



TR-515 F.A.P. Plus™ and
TR-51640 F.A.P. Plus™ ZW Pump
Systems

User Manual

Version 2.0

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IMPORTANT

Before beginning installation procedures, these Installation and Operating Instructions should be studied carefully. The installation and operation should also be in accordance with local regulations and accepted codes of good practice.

Information Record

Model #: _____

Serial #: _____

Sold By: _____

Date Purchased: _____

The serial number for the pump is listed on the side of the pump head. You will need this number if you call DGSi for service or support.

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IMPORTANT SAFETY INSTRUCTIONS

- Safety is a priority in the design of our remediation equipment. This manual highlights the areas that are important when you install and use this equipment. Following is a partial list of safety procedures:
- Wear chemically resistant clothing
- Wear safety goggles to protect your eyes
- Point air and discharge hoses away from your person and other personnel
- Turn off the air supply to the pump prior to service
- Avoid the pinch points during assembly and disassembly of the pumps
- Properly protect air supply and fluid discharge hoses from damage



WARNING!

Any electrical components used in an explosive atmosphere must be located in compliance with Chapter 5 of the National Electrical Code and any other local codes. This applies to electrically powered air compressors as well.

INTRODUCTION

Congratulations and Thank You for purchasing a FAP Plus™ Pump System.

Upon receipt, please inspect the pump and attachments for damage. If you note any problems, please notify the freight company that delivered the frame and call Durham Geo-Enterprises, Inc. at ☎ 1-800-837-0864 (outside the USA) ☎ +1-770-465-7557 (inside Georgia) or fax at 1-770-465-7447.

The FAP (Flexible Axial Peristaltic) Plus™ Pump System is designed to remove floating free-phase petroleum products from contaminated groundwater wells and excavations. The FAP Plus™ Pump is adaptable to a wide range of applications and is a proven, economical system for remediation. The FAP+ZW has additional features that prevent the accidental pumping of water and has built-in product-water level measuring capability.

This manual introduces the FAP Plus™ and the FAP+ZW Pump System and provides step by step guidelines for successful installation and operation. Please read this information carefully before using the pump and keep the manual handy for field reference or review by the first-time users.

Should you have any questions about using your FAP Plus™ Pump System, please call at the applicable number listed above.

OPERATION

System Components

The FAP Plus™ Pump system consists of eight basic components:

- | | |
|-----------------------------------------|---------------------------------------------------------------|
| 1. FAP Plus™ or the FAP+ZW Pump | 6. Filter/regulator mount |
| 2. Skimmer | 7. Conversion Kit for use in shallow groundwater applications |
| 3. Well Cap | 8. Air Compressor |
| 4. Pneumatic Overfill Protection Device | |
| 5. Filter/regulator | |

The FAP Plus™ Pump System is powered by air pressure, which can be provided by an air compressor, bottled air or bottled nitrogen. Each component is briefly described and illustrated.

FAP Plus™ Pump

Please refer to figure 1 on the following page. The FAP Plus™ Pump (TR-515) features an integral controller, which uses micro-pneumatic circuitry to control the pulsing of the pump bladder. This feature eliminates the need for surface mounted controllers. The cycle rate of the pump is pre-set at the factory to provide optimum pumping performance. The pump is a flexible assembly consisting of an inner and outer bladder with a check valve at both ends. The inner bladder is constructed of heavy-walled Tygon® Special tubing and an outer bladder of synthetic rubber, Buna-N lined hose. The spring return check valves are arranged to permit flow in one direction through the inner bladder. The Skimmer connects at the bottom of the pump; the top of the pump has fittings for the fluid discharge hose and air supply tubing.

FAP Plus™ ZW Pump

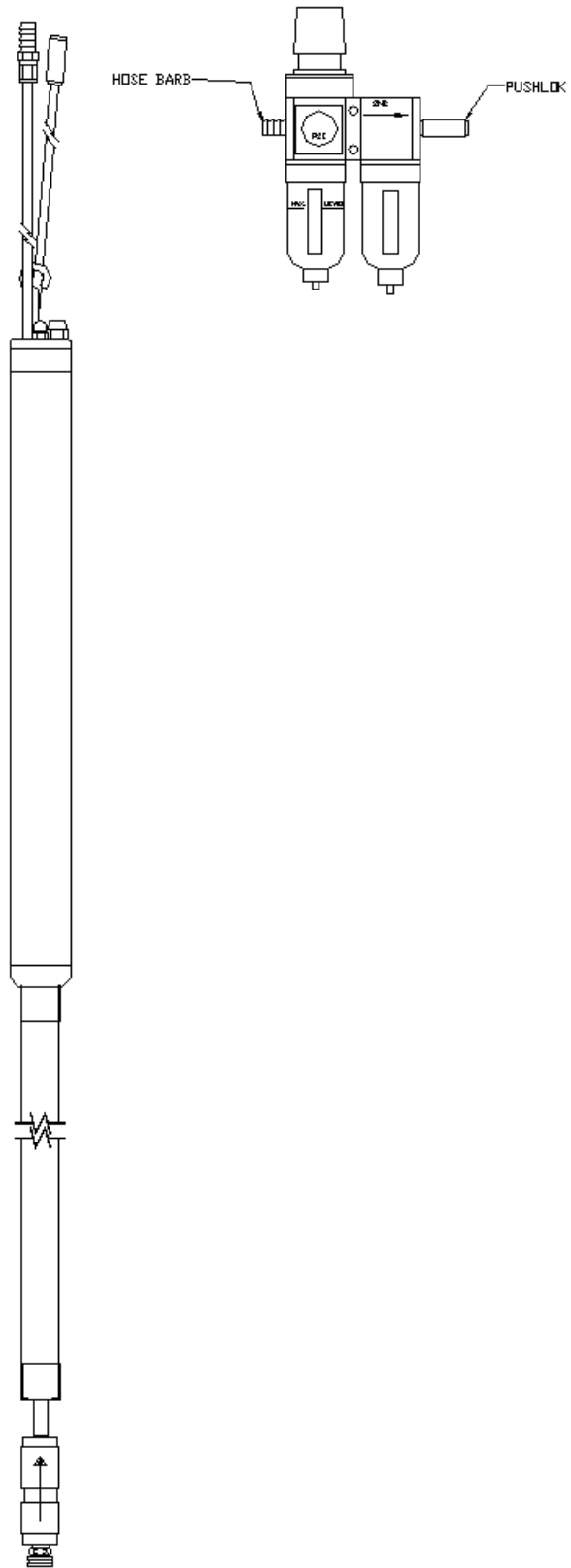
The FAP+ZW Pump (TR-51640) incorporates all the features and functions of the FAP PLUS with the added benefit of automatic shut down to prevent pumping of water. The unit also has an above grade indicator that is used to determine pumping status along with product-water interface measuring capabilities for correct skimmer placement.

Notice!

Air Pressures in excess of 100 psi (689 kPa) will damage the FAP Plus™ Pump or FAP Plus™ ZW.

OPERATION

Figure 1
FAP Plus™
Pump TR-516



Combination
Skimmer

The skimmer consists of a combined density float, hydrophobic skimmer, product bypass float, guide rod and coiled hose. With a specific gravity of approximately 0.95, the skimmer is designed to float with the inlet position just below the water/product interface. The midsection of each skimmer is fitted with a hydrophobic filter, which lets petroleum hydrocarbons pass and repels water which allows product skimming to a sheen. Above the hydrophobic filter is a product bypass float. The product bypass float allows product to be skimmed without passing first thru the hydrophobic filter. Product will bypass over the hydrophobic filter when product thickness in the recovery well exceeds 4 to 6 inches. The skimmer is attached to the FAP Plus™ Pump by a plug and socket quick connect which in turn is connected to a stainless steel tube that runs the complete length of the skimmer assembly. A coiled polyurethane hose is guided by the stainless steel tube. This coiled hose can compress and extend, allowing the float to rise and fall in response to the groundwater fluctuations. The coiled hose can accommodate changes of up to 36 inches (0.91 m) in water level, automatically maintaining the skimmer intake at the proper position. A stainless steel support tube guides the float and hose as they travel in the well.

Please refer to figures **2 & 3** on the pages 7 & 8, respectively. The Skimmer allows the FAP Plus™ Pump to be used in various well sizes. Though it is used in various wells, there are limitations on product viscosity that the pump can effectively skim. The standard FAP Plus™ Skimmer is limited to skimming NAPL products with a viscosity less than 40 SSU. Skimming of NAPL products with a viscosity greater than 40 SSU requires an optional density skimmer, instead of the standard FAP Plus™ Skimmer.

The FAP+ZW skimmer has a high level shut-off valve at the top of the stainless steel support tube just below the quick connection to the FAP+ZW pump. The valve is housed in the centralizer that keeps the density, hydrophobic filter, product bypass combination float from coming in contact with the inside diameter of the well screen. (See figure 13) Other than this high level shut off valve and housing the skimmer is the same as described as above.

When the combination float rises to the top of the stainless steel support tube, it opens the normally closed air valve before water can enter the thru the product bypass float. This stops the FAP+ZW pump from pumping water until the water level recedes or the operator adjusts the skimmer elevation in the well casing. When the valve returns to its closed position, air is again allowed into FAP+ZW Pump, resuming operation.

THE FAP Plus ZW CAN ONLY BE USED IN CONJUNCTION WITH THE SKIMMER DISCRIBED ABOVE.

Density Skimmers

Density Skimmers are required when the product viscosity is too high for the combination skimmer or where the well construction will not allow the use of the combination skimmer. The Density Skimmers are constructed of ultra-high molecular weight (UHMW) polyethylene. With a specific gravity of approximately 0.95, they float with the inlet just above the water/product interface. The 4", 6", and 12" Density Skimmer is fitted with a Nylon® mesh filter at the top or inlet to keep floating debris from entering the FAP Plus™ pump.

The 4", 6", and 12" Density Skimmers allow higher pumping rates for bulk product removal. They are attached to the FAP Plus™ Pump with a coiled polyurethane hose. The coiled hose will compress and extend allowing the float to rise and fall in response to groundwater fluctuations and product removal. The coiled hose can accommodate changes in the water level of up to 30" (762 mm), automatically maintaining the skimmer at the proper position. A restraining cable passes through the coiled hose preventing over-extension or tangling during installation and removal.

Hydrophobic Filter The amount of product that the hydrophobic filter will pass depends on the amount of product the well will yield and the hydrostatic pressure of the product against the filter.

