pump is turned on and full pump pressure is realized immediately, the leak detector is not operating properly.

The amount of pressure experienced by the leak detector can be determined by installing a pressure gauge on the line test port of the pump. The gauge must remain at the level of the line test port and should have a low pressure range (i.e., 0 to 30 psi) to get accurate readings.

After the pump is turned off, use the valve on the test apparatus to bleed the pressure from the highest vertical point in the system, typically located at the dispenser shear valve. The gauge on the line test port will read the static head present on the leak detector.

Possible solutions to the problem of excessive static head are:

1. Test the operation of leak detectors. Replace the leak detector with a low threshold attempting to find one with a higher threshold by observing test results.
2. Modify the system by raising the leak detector to decrease its static head. This can be done by installing a longer riser pipe between the pump and the tank. Note that this will raise the pump inlet further from the bottom of the tank by the distance added to the riser.

In all cases, operation of the mechanical leak detector must be verified by inducing a leak and confirming correct operation of the unit after it is installed at the site.

Testing Procedures

Tester Setup with FX2 Series Models

HOSE CONNECTIONS

When installing the FXT onto a submersible pumping system with an FX2 Series LLD, care must be taken to assure proper connection of the hoses. Only submersible pumps equipped with a tank test port allow the closed loop testing method to work properly.

USE OF EXTENDER HOSES

Certain situations, such as pumps with a deep bury depth, may require 'extender hoses' with the FXT. The 5-foot (1.5 m) hoses are available from V-R as an accessory. See "Parts Description & Replacement Parts List" on page 18.

Simulated Leak Test - 4 Step Test

This is a general overview of the procedure to properly install the FXT and how to set a leak rate at a given pump pressure by utilizing Figure 2 (Standard pump example) and Figure 3 (the Red Jacket pump example).

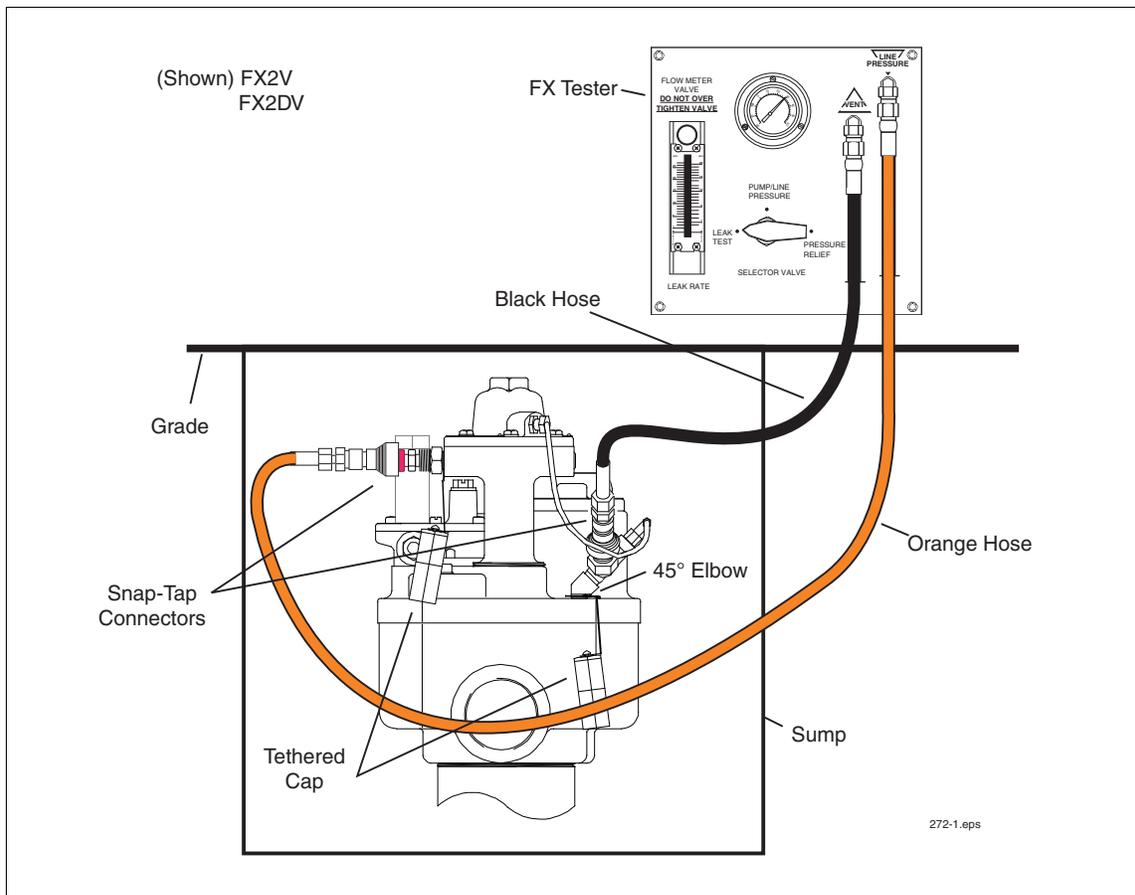


Figure 2. Example FX tester connection to the Standard pump

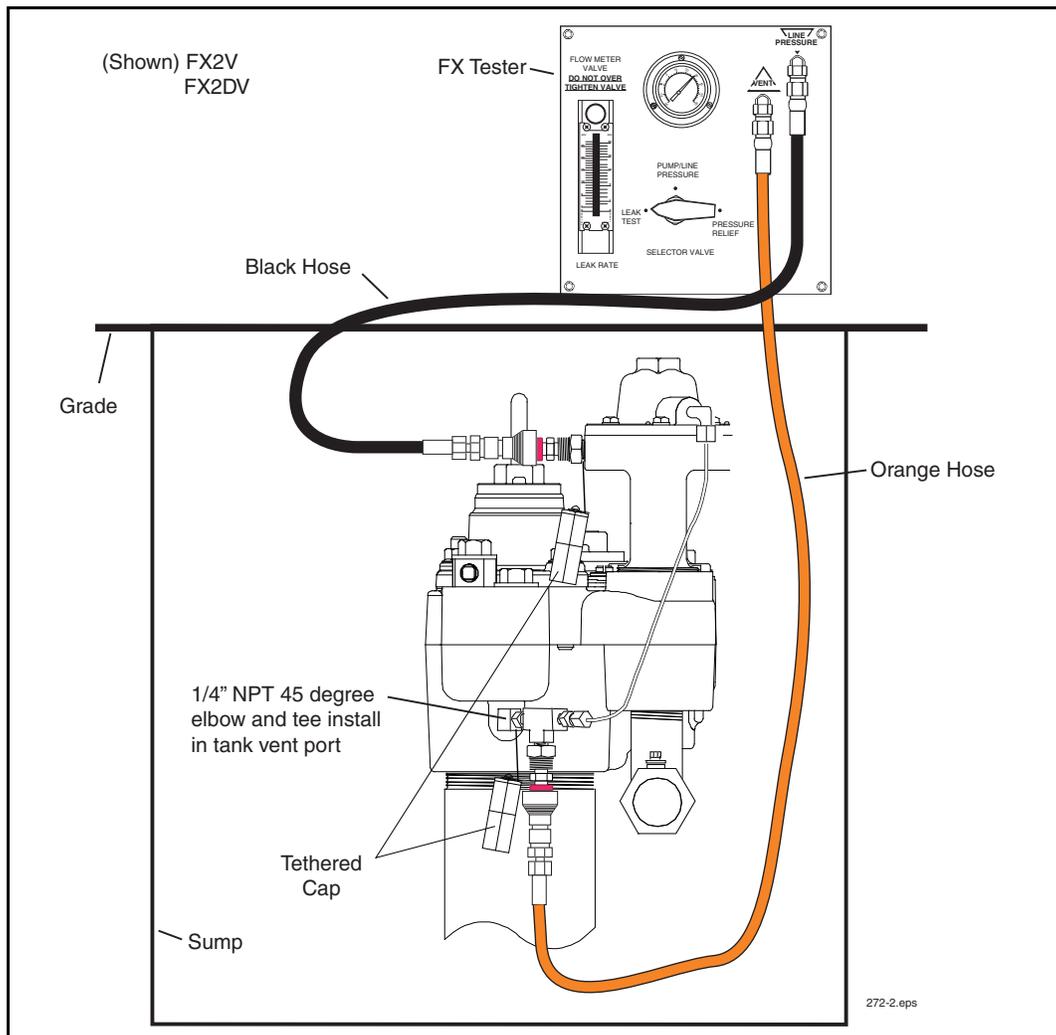


Figure 3. Example FX tester connection to the Red Jacket pump

The FXT will be required for this procedure. The V-R FX2 Series LLD and the Snap Tap Connectors must be installed before testing can begin. Refer to FX installation instructions 042-106-1.

1.

- a. Connect the black hose of the FXT to the Snap Tap Connector at the tank test port of the pump. The black hose is the path to the tank. Line pressure can be relieved through this path.
- b. Connect the orange hose of the FXT to the Snap Tap Connector on the FX2 Series LLD. The orange hose is the path to the line.
- c. Turn FXT's Selector Valve to 'Pump/Line Pressure' position as shown in Figure 4. When the selector valve is in this position, the FXT is monitoring actual line pressure. As actual line pressure is displayed on the compound gauge, specifications can be checked.
- d. Observe pump operating pressure. This step may be done while dispensing is in progress. Check pump operation specifications to verify pump pressure output and relief pressure.
- e. From Table 1, below, select a leak rate at which to test. The top row of numbers (starting with 3) are the choices, reflected in gph.

- f. Follow this column down until it intersects with the 'Pump Operating Pressure' which was observed in Step 1c. Record this value (sample chart is provided at the back of this document).