The hydrophobic filter will prevent the passage of water to a certain extent. Two factors of influence are: product saturation of the filter and the hydrostatic pressure of the water against the filter. If the hydrophobic filter remains wet with product, water will not pass through the filter. Should the filter become dry of product, water will pass through the filter at a moderate rate. This often occurs after the product has been removed from the well and the filter is no longer wet with product. When the filter becomes re-saturated with product, the capability to hold back water is regained.

Note!

The surface tension present between a new filter and water, preventing the passage of water through the filter, is much less after the filter has been wet with product and dried.

Filter Maintenance

- Should a filter be removed from a well and allowed to dry or become dry of product in the well, it should not be placed back into skimming operation without first soaking the filter in the product that it will be skimming. This will help restore the hydrophobic capability of the filter.

- When the filter becomes fouled due to iron or other biological growth it must be replaced. Filters that have become slightly soiled (dirt, grease smudges, etc.) can be cleaned with a mildly abrasive household soap. Heavy grease or oils may be removed with readily available solvents such as ethylene chloride. For organic materials and micro-organisms, submerge the filter in 50% to 75% solution of muriatic acid in water in a vertical section of PVC pipe and leave overnight. Rinse the tubes thorough with water and allow to dry. If the filter is still dirty or fouled after this cleaning process, replace with a new filter. Before placing the filter back into operation, soak the filter in the product it will be skimming.

Figure 2
FAP Plus™ Skimmer
(TR-517)

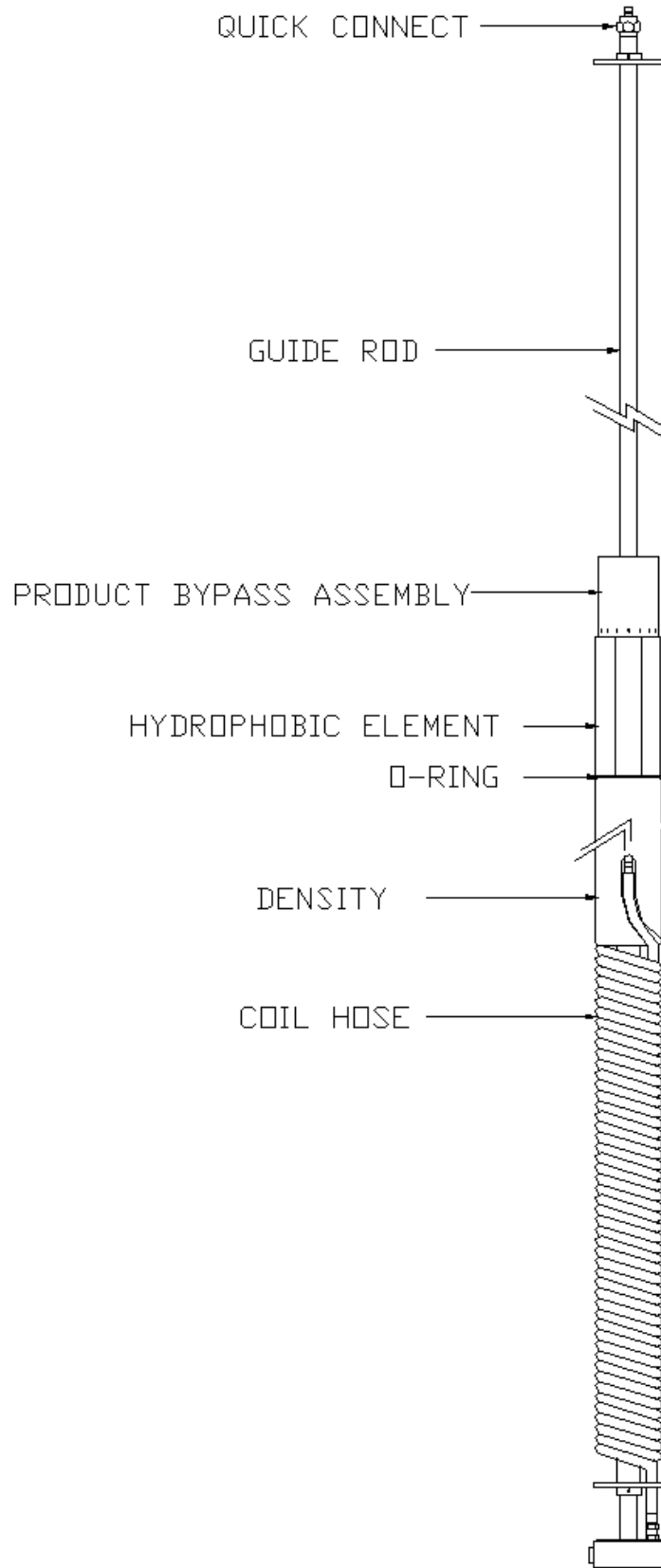


Figure 3
Density Skimmers

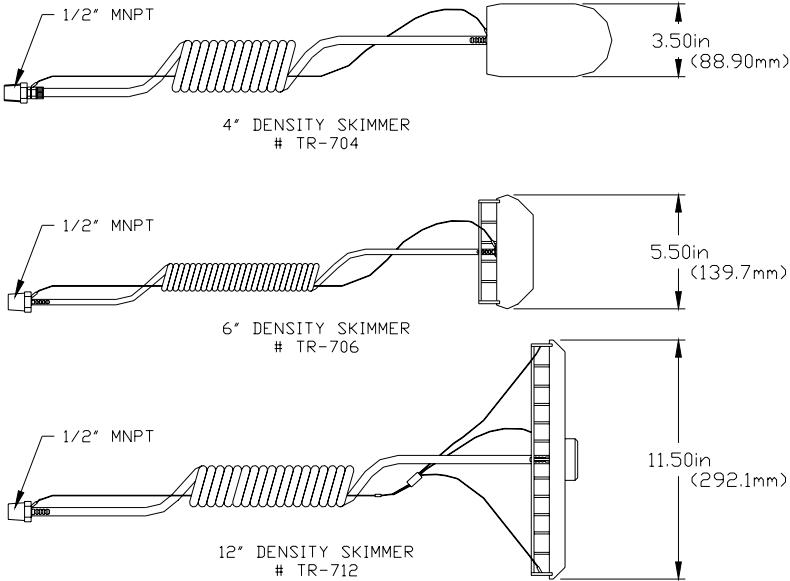
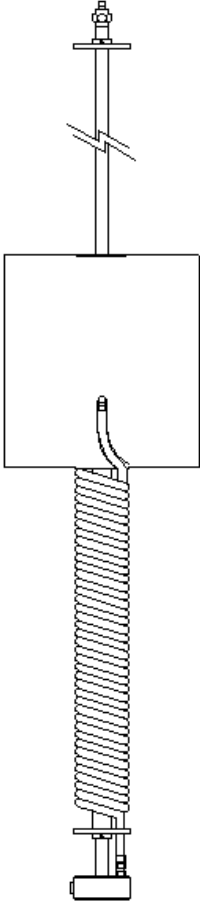


Figure 14
High Viscosity Skimmer
(TR-70410)

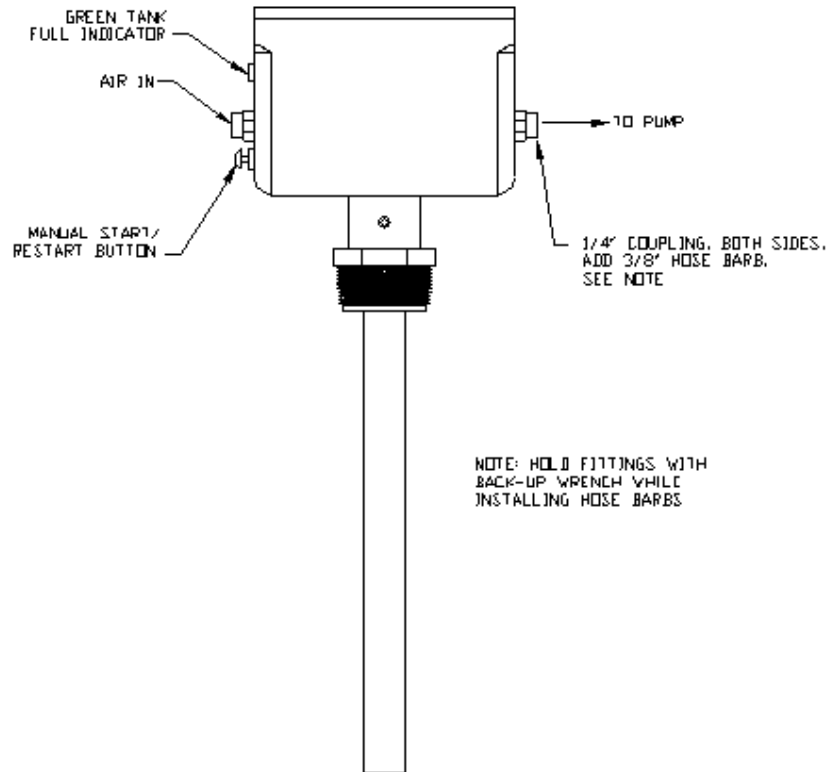


Installation of FAP Pump Accessories

All-Pneumatic Overfill Protection Device

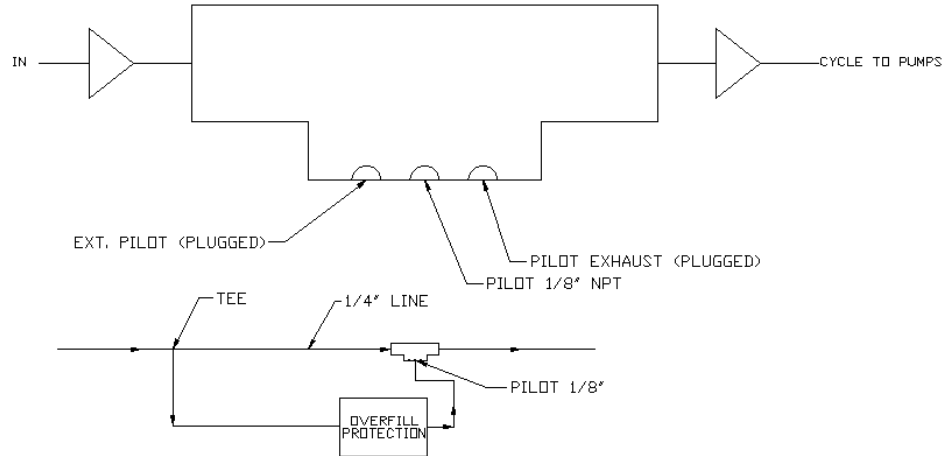
The standard All Pneumatic Overfill Protection Device serves as an interface between the air source and the product storage tank. This Overfill Protection Device is a compact, all pneumatic device which is easily installed at the product storage tank. The all-pneumatic operation makes it safe for use in explosive vapor environments. When the product storage tank is nearly full, an air valve shuts off the main air supply, and deactivating the FAP Plus™ Pump System. After the product storage tank has been emptied, and the manual restart button has been depressed, the Overfill Protection Device will restart the pumping system. Figure 4, below, shows the All Pneumatic Overfill Protection Device, while Figure 5, on page 12, shows a FAP Plus™ System installation using the All-Pneumatic Overfill Protection Device. Installation instructions follow:

Figure 4
All Pneumatic
Overfill Protection
Device



If used with multiple pumps, the bypass valve must be used (TR-75711) Refer to diagram.