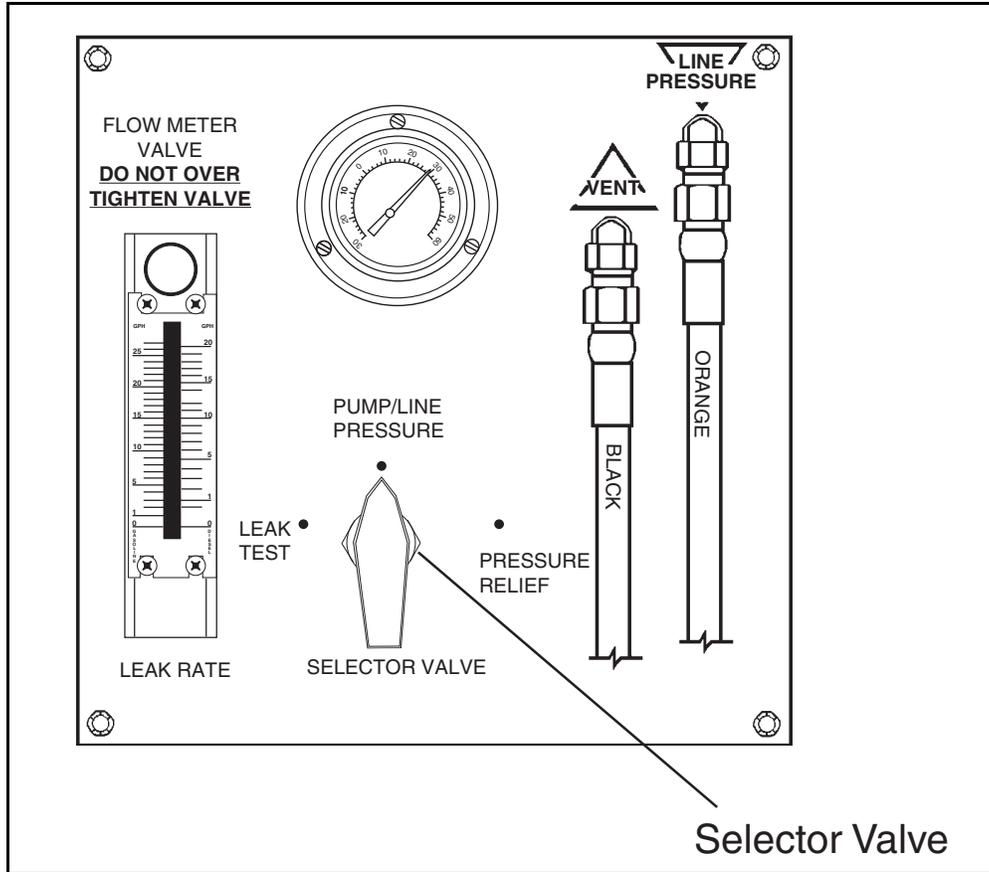


Figure 4. FXT selector valve

Table 1. Test Leak Rate Selections

Pump Operating Pressure	Equivalent Leak Rates at 10 psi Flow Rates to set at Pump Pressure							
	3 GPH	4 GPH	5 GPH	6 GPH	7 GPH	8 GPH	9 GPH	10 GPH
20	4.2	5.7	7.1	8.5	9.9	11.3	12.7	14.1
22	4.4	5.9	7.4	8.9	10.4	11.9	13.3	14.8
24	4.6	6.2	7.7	9.3	10.8	12.4	13.9	15.5
26	4.8	6.4	8.1	9.7	11.3	12.9	14.5	16.1
28	5.0	6.7	8.4	10.0	11.7	13.4	15.1	16.7
30	5.2	6.9	8.7	10.4	12.1	13.9	15.6	17.3
32	5.4	7.2	8.9	10.7	12.5	14.3	16.1	17.9
34	5.5	7.4	9.2	11.1	12.9	14.8	16.6	18.4

Table 1. Test Leak Rate Selections

Pump Operating Pressure	Equivalent Leak Rates at 10 psi Flow Rates to set at Pump Pressure							
	3 GPH	4 GPH	5 GPH	6 GPH	7 GPH	8 GPH	9 GPH	10 GPH
36	5.7	7.6	9.5	11.4	13.3	15.2	17.1	19.0
38	5.8	7.8	9.7	11.7	13.6	15.6	17.5	19.5
40	6.0	8.0	10.0	12.0	14.0	16.0	18.0	20.0
42	6.1	8.2	10.2	12.3	14.3	16.4	18.4	----
44	6.3	8.4	10.5	12.6	14.7	16.8	18.9	----
46	6.4	8.6	10.7	12.9	15.0	17.2	19.3	----
48	6.6	8.8	11.0	13.1	15.3	17.5	19.7	----
50	6.7	8.9	11.2	13.4	15.7	17.9	----	----

2.
 - a. While the pump is running and no nozzles are dispensing, turn the FXT's Selector Valve to the 'Leak Test' position.
 - b. Using the flowmeter valve, adjust the leak rate to the value recorded in 1f above. this will create the equivalent desired leak rate.
 - c. Check the pressure reading to make sure it is still the same as in 1d above. If it is different, repeat step 1e and 1f for the new pressure before proceeding.
3.
 - a. Turn off the pump and wait for dispensing to stop. Observe pump pressure fall to seating pressure.
 - b. Turn the FXT's Selector Valve to the 'Pressure Relief' position.
 - c. Observe line pressure fall to 0 psi.
4.
 - a. Turn the FXT's Selector Valve to the 'Leak Test' position.
 - b. Turn on the pump.
 - c. Observe the pressure gauge:
 - A pressure of approximately 12 - 16 psi (83 - 110 kPa) or less for the FX Series (FX1 Series or FX2 Series) LLDs indicates that the LLD has reacted to the imposed leak and is in its leak sensing mode.
 - A Pressure of approximately 25 psi (172 kPa) or greater indicates that the LLD did not see the leak.
 - d. Disconnect the FXT by first removing the orange hose, then remove the black hose. Replace the caps on the Snap-Tap fittings.

Observation of Leak Detector Opening Time

1. Rotate the FXT's Selector Valve to the 'Pressure Relief' position with the submersible pump off. Observe the pressure fall to zero.
2. Rotate the FXT's Selector Valve to the 'Pump/Line Pressure' position.

- Operate the submersible pump. Observe that line pressure will rise to a constant level and pause there momentarily. At this point, a slight drop on the pressure gauge may be observed followed by an immediate sharp increase to full line pressure.

For FX Series leak detectors, the constant level (metering pressure) will be approximately 8 to 16 psi (55 - 110 kPa). Full line pressure of approximately 25 to 40 psi (172 - 276 kPa) will also be observed, determined by the size of the submersible pump and the product it is pumping.

- Using a stopwatch, observe the approximate opening time in seconds from pump start (zero pressure) to full pump pressure, 25 to 40 psi (172 - 276 kPa), as being approximately 2.0 to 3.5 seconds for the FX Series LLD. Longer opening times may be indicative of air in the system, system resiliency or a small leak. See Red Jacket publications RJ-5191, and the mechanical leak detector manual.
- Record opening time.
- Turn off the submersible pump.

Operating Test - Pressure Relief

- With the FXT's Selector Valve to the 'Pump/Line Pressure' position, observe holding pressure of functional element. If a standard functional element is used, a holding pressure of between 8 to 20 psi (55 - 138 kPa) is normally observed. If a precision functional element is used, a holding pressure of about 11 to 13.5 psi (76 - 93 kPa) should be observed. Adjustable functional element models manufactured after February 1995 are also factory set at 11 to 16 psi (76 - 110 kPa). The holding pressure of approximately 19 to 25 psi (131 - 172 kPa) should be observed when testing The Red Jacket pump.
- Record the holding pressure under pressure relief test on the sample test chart.
- Adjustable functional element models may have their relief pressures changed by turning down the adjusting screw to increase pressure and turning the adjusting screw upward to decrease relief pressure. The adjusted holding pressure may be observed as in Step 1.

Pump Operation

The FXT may be used to check pump pressure. With the orange hose connected to the FX2 Series LLD port, the pressure being delivered by the pump may be observed. The FXT's Selector Valve must be turned to the 'Pump/Line Pressure' position.

Refer to Table 2 for Red Jacket Pump operating pressures.

Table 2. Red Jacket Pump Operating Pressures

Model	60 Hz		Model	50 Hz	
	PSI (kPa)			PSI (kPa)	
	Gas	Diesel		Gas	Diesel
1/3 HP	25 (172)	28 (193)	3/4 HP	30 (207)	34 (234)
3/4 HP	28 (193)	32 (221)	1-1/2 HP	32 (221)	36 (248)
1-1/2 HP	30 (207)	34 (234)	X4 - 1-1/2 HP	40 (276)	45 (310)
X3 - 1/1/2 HP	43 (297)	49 (338)	2 HP	43 (297)	49 (338)
2 HP	43 (297)	49 (338)			

Thermal Contraction

Each winter a condition may exist in which the LLD, in performing its intended purpose, reacts.

The LLD will trip and cause restricted flow when the dispenser nozzle is opened prior to the submersible pump being turned on when line pressure is at zero. If the line pressure is above zero, the nozzle can be opened prior to starting the submersible pump, and full flow will be received. The problem is most prevalent in self-serve 'C' store type operations where the attendant is involved in the sale of various items and does not react to console requests for operation before the nozzle is opened.

The line pressure will drop to zero every few minutes in the winter due to thermal contraction of the product in the underground piping. Every time the line pressure drops to zero, the LLD resets to its relaxed position. The next time the submersible pump is started, the LLD will perform a line test. The FX Series LLD takes 2-3 seconds to perform a line test. The nozzle must be kept closed until the LLD has completed the test. The test cannot begin until the pump is turned on. When the pump is turned on, the time interval required for the line test to begin will vary. A mechanical dispenser may take anywhere from 7-9 seconds to reset its computer before a switch is actuated which turns on the pump and allows the test to begin. In such cases, an electronic solenoid valve with time delay should be installed on the flow valves of the dispenser. The delay must be set to exceed the dispenser's reset interval. When considering an electronic dispenser, the reset is accomplished almost instantaneously and a switch is actuated which turns the pump on, allowing the test to begin. Even though the reset interval of an electronic dispenser is considerably shorter than that of a mechanical dispenser, it also requires an electronic solenoid valve installed on the flow valves to alleviate false tripping problems.

To put this in perspective, every time line pressure drops to zero, there will be an opportunity for someone to open the nozzle prior to completion of a leak test. If this happens, the LLD will cause restricted flow because the LLD will interpret an open nozzle as a line leak.

In the summer months, thermal contraction of the product throughout the day rarely occurs. The line pressure may only drop to zero once a day; usually during the late night hours when the demand for product and the ambient temperature outside are at their lowest level of the day. It should be noted that occasionally, a rain shower will cool the pavement down enough to allow line pressure to drop to zero. However, there is usually only one opportunity per day for someone to open a nozzle prior to starting the submersible. This usually will occur during the first delivery of the morning.

The opportunity for the nozzle to be opened prior to completion of a line test occurs regularly in the winter, subsequently causing the leak detector to trip, resulting in limiting flow (3 gpm [11 lpm]). This is due to the line pressure constantly dropping to zero (which resets the LLD) throughout the day because of thermal contraction of the product, therefore, requiring additional line tests by the LLD. Replacing LLDs, pump check valves, pump o-rings or functional elements will not cure thermal contraction. The only cure is to be certain that the nozzle is closed until the LLD completes the line test.

Thermal contraction is based upon a simple principle. Obviously, during the cold winter months, the temperature of the product in the underground tank is warmer than the temperature of the underground piping, therefore, warm product is continually pumped into cold piping. All product has a coefficient of expansion and contraction. Gasoline has a very high coefficient of expansion and contraction. This means that a slight change in temperature will result in a rapid volume increase or decrease. When the warm gas is allowed to sit idle in the cold piping, it rapidly contracts, and line pressure quickly drops to zero.

Vacuum Test

At times, the effects of thermal contraction on gas are so extreme that low pressure areas are created within the pressurized piping system. The FXT is equipped with a compound gauge which is capable of displaying psi and inches of mercury. Therefore, if a station is experiencing slow opening times, the FXT can be used to troubleshoot this problem by verifying the existence or non-existence of a vacuum in the piping system. This may occur especially after long idle times in the facility such as overnight periods.

TO PERFORM A VACUUM TEST

1. Install the FXT.
2. Turn on the submersible. Observe the compound gauge. Make sure line pressure is at least 25 psi (172 kPa).
3. Turn off the submersible. Observe the compound gauge. Make sure line pressure drops to 0 psi.
4. Continue to watch the gauge for approximately 10-15 minutes.
5. If you observe the gauge reading pass 0 psi and falling into the vacuum range, thermal contraction is affecting the piping system and a good possibility exists that air may be entering the system.

NOTE The most severe thermals will occur after dispensing of a large volume of fuel from the dispenser that is farthest away.

Resiliency Test

1. With the FXT's Selector Valve set to the 'Pump/Line Pressure' position, install a 014-605 fitting onto the black hose. This will allow a discharge to occur from the dry break fitting on the hose. Put the discharge of the hose into a measuring container such as a graduated cylinder. Attach the orange pressure hose to the FX2 leak detector.
2. Turn the submersible pump on and then off.
3. Turn the FXT's Selector Valve slowly to the 'Pressure Relief' position as product begins to flow into the graduated cylinder.
4. As the pressure falls to 0 psi, record the total volume collected between the holding pressure and zero pressure.

NOTE Values for a typical station should be about 150 ml or less if an FX Series LLD is used. If larger amounts of product are measured, it is possible air is still present in the system which will prolong the time required for the LLD to perform the line test.

Using the FX Tester for Testing at the Impact Valve

Some submersible pumps are not equipped with tank vents. In this case, the LLD should be tested from the shear valve under the dispenser. A Snap-Tap can be installed in the shear valve (see Figure 5). Once the Snap-Tap is installed, the line can be accessed. A 014-605 fitting must be installed on the black discharge hose to allow flow to occur into the container.



Snap Tap connectors shall not be left permanently installed into the impact/shear valves and must be removed upon completion of testing.