OPERATION



Attach the main air supply line to the port labeled "Air In" on the Overfill Device. Use the provided hose barbs.

Notice!

1. Be sure to hold the fittings steady with a backup wrench while installing those barbs; so as to prevent internal damage to the Overfill Device.
2. 3/8" ID Buna-N hose is commonly used for the main air supply line. For larger systems, it may be necessary to increase the size of the main air supply line substituting appropriately sized hose barbs for the 1/4" MNPT x 3/8" hose barbs supplied with the device.

Connect the main air supply line from the port labeled "To Pump" on the Overfill Device to the inlet side of the filter/regulator assembly.

Verify proper Overfill Protection Device operation by pressing the reset button to pressurize the system and then submerging the sensor tube, simulating tank "high level". The device should immediately shut off main air supply. Mount the Overfill Device to an upright position and depress the manual restart button. The device will now allow the system to resume operation.

Note!

For long runs of main air supply lines down stream of the Overfill Device, the manual restart button should be depressed for several seconds to re-pressurize lines and allow the restarting of the system.

Install the Overfill Device into a 2" NPT bung hole on the product storage tank and drum.

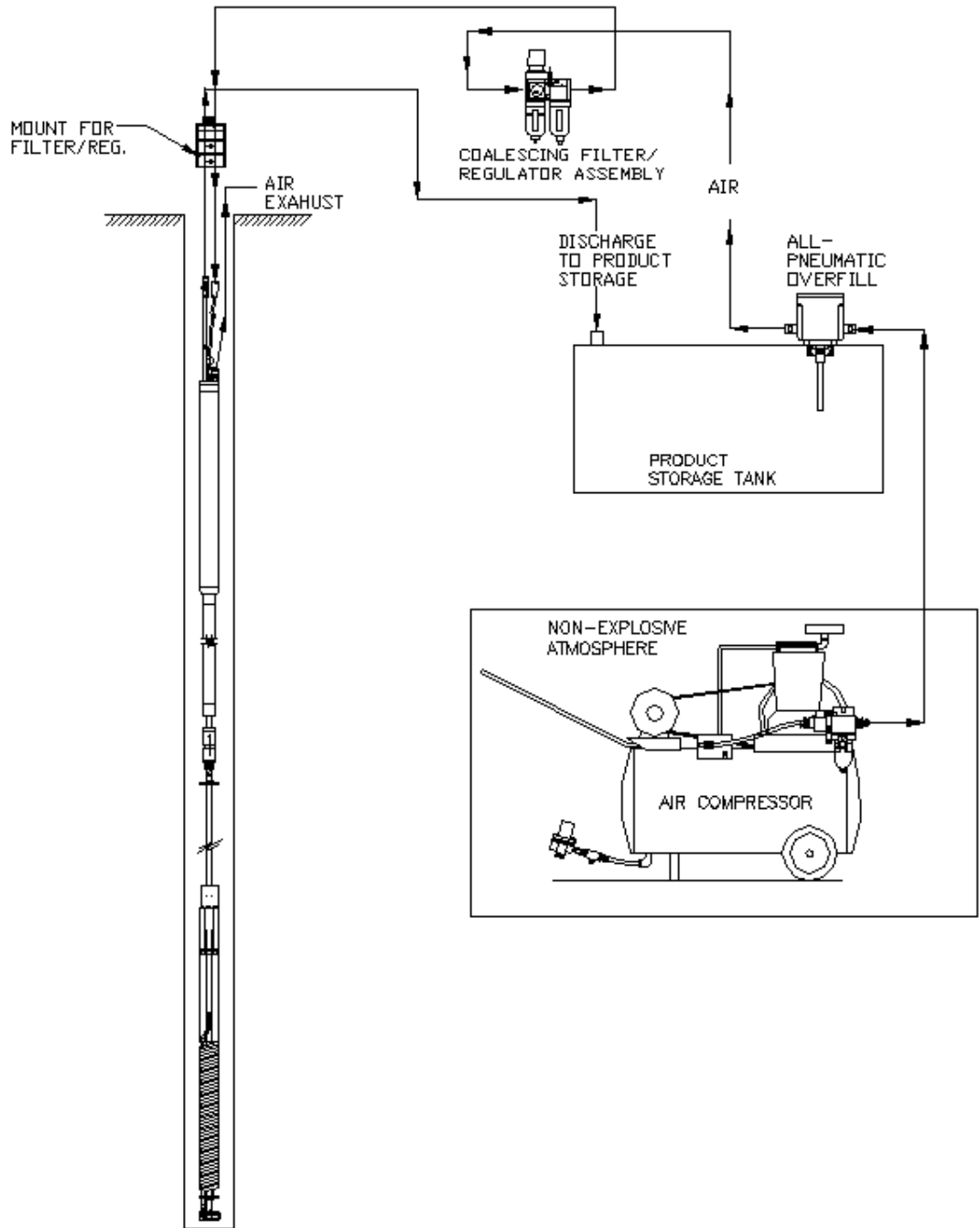


Figure 5
FAP Plus™ System
Installation

Air Source

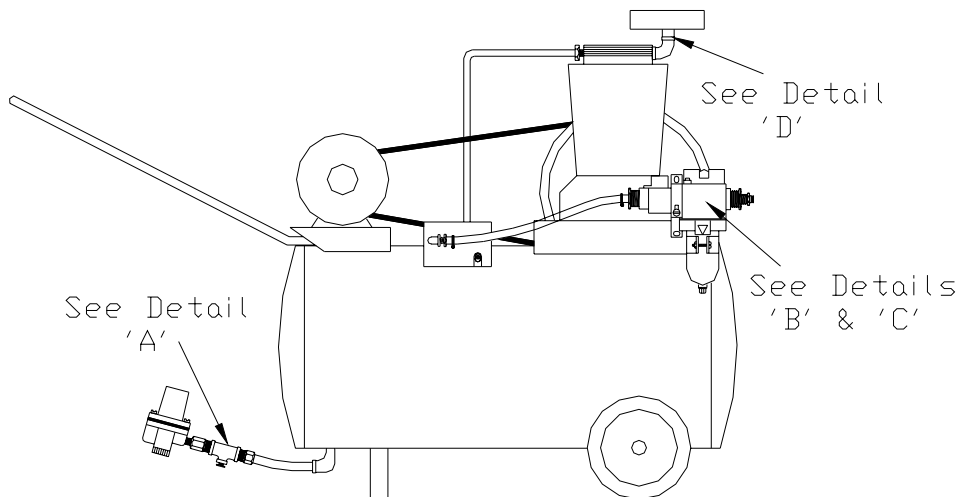
The FAP Plus™ Pump System package (TR-515) includes a non explosion-proof, 2 hp (1.5 kW), indoor-use air compressor with a coalescing air filter and auto-drain attachments (figure 6). These components are covered by the manufacturer's Operations Manual and Warranty.

Warning!

- 1) If other air sources are used, it is necessary that they include, as a minimum, a 5-micron coalescing type air filter.
- 2) In freezing weather conditions, the addition of an air dryer is strongly recommended to avoid freeze damage to the system.
- 3) Air pressure in excess of 100 PSI (689 kPa) will damage the FAP Plus™ Pump.

Bottled air or nitrogen may also be used to power the FAP Plus™ Pump System temporarily. A high-pressure regulator must be used to modify cylinder air pressure to the working range of the Controller, 60 to 100 psi (275 to 689 kPa).

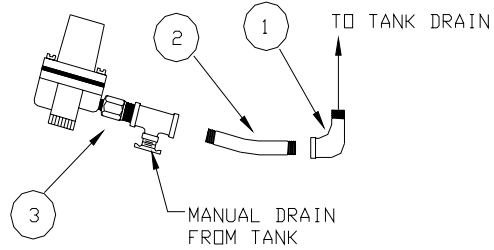
Figure 6
Air Compressor Kit
TR-902



AIR COMPRESSOR SET-UP

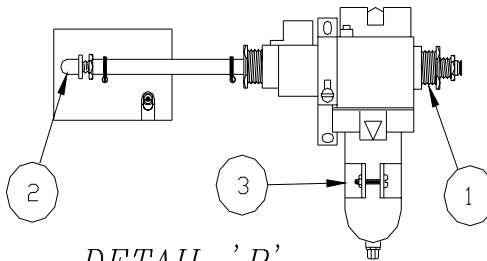
OPERATION

The previous page shows the correct air compressor setup. Please follow the instructions for each sub-system setup on the following pages. Starting with Detail 'A' simply follow the numbered instructions in the order listed.



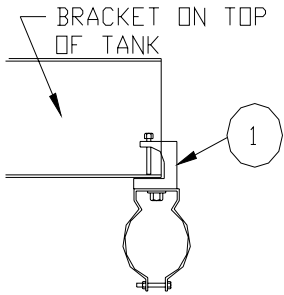
DETAIL 'A'

1. Screw in elbow to air compressor.
2. Screw extension tube into elbow.
3. Attach drain valve system to extension tube.



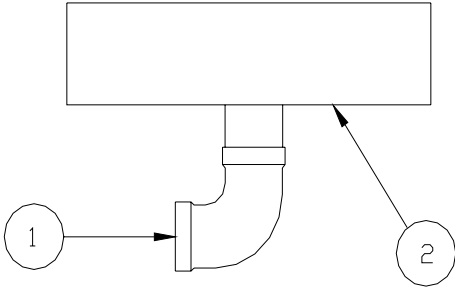
DETAIL 'B'

1. Attach desired hose hookup (It comes with $\frac{1}{4}$ " adapter attached, but a $\frac{3}{8}$ " and $\frac{1}{2}$ " adapter are also included.)
2. Screw in elbow (with attached components)
3. Mount system with attached mounting bracket. (See Detail C below)



DETAIL 'C'

1. The mounting bracket shown from a top view on the air compressor system.



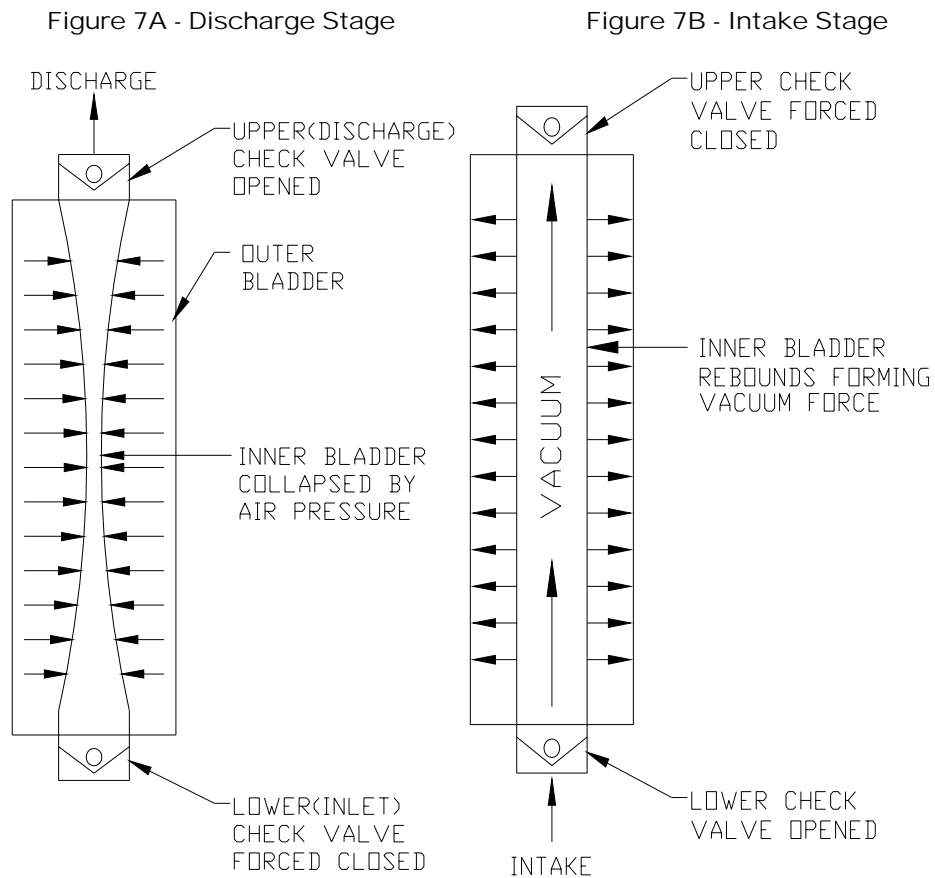
DETAIL 'D'

1. Attach the enclosed elbow to the air compressor as shown in the Air Compressor Set-up (page 1).
2. Screw the air filter to the elbow.

Principles of Operation FAP Plus™ and FAP Plus™ ZW

The FAP Plus™ Pump System works by cycling air pressure to the bladder. Figure 7A & 7B illustrates the two stages of a single cycle. In Figure 7A, the system is in the "ON" or discharge stage. The bottom check valve is forced closed as high-pressure air is introduced into the annular space between the inner and outer bladders. The pressure squeezes and collapses the inner bladder forcing its fluid contents to be emptied out through the discharge line. In Figure 7B, the air pulse is exhausted during the "OFF" or filling stage. The inner bladder rebounds creating a strong suction or vacuum. This vacuum forces the top check valve closed and draws fluids into the bottom inlet of the Pump filling the inner bladder. The cycle then repeats.

Figure 7A & 7B
Principles of FAP
Operation



The skimmer and coiled hose are connected to the bottom inlet of the FAP Plus™ Pump by a stainless-steel guide rod. Fluids enter the coiled hose through the top of the float during the pumps "OFF" stage. The Skimmer is designed to float with the inlet just above the water/product; since the top of the float is immersed in product, only floating product is removed by the FAP Plus™ Pump.

During the course of FAP Plus™ Pump operation, the location of the water/product interface may change due to changes in the product thickness or fluctuations in the groundwater level. The coiled hose will extend or compress automatically to accommodate interface fluctuations of approximately 36" (914 mm). The position of the Skimmer at the interface then remains unchanged, and the system can continue to "skim" product only.

When the product layer has been reduced to a minimum, the float will still float above the water's surface. The float inlet will be exposed to air and will, therefore, pump air into the system. The air will be discharged during the "ON" stage. This phenomenon of "sucking air" is often reported as a system problem, but most often simply means that the pump is removing product at a rate greater than the product yield in the well. Under normal operation, the FAP Plus™ Pump equipped with a FAP Plus Skimmer can typically remove product to a sheen.

Situations can occur during skimming operations that can cause the water level to rise beyond the automatic interface adjustment capacity of the combination skimmer. In this situation the FAP+ZW can prevent the accidental pumping of ground water. The FAP+ZW has the same operating specifications as the FAP Plus™ and incorporates additional pneumatic circuitry that will shut the pump off when the combination skimmer has reached the upper limit. When the ground water falls or the operator raises the skimmer the FAP+ZW will start pumping again. Included with the FAP+ZW is a surface mount indicator gage that at quick glance can show the operational status of the FAP+ZW pump.

When using the combination skimmer and the FAP+ZW the pressure reading on the surface mount gage will be between 50 to 60 PSI when the combination skimmer is within its operational elevation range and is operating normally. If the combination skimmer rises to its maxim limit due to water table fluctuations or other reasons the surface mount gage will abruptly fall to 0 PSI. The pump will stop pumping before the water level rises to the level of the product bypass float intake. Using this feature an individual can slowly lower a operating FAP+ZW pump with the combination skimmer and locate the approximate product/water interface.

Installation and Operation

System Configuration

The FAP Plus™ Pump System may be used to remove product from 2" and larger diameter wells, recovery trenches, excavations, or from open water. The relative location of the system components may differ among various sites; similarly, the length of discharge and air hose required to connect the components will vary. Otherwise, the installation and operation of the FAP Plus™ Pump System is essentially the same for any application.

1. The FAP Plus™ Pump System is intended for use with refined petroleum products such as gasoline, diesel fuel, kerosene, jet fuel, and #2 fuel oil. For other applications, please contact Durham Geo-Enterprises for technical assistance.
2. Product viscosity will greatly affect performance of the FAP Plus™ Pump. Viscosity's greater than 40 SSU (4 centistokes @ 55°F/13°C) are not recommended. (For questions concerning product viscosity, please call Durham Geo-Enterprises for assistance.) The Density Skimmers must be used in this application.

Warning!

Any electrical components used in explosive atmosphere environments must be located in compliance with Chapter 5 of the National Electric Code and any other applicable local codes. This would apply, for example, to electrically powered air compressors and to the Durham Geo Electro-Pneumatic Overfill Protection Device.

3. Clean and dry air must be provided to the FAP Plus™ Pump, to enable proper operation and prolong life of the pump. We recommend that the air source be fitted with a 5 to 10 micron combination particulate and coalescing type air filter with automatic water drain as a minimum (this is included in the FAP Plus™ Pump System package). Air compressors rated for outdoor use should be protected from precipitation.

Notice!

We recommend that the product discharge hose be comprised of a material (such as Buna-N lined hose) that is rated for use with petroleum-hydrocarbon products. The down-hole air supply line should be ¼" (6.3 mm) OD polyethylene tubing. Main air supply and main discharge lines should be sized according to the length of run and the total flow rate required. You may call Durham Geo-Enterprises for assistance with sizing main air supply and product discharge lines.

FAP Plus™ Pump / Skimmer Installation Procedure

Connecting the Components

The assembly of the FAP Plus™ Pump and Density Skimmer is shown in Figure 8 (on the 2nd following page). The following information is provided as a guide for preparing the pump assembly for installation and operation.

1. Measure the length of the FAP Plus™ Pump plus the distance to the top of the density skimmer as shown in Figure 8 (L_{FAP}). The measurement must be made with the coil hose retracted and skimmer against the lower-stop. Note: When using the FAP Plus™ skimmer an additional two feet must be available below (L_{FAP}) for the skimmer to operate in the well.
2. Measure the depth to the water/product interface (H_w). If the product thickness is greater than 3 feet (1 m), correct H_w to account for rebound of the static water table.
Example: $H_{w(\text{corrected})} = H_w - (\text{product thickness}) \times (\text{specific gravity of product})$
3. Determine the required down hole length of the discharge and air supply hose (L_H). This length will be: $L_H = H_w - L_{FAP}$. The total required length of discharge and air hose equals L_H plus additional hose to reach the product storage tank and filter/regulator assembly.
4. Connect discharge hose, air line, and safety cable to the FAP Plus™ pump. Be sure each line is securely fastened.

Note: The ID of the air line must be kept clean and dry prior to connection.

The following instructions are relevant to all installations, but are written assuming a GDSI Well Clincher is being installed. Pass the loose end of each through the bottom side of the Well Clincher, positioning the clincher on the hoses and safety cable to equal the distance determined as H_w . Tighten fittings on the top of Well Clincher, and secure the safety cable with cable clamp provided.

Note!

To insure a leak free seal of the air line, make a square cut on the end of the air line before inserting it into the fitting. You should also inspect the outer surface of the tubing to be sure that it is smooth and free of scratches.

5. Place filter/regulator-mounting adapter on the well casing. Lower the FAP Plus™ skimmer and pump into the well. Place the Well Clincher on top of the filter/regulator mount.
6. Mount the filter/regulator assembly on the mounting adapter supplied with the well Clincher using the bolts provided. Connect the air line from the pump to the outlet side of the filter/regulator assembly. Connect the discharge hose from the pump to the product storage tank.