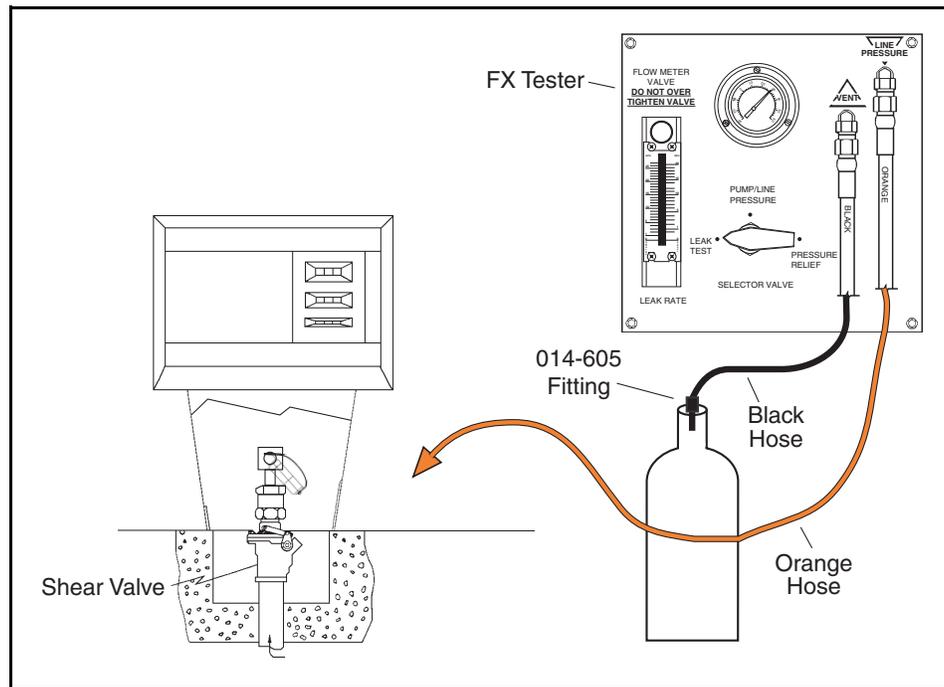


Figure 5. Installing Snap Tap at shear valve

Installation of the FX Tester at the Impact Valve

1. **Carefully bleed** any residual pressure present in the system, catching the fluid discharged in a suitable container. The test plug in the shear valve can be used for this purpose



CAUTION! Use a suitable container to receive product throughout this procedure. Plastic containers may store static electricity which could discharge, causing severe personal injury, fire and/or explosion. Use only approved metal type containers. Use adequate absorbents to catch any spillage and avoid ground contamination.

2. Install a Snap-Tap connector into the shear valve port.

NOTE

A 3/8-inch to 1/4-inch reducer may be necessary depending on the size of the test port in the impact valve. This reducer is not called out in the parts list.

Loss of product as well as introduction of air into the system can be minimized by closing the emergency valve previous to removing the plug from the test port. Reopen the valve after installing the FX Tester.

Check for any leakage of product around any of the fittings on the dispenser impact valve.

The simulated leak must be created at a height between the solenoid valve and the impact valve.

DO NOT attempt to perform a leak test above the solenoid valve. Properly installed leak detectors may not react to leaks above solenoid valves that are normally inside dispensers - sometimes several feet above island level. See Figure 6.

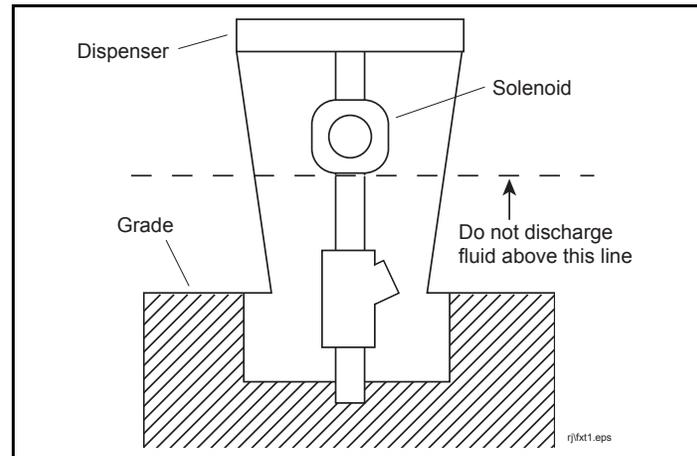


Figure 6. Discharge fluid height limit example

By raising the discharge point of the simulated leak from the FXT above the test area, additional static head is placed on the LLD. Static head is defined as the pressure exerted on the LLD by the vertical column of fluid contained within the piping, from the LLD upward to the point of discharge of the leak. By placing the point of discharge high enough above the island, sufficient static head pressure could be placed upon the LLD to keep it from entering the leak sensing position. It is assumed that piping from the LLD to the point of discharge is a continual, gradual, upward or positive run and does not have a negative (declining) run.

For more information on static head effects, please see Red Jacket Service Bulletin 23-5 and 23-18 or the application section of the mechanical leak detector manual covering the effects of static head on mechanical leak detectors.

NOTE

If the LLD or pumping system operation differs significantly from that described in this manual, see leak detector manual #5191 and/or Petroleum Products Service Manual #5190, for possible causes and solutions.

3. Plug the FXT into the Snap-Tap on the dispenser shear valve as shown in Figure 5 on page 14.



CAUTION! To avoid product spillage, assure the discharge is directed into a suitable container.

4. A leak check may now be performed by following "Simulated Leak Test - 4 Step Test" on page 7. In this case, product is not being returned directly to the tank via the Snap-Tap fitting on the pump but is collected in the container.



Snap Tap connectors shall not be left permanently installed into the impact/shear valves and must be removed upon completion of testing.

Manifolded Pumps with Leak Detectors

For manifolded systems that have two LLDs on a single line and the pumps operate simultaneously, testing must be performed at the impact valve, as shown in Figure 5.

The minimum leak detectable will be the sum of the two LLD's capabilities; typically 6 - 7 gph at 10 psi (23-26 lph at 69 kPa).

If the minimum leak detectable is unacceptable, the LLDs may be tested individually by having only one pump come on during the test. This will help in determining which LLD is causing the unacceptable rate.

NOTE

Pumps must be activated simultaneously in manifolded systems. If they alternate, LLDs cannot be accurately tested.

The FX Leak Detector 3-Step Test

The V-R FX Series LLD is a pressure-sensing, diaphragm-operated valve designed to indicate a leak in the piping between the leak detector and the dispenser.

When the submerged pump is turned on, a controlled amount of product, 3 gph (11 lph) is metered through the LLD into the piping system. If a leak is present which equals or exceeds this amount, as much product escapes from the system as is metered in through the LLD. Under this condition pressure cannot build up in the piping system. When a nozzle is opened and the LLD poppet is in position one (ref. Figure 7), flow is restricted to approximately 1-1/2 to 3 gpm (5 - 11 lpm). If the poppet of the LLD is in position two when a nozzle is opened, flow is restricted to approximately 1-1/2 to 3 gph (5 - 11 lph). This is the indication to the operator that the leak is present.

If there are no leaks, pressure rapidly builds in the system forcing the LLD to open to the full-flow position. In a system with no leaks, it takes approximately 2 - 3 seconds for the complete test. No further line testing takes place until the line pressure drops below 3 to 5 psi (21 - 35 kPa) depending on which LLD is installed.