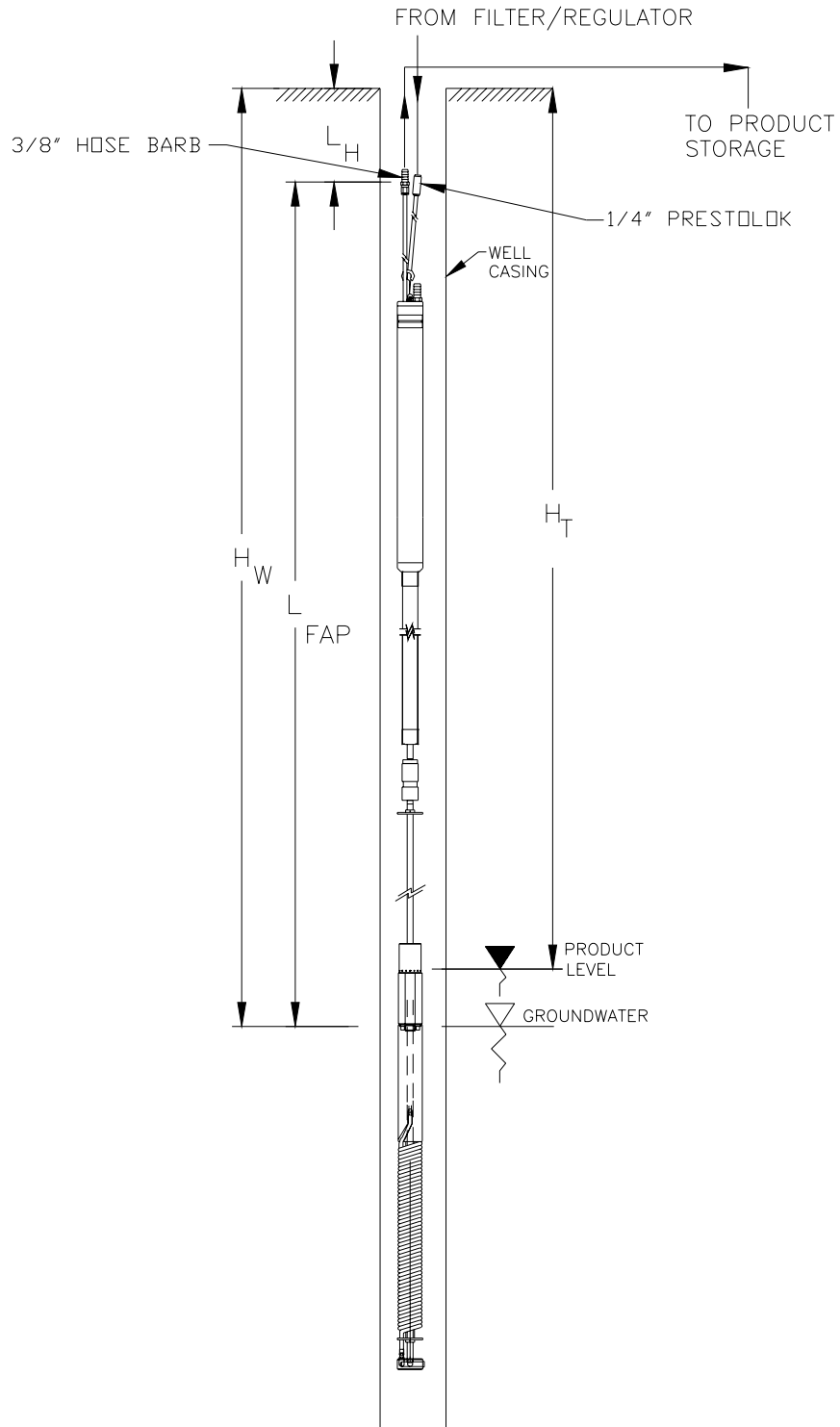
OPERATION

7. Mount the pneumatic overfill device on the product storage tank. Connect an air line to the fitting labeled "TO PUMP" and the opposite end will connect to the inlet side of the filter/regulator assemble at the well.
8. Connect another air line to the fitting labeled "AIR IN" on the pneumatic overfill and connect the opposite end to the air compressor or compressed air source. A coalescing filter should be installed at the air compressor and the air line will connect to the outlet side of this filter.

**Note: The air compressor must be located
in a non-hazardous area.**

OPERATION

Figure 8
FAP Plus™
Operation



For the first-time user it is very helpful to visually observe the pump in operation prior to installation. To do this, simply immerse the inlet end of the FAP Plus™ Pump in a 5-gallon (20 L) bucket of water and follow steps 6 - 8 of the operating procedure. After a few cycles, you can feel the changing pressures inside the pump as the air cycles "ON" and "OFF".

Notice!

We recommend that a safety rope or cable be attached to the eye bolt on the FAP Plus™ Pump and secured at the well head. (Included with the system)

FAP+ZW Pump and Skimmer Installation Procedure

Note: Please refer to Figures 13 & 15.

1. On the rod skimmer, remove the quick connect on the top of the stainless steel 1/8" pipe and remove the top centralizer by loosening the set screw. Replace it in approximately the same location with the high level switch/ top centralizer and secure it to the 1/8" pipe with the set screw provided. Reinstall the quick connect, sealing the thread with Teflon pipe tape.
2. Connect the rod skimmer assembly to the FAP Plus ZW pump using the quick connect fittings attached to each component. Connect the 1/8" O.D. high level sensor tube to the FAP+ZW pump using the 1/8" push-in tube union if the tubing was disconnected during the installation of the high level switch/centralizer. The extra length of 1/8" tubing can be coiled like a spring around the bottom hose of the FAP Plus ZW pump to prevent it from being kinked during installation.
3. Determine the depth the skimmer will be positioned in the well. See Figure B for proper well position.
4. When the skimmer position has been determined, obtain the required length of down well discharge and supply hose (LH). This length will be $LH = HW - LFAP$. Additional hose and tubing length must be added to each to make connections to the product storage tank and filter/regulator assembly and for adjustments when large water table fluctuations occur. The high level sensor output gage is supplied with 100 feet of 1/8" O.D. tubing with each FAP Plus ZW pump.
5. Connect discharge hose, airline, and safety cable to the FAP Plus™ ZW pump. Be sure each line is securely fastened.

Note: The I.D. of the airline must be kept clean and dry prior to connection.

OPERATION

6. Pass the loose end of each through the bottom side of the Well Clincher, positioning the clincher on the hoses and safety cable to equal the distance determined as HW. Tighten fittings on the top of Well Clincher, and secure the safety cable with cable clamp provided.
7. Place the assembled pump and skimmer on a flat surface near the well head. Refer to OPERATION below before continuing with the in well installation. The FAP Plus ZW pump should be operated with the high level sensor and high level sensor gage connected before installation in the well to ensure proper operation and to familiarize new operators with it's functions.
8. Place filter/regulator-mounting adapter on the well casing. Lower the FAP Plus ZW skimmer and pump into the well. Place the Well Clincher on top of the filter/regulator mount.
9. Mount the filter/regulator assembly on the mounting adapter using the bolts provided. Connect the airline from the pump to the outlet side of the filter/regulator assembly. Connect the discharge hose from the pump to the product storage tank.
10. Mount the pneumatic overfill device on the product storage tank. Connect an airline to the fitting labeled "TO PUMP" and the opposite end will connect to the inlet side of the filter/regulator assemble at the well.
11. Connect another air line to the fitting labeled "AIR IN" on the pneumatic overfill and connect the opposite end to the air compressor or compressed air source. A coalescing filter should be installed at the air compressor and the airline will connect to the outlet side of this filter.

Note: The air compressor must be located in a non-hazardous area.

Operation

1. Be sure all airlines are secure and the fittings are tightened.
2. Be sure the product discharge line is secure to the product storage tank.
3. The FAP Plus™ ZW system must be supplied air from an air compressor that will deliver 1 cfm @ 100 psi constant usage.
4. Do not operate the system in excess of 100 psil.
5. Check the compressor for proper oil level.
6. Note: Do not use synthetic oil in the compressor, damage can result to pneumatic components.
7. Pressurize the air line from the compressor to the pneumatic overfill device. Air pressure within the range of 80 to 100 PSI is suitable for most applications.
8. Activate the operation of the pneumatic overfill device by depressing the green button and holding down for several seconds. Release the green button and the indicator should remain green indicating the airline is pressurized and the device is in operation.
9. At the well adjust the pressure on the filter/regulator assembly to 60-PSI minimum. With the high level switch not activated by the density float, (float not touching the white ¼" diameter plastic ball of the high-level switch), observe the high level sensor output gage. The gage pressure will rise slowly, and in approximately 30 seconds, will reach 55-60 psi, and the FAP Plus ZW pump will start to operate. While observing the high level sensor gage, move the density skimmer enough to push on the ¼" plastic ball on the high level switch. The pressure reading on the high-level sensor gage should drop to zero and the FAP Plus ZW will stop operating. Repeat this operation and with some practice an operator can determine the approximate product/ water interface just using the high level sensor gage pressure when installing or adjusting the level of the FAP Plus ZW in the recovery well.
10. Check the product storage tank for product. Allow several minutes for product to fill the line before the product begins to discharge into the tank.
11. When the tank fills, the pneumatic overfill device will shut the air off to the FAP Plus ZW system. The tank must be emptied before the device can be reset and skimming resumed.
12. Provide routine maintenance as described in the Upkeep section of the Operator's Manual.