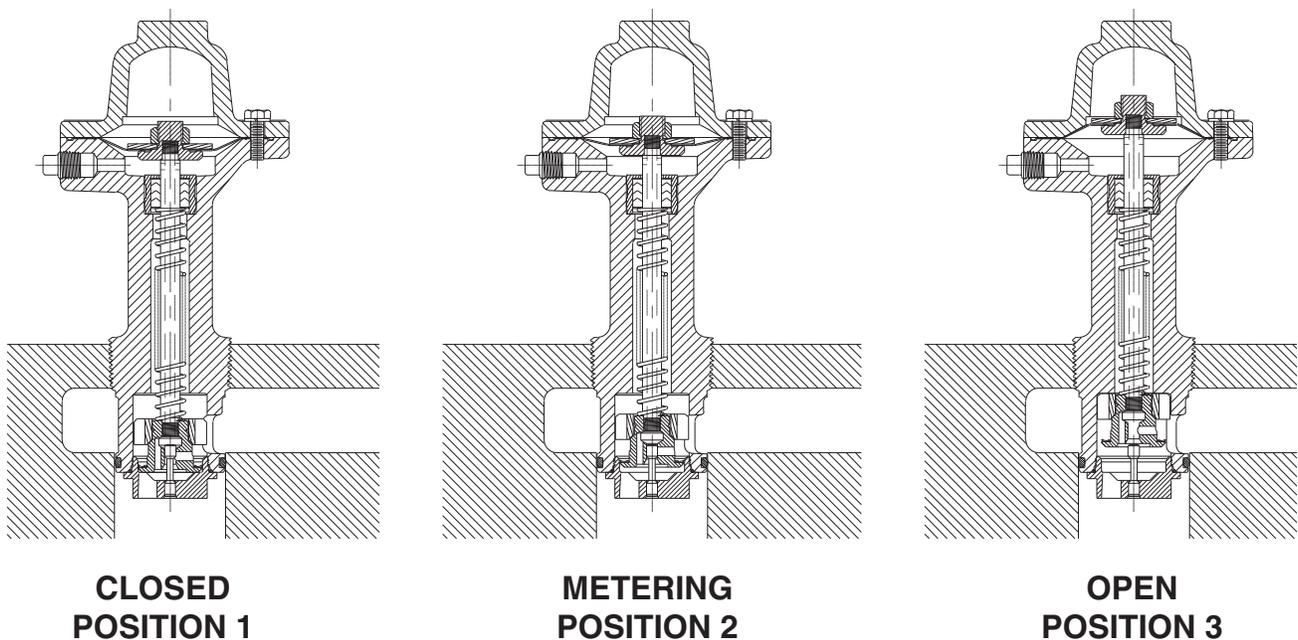


Figure 7. FX Tester operating positions

1. The Trip or Relaxed Position (Closed)

Under normal operating conditions, it is assumed that the lines are filled with gasoline. When the system pressure is less than 3 to 5 psi (21 - 35 kPa), the diaphragm and poppet are in their 'down' or 'tripped' position. the position of the valve 'poppet' is such as to allow approximately 1-1/2 to 3 gpm (5 - 11 lpm) flow into the delivery line through a bypass opening in the LLD valve poppet when the submersible pump starts. Since the system is full, pressure builds rapidly and the poppet moves to the leak sensing position assuming there is no leak present.

2. Leak Sensing Position (Metering)

As the pressure builds to approximately 8 to 16 psi (55 - 110 kPa) (rapidly) the diaphragm has moved the poppet to such a position as to almost stop the flow into the piping through the LLD valve poppet. In this position, all the flow must then travel around the metering pin which limits it to approximately 3 gph (11 lph) rate. If a simultaneous loss from the system equals or exceeds this amount, the line pressure will not build beyond this point and the valve will remain in the leak sensing position with the main flow blocked. If there is an attempt to dispense while the valve is in this position, the line pressure will drop, the diaphragm will respond, and the poppet will return to Position 1 where the 1-1/2 to 3 gpm (5-11 lpm) will flow to the dispensers. Leaks smaller than 3 gph will be indicated by the LLD taking longer than 2 - 3 seconds to open completely. If there is no leakage in the system, the small flow around the metering pin increases the line pressure to 12 - 16 psi (83 - 110 kPa) in approximately two seconds at which point the diaphragm will snap the poppet to Position 3. This all takes place in less time than it takes to reset the dispenser, walk to the car, remove the gas tank cap, insert and open the nozzle.

3. Non-Leak Position (Open)

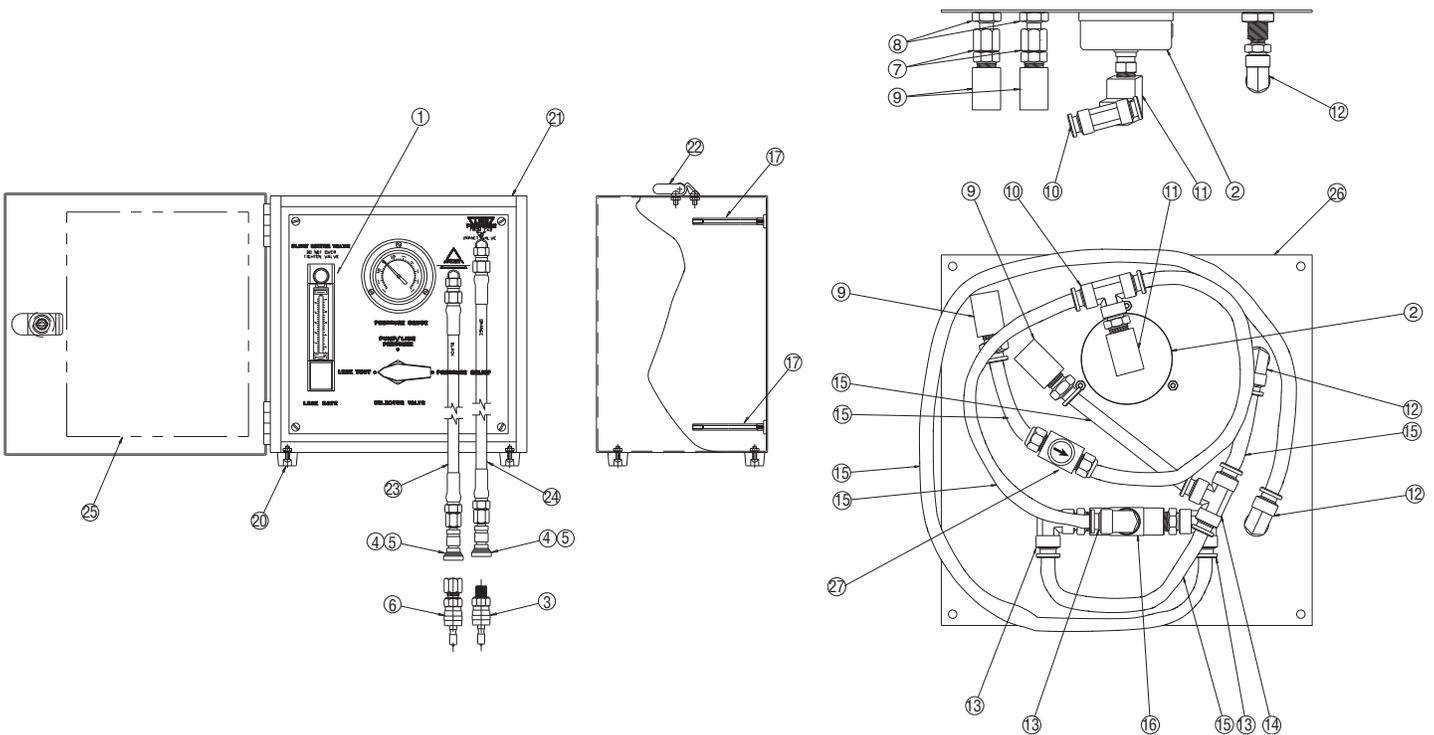
This position allows full flow. The poppet will remain in this position as long as the system pressure remains above 3 to 5 psi (21-35 kPa). At less than 3 to 5 psi, the poppet will return to Position 1 and the next time the pump is activated, the LLD will perform a line test.