Figure 13

FAP Plus™ ZW System
Installation

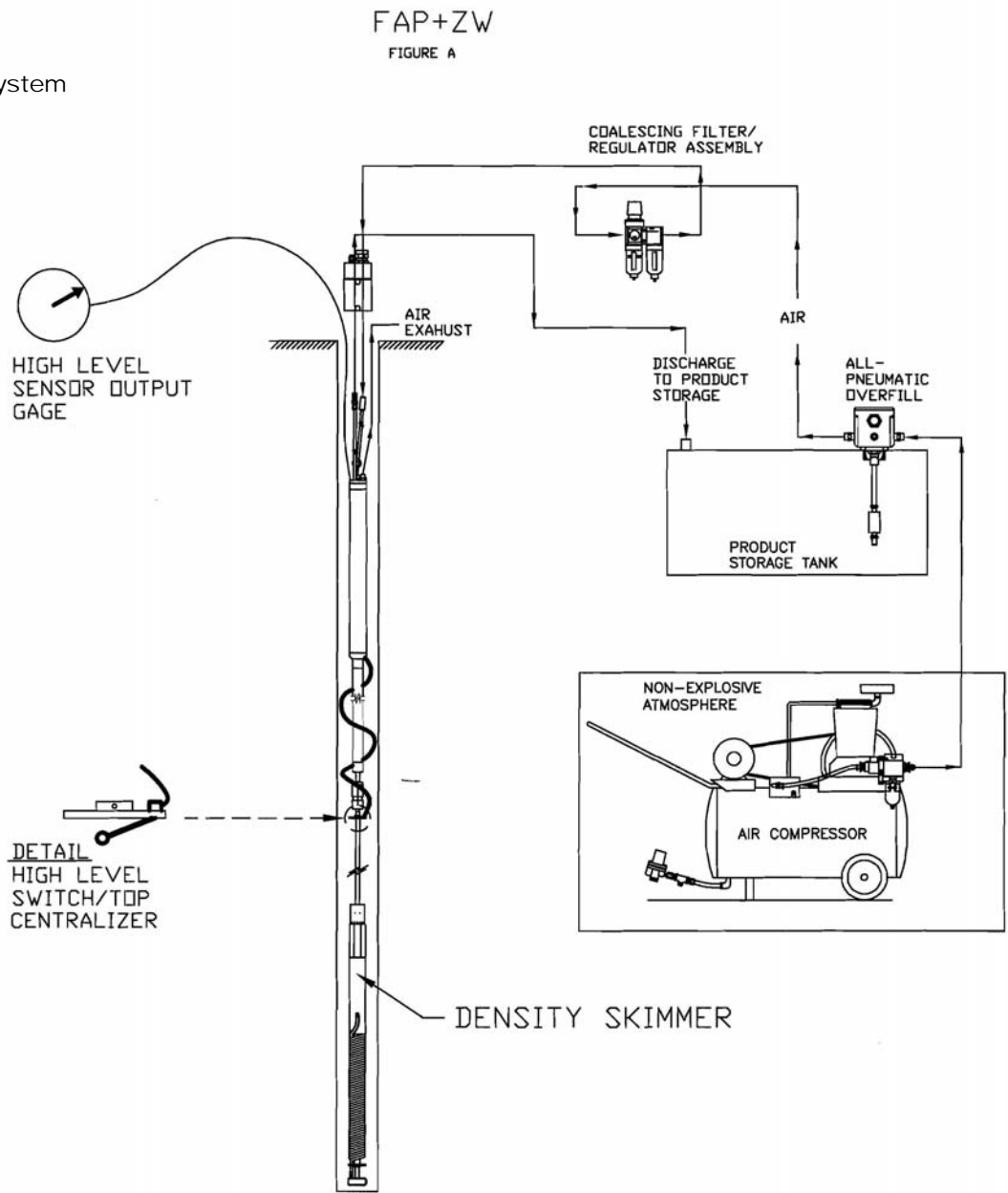
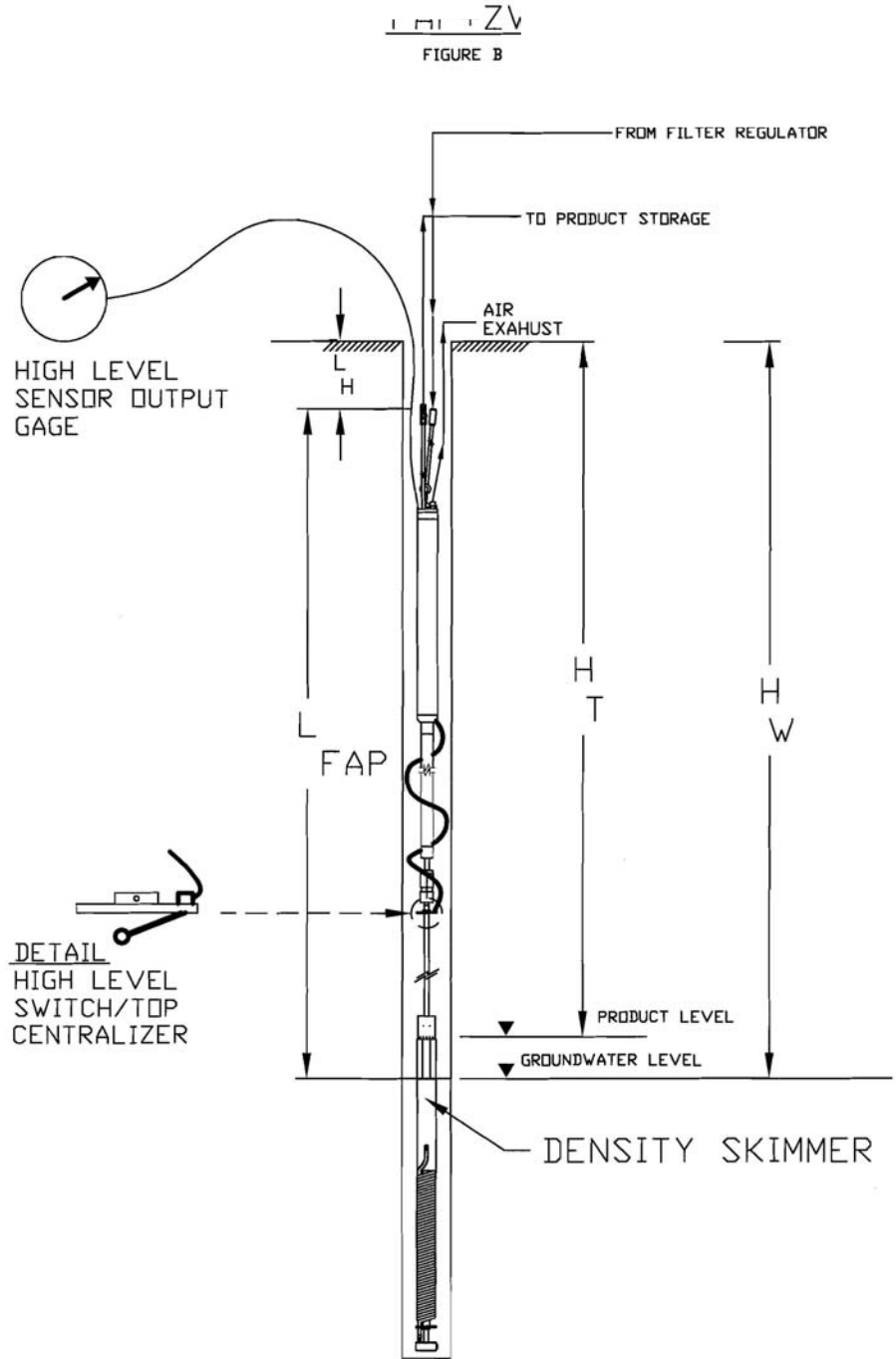


Figure 15



Operating Instructions

Notice!

1. The air compressor must be located in a non-hazardous area.
 2. If the overflow protection device is being used, refer to pages 9-11 for details.
 3. For shallow groundwater table applications, it may be necessary to coil the FAP Plus™ Pump body in the well head. In such applications, adapt the shallow groundwater kit to the pump & skimmer. (See instructions with kit)
1. Be sure all air lines are secure and the fittings are tightened.
 2. Be sure the product discharge line is secure to the product storage tank.
 3. The FAP Plus™ system must be supplied air from an air compressor that will deliver 1 cfm @ 100 PSI constant usage.
 4. Do not operate the system in excess of 100 PSI.
 5. Check the compressor for proper oil level.

Notice!

Do not use synthetic oil in the compressor, damage can result to pneumatic components.

6. Pressurize the air line from the compressor to the pneumatic overflow device. Air pressure within the range of 80 to 100 PSI is suitable for most applications.
7. Activate the operation of the pneumatic overflow device by depressing the reset button and holding down for several seconds. Release the button, the indicator should remain green indicating the air line is pressurized and the device is in operation.
8. At the well adjust the pressure on the filter/regulator assembly to 60-PSI minimum. The FAP Plus™ pump will now begin operating.
9. Check the product storage tank for product. Allow several minutes for product to fill the line before the product begins to discharge into the tank.
10. When the tank fills, the pneumatic overflow device will shut the air off to the FAP Plus™ system. The tank must be emptied before the device can be reset and skimming resumed.

Electro-Pneumatic
Overfill Protection
Device (Optional
Accessory)

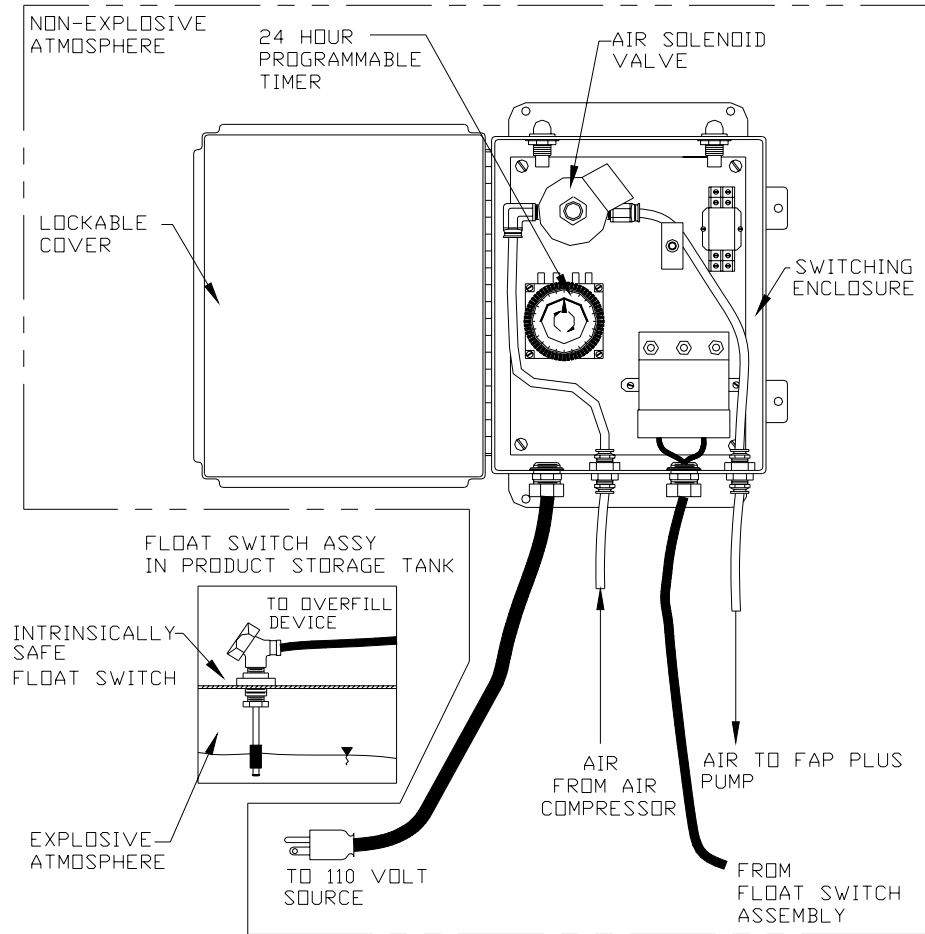
This Electro-Pneumatic Overfill Protection Device serves as an interface between the air source and the product storage tank. It comes standard with a 24-hour programmable timer. The intrinsically safe float switch activates the Overfill Protection Device when the storage tank is nearly full. The device, in turn, closes an electrically powered air solenoid valve, which deprives the pump of supply air and deactivates the FAP Plus™ Pump System. After the product storage tank is emptied, the Overfill Protection Device restarts the system.

Warning!

1. Please note that the Electro-Pneumatic Overfill Protection Device switching enclosure is NOT rated for use in explosive vapor environments.
2. Do Not attempt to remove any panel with the unit plugged in. Before examining the interior of the machine, disconnect the power to the machine. Either 110 V_{AC} or 220 V_{AC} will cause serious injury to you and the machine.

Figure 9 (on the following page) shows a schematic of the Electro-Pneumatic Overfill Protection Device installation, while Figure 10 (on the second following page) shows a typical FAP Plus™ installation using the Electro-Pneumatic Overfill Protection Device.

Figure 9
Electro-Pneumatic
Overfill Protection
Device w/Timer



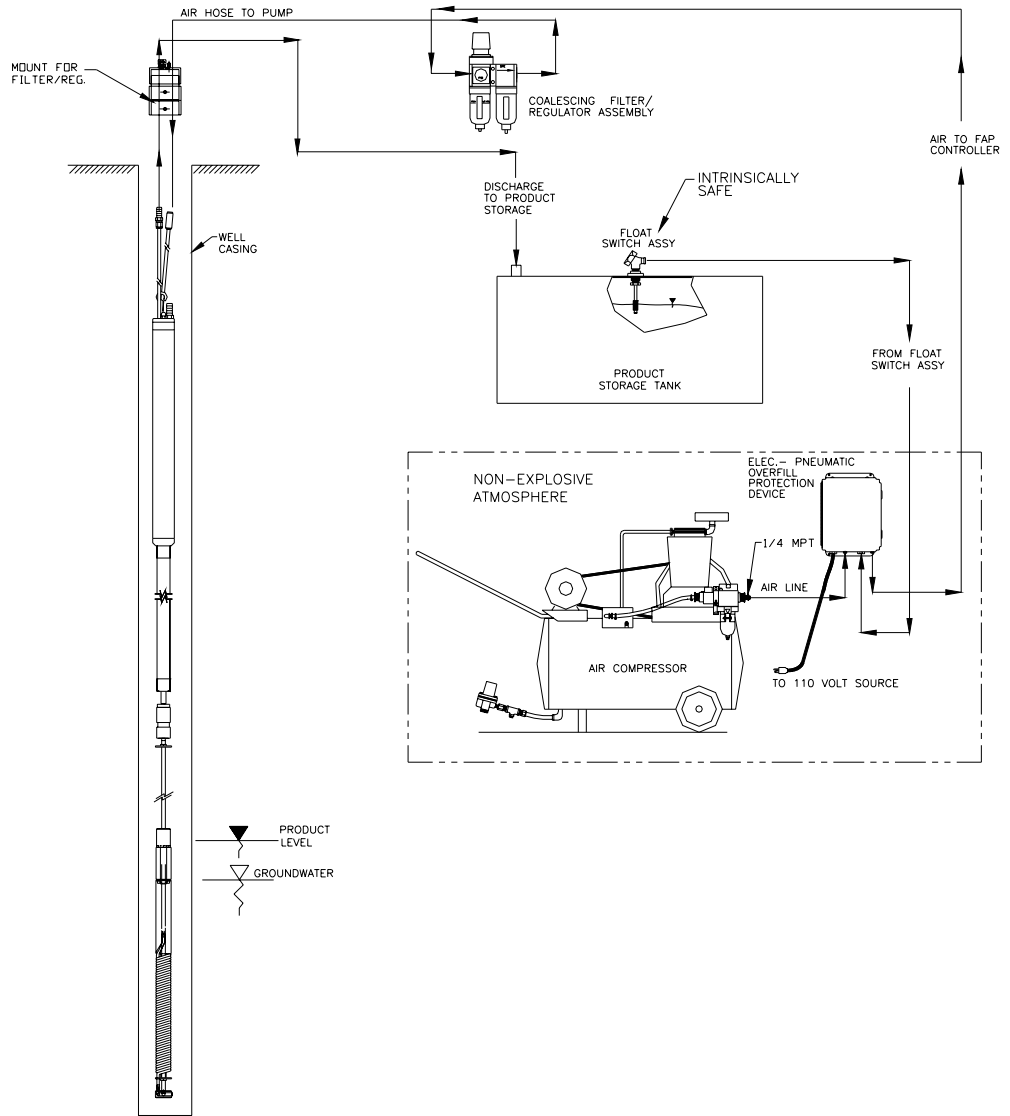
Installation:

1. Connect the main air supply line from the air compressor to the overfill device port labeled "Air In". Next, connect the air line from the inlet of the filter/regulator assembly to the overfill device port labeled "To Pump".
2. Connect the male plug of the Electro-Pneumatic Overfill Protection Device to an approved 110V source. The unit is supplied with 8' (2.4 m) of cord.

OPERATION

Figure 10
FAP Plus™
Operation

Electro-Pneumatic
Overfill Device
Installation



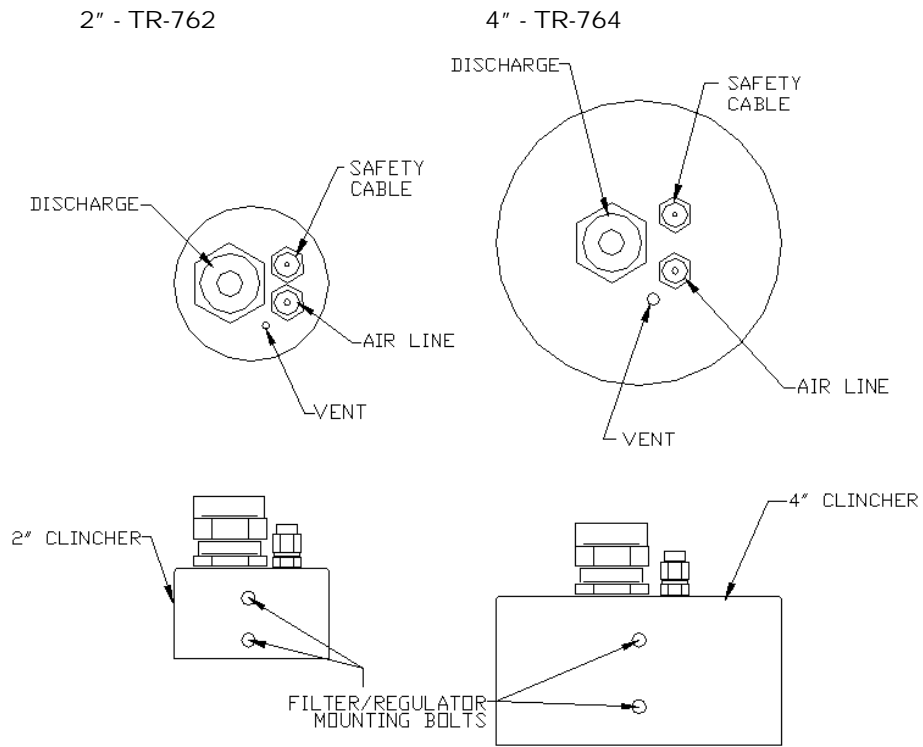
3. Install the intrinsically safe float switch assembly into a 2" NPT bung hole in the product storage tank or drum (see Figure 10). 100' (30m) of cable is supplied to connect the Electro-Pneumatic Overfill Protection Device to the float switch assembly.

Well Clincher

The Well Clincher (shown in Figure 11) provides a convenient water resistant seal for a Product Recovery Well. Well Clinchers are available for 2", 4" or 6" diameter wells and allow easy installation of the FAP Plus™ Pump. Bulkhead hose fittings are provided for the installation of air and discharge hoses and safety cable.

The bulkhead fittings are easy to use. Simply loosen the upper cap by turning counterclockwise until the appropriate line can pass through the fitting. Position the clincher on the hoses/safety cable to the marked location as previously determined by H_w , and tighten the upper cap by turning clockwise. Tighten each cap until the lines are snug and will not slip. Secure the safety cable by placing the cable clamp provided around the stainless-steel cable and against the upper cap, tighten the nuts on the clamp.

Figure 11
Well Clincher



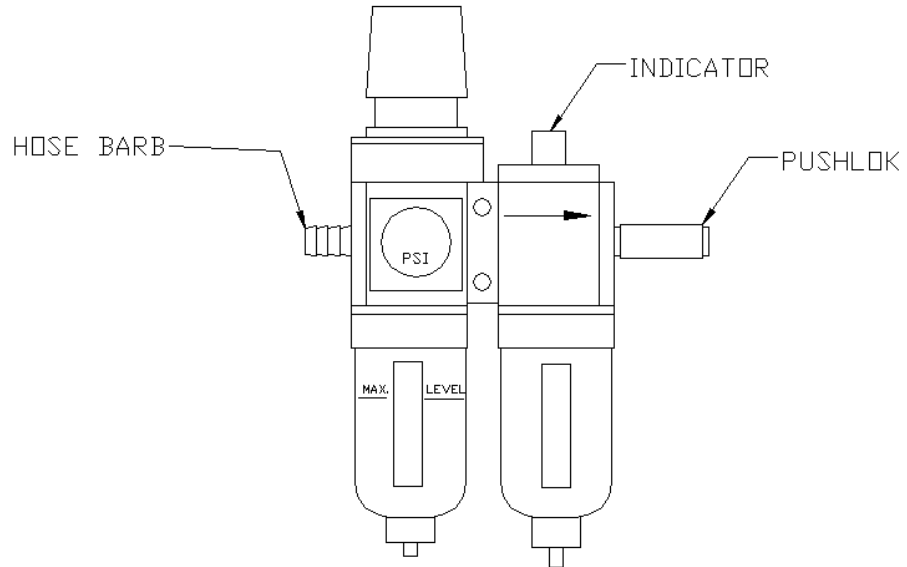
Air Filter/Regulator Assembly

A modular Air Filter/Regulator Assembly (shown in Figure 12) is provided with each FAP Plus™ Pump, an additional coalescing filter (w/o regulator) is provided with the full FAP Plus™ System package. The additional coalescing filter should be located after the air compressor just prior to the All-Pneumatic Overfill Protection Device (see Figure 5 or 10). The modular filter/regulator assembly should be located at the well head.

Notice!

The importance of a clean, dry air cannot be overstated. It is crucial to the proper operation of any device using pneumatic logic circuitry (i.e. the FAP Plus™ Pump and the All-Pneumatic Overfill Protection Device).