NOTE Per the above process, this product is designed and sold to detect leaks of 3gph (11 lph) or greater only. For leaks of less than 3 gph, please consult with your V-R Company Representative.

Parts Description & Replacement Parts List

Table 3. FX Tester Parts List

Item	Description	P/N Number	Item	Description	P/N Number
1	Accucal Flowmeter	028-178-1	16	Valve-3-Way, Selector	088-153-1
2	Compound Gauge	031-323-1	17	Standoff, Hex Stud	080-746-1
3	1/8-In. NPT Male Snap-Tap Deso Stem	014-605-1	18	Extender, Hose Ass'y., 5 feet, Male X Female, Snap-Tap, Black (N/S)	138-208-4
4	1/4-In. NPT Female Snap-Tap Body	014-606-1		Extender Hose Only, Black (N/S)	038-212-1
5	Swagelok Tube Connection Body	014-696-1	19	Extender, Hose Ass'y., 5 feet, Male X Female, Snap-Tap, Orange (N/S)	138-209-4
6	Swagelok Tube Connection Deso Stem	014-697-1		Extender Hose Only, Orange (N/S)	038-213-1
7	Swivel Connector (9/16-In. Swivel Hex, 9/16-In. Hex)	027-241-1	20	Bumper	006-729-1
8	Bulkhead Union Elbow w/Locknut	027-244-1	21	Box	008-567-1
9	Elbow - Female	027-291-1	22	Handle	036-450-1
10	Male Branch Tee	027-290-1	23	Hose, Tester, Black	038-209-1
11	Union Elbow	027-242-1	24	Hose, Tester, Orange	038-210-1
12	Elbow, Male (1/8-In. NPTF)	027-287-1	25	Label	051-258-1
13	Elbow, Male (1/4-In. NPTF)	027-288-1	26	Panel	064-127-1
14	Tee-Union	027-289-1	27	Strainer	027-249-1
15	Nylon Tubing (0.375-In. OD; 0.275-In. ID) 10 Feet	780-311-1			



Scale Changing Instructions

1. Remove clear front shield (20) by removing four screws (18) securing it to flowmeter body.
2. Position scale (14) with desired units, GPH or ML/MIN, facing upward.
3. Align zero mark on scale (14) with zero mark on flow tube (9).
4. Using a 3/16-inch hex wrench, loosen the cylinder screw (21) at the top of the flowmeter, approximately 1 to 2 turns.
5. Rotate the flow tube (9) so scale numbers do not appear in viewing window.
6. Using a 3/16-inch hex wrench, tighten the cylinder screw (21) to secure the flow tube (9) in its new position.
7. Reinstall clear front shield (20) with notch towards valve (15) and countersink holes facing up, align holes, and secure with four screws (18). Torque to 2.5 - 3 in-lbs.

Variable Area Flow Meter

Variable Area flow meters are used to measure flow rate of liquids and gases. The meters consist of a spherical float moving vertically in a glass tube with a tapered inside diameter and a valve. As the valve is unscrewed (counterclockwise), flow through the tube increases allowing the float to rise in the tube. A scale marked on the tube is used to obtain an accurate measurement of flow rate.

The recommendation from Veeder-Root regarding the use and maintenance of the FX Tester is that this equipment should be periodically compared against standards which are traceable to the National Institute of Standards and Technology (NIST) or other recognized national metrology institutes, or compared to nationally or internationally recognized consensus standards. The frequency of this comparison will vary with use and conditions to which the tester has been subjected and is the responsibility of the owner.

Cleaning the Flow Meter

Refer to Figure 8 for disassembly and assembly.

TO DISASSEMBLE

1. Remove clear front shield (20) and scale (14) by removing the four screws (18) securing it to the flowmeter body.
2. Remove two mounting nuts (4) and rear white plastic shield (17).
3. To free the flow tube (9), turn the locking screw (21) on the top of upper block (1) counter-clockwise using a 3/16-inch hex wrench.
4. Remove the flow tube (9), stops (6 & 11), two upper o-rings (5 & 7), two lower o-rings (5 & 10), and the float (8).

NOTE

If only cleaning of the stops, float, and tube is required, refer to Cleaning. If complete disassembly is required, continue to step 5.

5. Remove eight screws (18) securing side plates (19) to upper and lower blocks (1 & 13).
6. Remove connector (3) with o-ring (2) from upper block (1) using 1/2-inch wrench.
7. Remove connector (3) with o-ring (2) and orifice (12) from lower block (13) using 1/2-inch wrench.
8. Remove valve (15) and o-rings (2 & 22) from lower block (13) using 1/2-inch wrench.

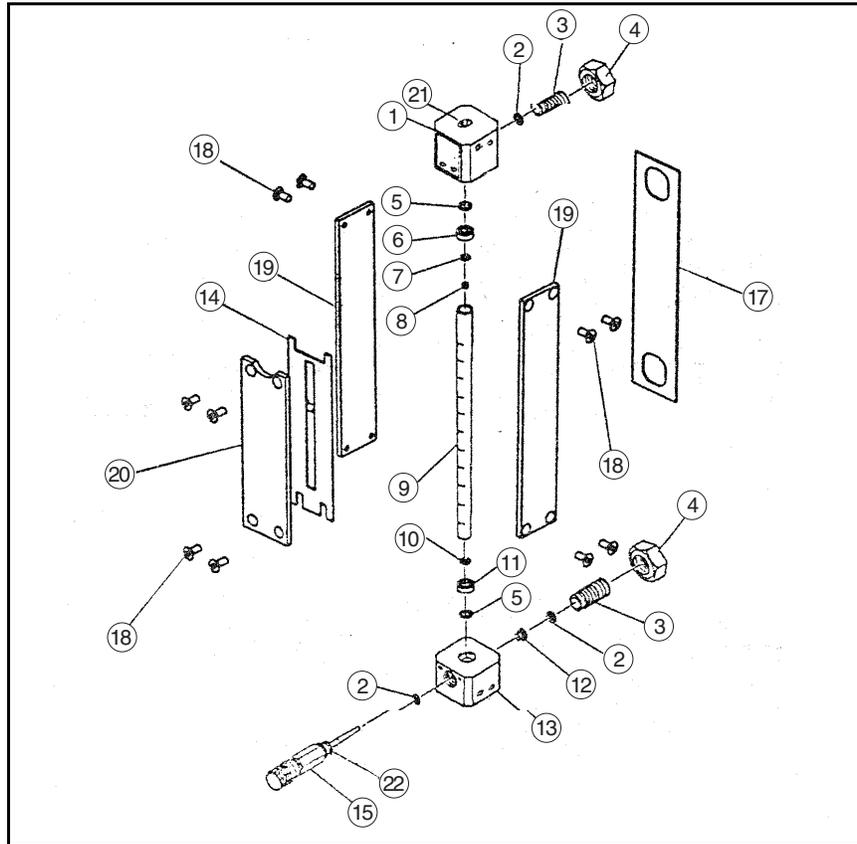


Figure 8. Flow meter exploded view

CLEANING

Clean all parts except front shield with a solvent or ultrasonic cleaner. Shield should be cleaned with mild detergent and water.

ASSEMBLY

1. Open the valve (15) by turning it counter-clockwise to prevent damage. Install valve (15) into lower block (13) ensuring that the two o-rings (2 & 22) are in place. Torque 25 - 27 in-lbs.
2. Install connectors (13) into lower and upper blocks (1 & 13) and torque 25 - 27 in-lbs.
3. Install side plates (19), with countersink holes facing up, to upper and lower blocks (1 & 13) with eight screws (18) - four each side. Ensure connectors (13) are facing same direction. Torque 8 in-lbs.
4. Turn locking screw (21) in top block (1) counter-clockwise until it stops. Install small o-ring (5), plastic stop (6), and then larger o-ring (7) into upper block (1).
5. Install open end of flowtube (9), with stop (11), two o-rings (5 & 10) pre-assembled on bottom, and float ball (8) inside, over stop in top block (1) and push in bottom of flowtube (9) until it seats in bottom block (13). Scale division 100 must be at end of frame with valve (15). Turn glass tube (9) so that scale numbers do not appear in viewing window.

6. Turn locking screw (21) in top block clockwise while holding flowtube (9) so as it does not turn. Torque 7.5 - 8 in-lbs.
7. Install scale (14) with desired units facing up. Align zero mark on scale (14) with zero mark on flowtube (9). Place clear cover (20), with countersink holes facing up, align holes, and secure with four screws (18). Torque 2.5 - 3 in-lbs.
8. Install white plastic shield (17) on back over connectors (13).
9. Remount flowmeter with two mounting nuts (4).

NOTE Stops are not interchangeable. The top stop is larger to accommodate the tapered tube ID.



Leak Detector
FUNCTIONAL EVALUATION CHART

Site Location _____

Service Company _____

Date _____

Technician Performing Test _____

TECH Number _____

TYPES OF LEAK DETECTORS TESTED

BFLD (117-182-5)

FX2V (116-057-5)

FX2DV (116-059-5)

FX1V (116-056-5)

FX1DV (116-058-5)

TEST INFORMATION

Product	Serial Number	Opening Time	Pump psi/kPa	Dispense (Yes/No)	Pump psi/kPa Pressure
1					
2					
3					
4					
5					
6					
7					
8					

Owner/Operator

(Signature)

(Date)



Leak Detector FTA EVALUATION CHART

Site Location _____

Service Company _____

Date _____

Technician Performing Test _____

TECH Number _____

TYPES OF LEAK DETECTORS TESTED

BFLD (117-182-5)

FX2V (116-057-5)

FX2DV (116-059-5)

FX1V (116-056-5)

FX1DV (116-058-5)

TEST INFORMATION

Product	Serial Number	Resiliency	Opening Time	Test Leak Rate ml/Min gph	Pressure Relief Holding psi/kPa	Metering psi/kPa	Pass/Fail Test Leak Rate ML/Min GPH	Pump psi/kPa Pressure
1								
2								
3								
4								
5								
6								
7								
8								

Owner/Operator _____

(Signature)

(Date)



Leak Detector FXT EVALUATION CHART

Site Location _____

Service Company _____

Date _____

Technician Performing Test _____

TECH Number _____

TYPES OF LEAK DETECTORS TESTED

BFLD (117-182-5)

FX2V (116-057-5)

FX2DV (116-059-5)

FX1V (116-056-5)

FX1DV (116-058-5)

TEST INFORMATION

Product	Serial Number	Opening Time	Metering psi/kPa	Pressure Relief Holding psi/kPa	Approximate Test Leak Rate ml/Min gph	Pass/Fail Test Leak Rate ml/Min gph	Pump psi/kPa Pressure
1							
2							
3							
4							
5							
6							
7							
8							

Owner/Operator

(Signature)

(Date)



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