Figure 12
Coalescing Air
Filter/Regulator
Assembly





UPKEEP

Maintenance

The system when properly setup requires minimal maintenance. Though, there are several items to check periodically to maximize the performance of the system.

- | | |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Compressor | <ul style="list-style-type: none"> • Maintain proper oil level in the compressor. The oil should be changed monthly. • Keep a clean air filter on the air compressor. • The coalescing filter element at the compressor should be changed every six months. • Check for proper operation of the auto tank drain. Drain the tank weekly if not equipped with an auto drain. • Check the belt monthly for wear. Replace when necessary. |
| Pneumatic overfill device | <ul style="list-style-type: none"> • Check the internal air filter monthly. Replace when the filter appears “red”. |
| Filter/Regulator assembly | <ul style="list-style-type: none"> • Inspect the auto bowl drain weekly for proper operation. Fluid level should never be above the float in the bowl. Air should never continuously leak from the auto drain. • When Indicator is red, change element. • Check the condition of the filter elements monthly. Replace every 12 months or when dirty. |
| Skimmer | <ul style="list-style-type: none"> • Inspect the hydrophobic filter on the skimmer. Replace when dirty. This will not apply to all skimmers. |

Additional Maintenance Notes

The FAP Plus™ Pump System has been designed to withstand the rigors of field use. With proper operation, in accordance with this manual, little maintenance is required to insure continued high performance.

The system should be stored in a dry location out of direct sunlight. As with any equipment, the FAP Plus™ Pump should be periodically inspected for signs of wear. The inlet filter on the Density Skimmers should be free of tears and debris. Some petroleum products may cause the coiled hose to become brittle with time. Prior to use, check the spring action of the coil.

We recommend the FAP Plus™ Pump be cleaned routinely, particularly if it is used in a temporary fashion at several locations. Prepare a mild cleansing solution in a 5-gallon (20 l) bucket. Immerse the hose portion of the FAP Plus™ Pump and coil, and allow the solution to circulate through the system for 10 to 15 minutes.

The need for maintenance of the FAP Plus™ Pump depends directly on the way it is used. The unit must be supplied with air that is clean and dry. Also, the unit must not be submerged. If these requirements are met, the FAP Plus™ Pump will require no special maintenance.

Maintenance instructions for the air compressor are detailed in the manufacturer's Operations Manual. In general, proper maintenance includes regular oil changes and periodic inspection of the inlet air filter, belts, and other parts for signs of wear.

Service

The Durham Geo FAP Plus™ Pump System has a Limited One-Year Warranty. Should the system need service, during or after the warranty period, please call Durham Geo for a Return Authorization number, then repackage the equipment carefully, in its original box and return it to repair:

Attn.: Repair Department RA#_____

Durham Geo-Enterprises, Inc.

2175 West Park Court, PO Box 870907

Stone Mountain, Georgia, USA 30087

Notice!

Any materials returned to Durham Geo must be decontaminated with an accompanying document detailing the decontamination procedure. Failure to decontaminate material and provide appropriate documentation may result in our refusal to receive the goods. Additionally, the shipper may refuse to transport the goods.

For your protection, when mailing packages, please use insured Parcel Post or United Parcel Service.

Enclose a note describing why the device needs repair. Be sure to reference the return authorization number on the mailing label and on any correspondence. If your system is out of warranty, we will notify you of the cost of repairs before repair work begins. Typically, repairs can be performed within one to two days of receiving of the return.

HELP!

Each site poses different system installation conditions and constraints. The following notes provide guidance for some unique situations.

- The field components in a multi-pump set-up are VITAL to system performance. Please contact Durham Geo-Enterprises for technical assistance.
- Multi-well systems usually require long runs of product discharge hose. The resulting head losses adversely affect pump performance. We recommend the trunk line hose diameter be appropriately sized to minimize head losses. The same considerations also apply to main air supply lines. Undersized system pumping will adversely affect pump performance.
- In open excavations or open water applications, a floating boom can contain and concentrate the product for more effective removal.
- If the power source is remote, extension cords will be required for the compressor and Electro-Pneumatic Overfill Protection Device. Be sure to properly match the extension cord conductor size to the length of the run.

If you have any questions concerning the use or operation of the FAP Plus™ Pump System, call us toll-free at 1-800-837-0864. We suggest you check the Troubleshooting chart (on the following 2 pages) before calling; you can often diagnose and solve minor problems quickly using these guidelines.

Troubleshooting

Problem	Cause	Solution
FAP Plus™ Pump discharges air only.	Product has been removed	No correction required
	Product thickness has been reduced to 1” or less	
	Fluid level is below float inlet	Lower assembly such that float is at water/product interface
	Pumping rate exceeds product recharge rate	
FAP Plus™ Pump discharges water only or a water/product mixture	Float improperly installed below	Check water level and water/ product Interface adjust FAP Plus™ position Accordingly
	Groundwater has risen more than the travel of the skimmer	Check water level and adjust FAP Plus™ Pump position accordingly
	Float is “hung up” on an obstruction in the well casing	Remove obstructions from the sides of the well to enable the assembly to float free
Pump does not cycle	Air source is restricted or contaminated	Check for and straighten kinks in hoses. Check air source for water condensation. If present, disconnect pump and purge air lines and service filter
	Operation pressure is too high or too low	Verify the operation pressure is within the range 40 to 100 PSI. If upper limit has been exceeded, unit may be damaged. (Typically, 60-80 PSI)
Pump does not cycle (continued)	Pump has been submerged or otherwise damaged	Contact Durham Geo for replacement
	Product storage tank is full	Empty tank

☎ Factory Phone #: 1-800-837-0864 ☎

Troubleshooting (continued)

Problem	Cause	Solution
Air compressor runs continuously	Air leaking from line(s)	Check lines for air leaks
	Receiver auto-drain is stuck open	Check auto-drain for obstructions
	The number of FAP Plus™ Pump units exceeds the capacity of the compressor	Add additional compressor capacity as required
	Electro-Pneumatic Overfill Protection Device has blown a fuse	Inspect Overfill Device for damage and replace fuse
Air compressor runs erratically	Compressor pressure switch is damaged or improperly adjusted	Consult the compressor manufacturer's literature
	Excessive voltage drop caused by improperly sized extension cord	Consult the compressor manufacturer's literature for proper extension cord selection
FAP Plus™ Pump does not discharge product, and all other causes/ corrections have been checked	Float inlet is obstructed	Clean float inlet
	FAP Plus™ Pump is clogged internally	Contact Durham Geo for repair
	Inner bladder has ruptured	Use a bucket test to verify. Contact Durham Geo for repair
	Excessive head loss through discharge piping network	Typically requires an increase in piping diameter. Contact Durham Geo for technical assistance
	Failure of inner bladder due to chemical attack	Contact Durham Geo for repair
	Product viscosity exceeds specifications	System misapplied. Contact Durham Geo for assistance

☎ Factory Phone #: 1-800-837-0864 ☎

SPECIFICATIONS

FAP Plus™ and
FAP+ZW Pump

Size:	1.75 in OD x 63 in L (44.5 mm x 1600 mm)
Weight:	6 lb (2.7 kg)
Air Requirements:	0.85 cfm @ 100 psig 24 dm ³ @ 690 kPa
Operating Pressure Range:	50 to 100 psig (345 to 689 kPa)
Pumping Capacity:	15 to 20 gph @ 10 ft TDH (56 to 76 L/h @ 3 m TDH) 10 to 15 gph @ 100 ft TDH (38 to 57 L/h @ 30 m TD) Based on gasoline through 3/8 in (9.5 mm) ID discharge line.
Maximum Fluid Viscosity:	Less than 1000 SSU (0.22 Stoke); roughly equivalent to SAE 20 oil
Discharge Pressure:	2/3 of air supply pressure
Materials:	Flexible Buna-N® (outer bladder), Tygon® Special (Inner bladder) and brass
Air Supply to Pump:	1/4 in (6 mm) OD polyethylene tubing (down-hole)
Fluid Discharge:	3/8 in (9.5 mm) ID Buna-N® hose (down-hole)

NOTE: Filter regulator with a coalescing filter with auto drain included with each FAP Plus™ System.

FAP Plus™
Skimmer

Size:	1.75 in OD x 67 in Long (44 x 1700 mm). Fits inside a 2 in (51 mm) well
Materials:	UHMW, stainless steel, urethane tubing, hydrophobic filter material, Nitrophenyl float, brass fittings, PVC
Size (OD):	1.75 in (44.5 mm)
Materials	
Float:	UHMW polyethylene, specific gravity = 0.95

SPECIFICATIONS

Coil: Polyurethane
Effective Travel: Up to 36 in (0.91 m)

Overfill Protection
Device

All-Pneumatic Device

Size (W x D x H): 4 x 4 x 20 in (102 x 102 x 508 mm)
Total Length: 20 in (508 mm)
Enclosure Material: Fiberglass

Electro-Pneumatic Device

Size (H x W x D): 8 x 6 x 4 in (203 x 152 x 102 mm)
Pneumatic Valve Capacity: 23 scfm @ 100 PSI (651 dm³/min @ 689 kPa)
Float Switch: Intrinsically safe; includes 100 ft (30.5 m) of cable
Enclosure: NEMA 4 rating; solid-state GEM Pak® circuitry
Voltage: 110 V (ac)
Power Cord Length: 8-ft (2.4 m)
Timer: Provides 24-hour, time-delayed operation

Accessories and Related Products

FAP Plus™ Pump	TR-515	FAP Plus™ Skimming System; includes, FAP Plus™ Skimmer 2 hp (1.5 kW) air compressor
		well clincher tank overflow protection device
	TR-516	FAP Plus™ Pump
	TR-51640	FAP+ZW Pump
	TR-517	FAP Plus™ replacement skimmer (hydrophobic)
Overflow Protection Device	TR-757	All-Pneumatic Overflow Protection Device
	TR-903WT	Electro-Pneumatic Overflow Protection Device with 24-hour programmable timer
	TR-75711	Multiple Pump Overflow Protection
FAP Plus™ Pump Accessories	Standard down-hole tubing	
	TR-734	3/8" in (9.5 mm) ID Buna-N® Hose for discharge line
	TR-735	1/4" in (6 mm) OD Polyethylene tubing for air line
	Optional Tubing	
	TR-732	1/2" in (13 mm) ID Buna-N® Hose
	TR-733	3/4" in (19 mm) ID Buna-N® Hose
	Well Clinchers	
	TR-762	2 in (51 mm) Well Clincher for use with the F.A.P. Plus™ Pump
	TR-764 Plus™	4 in (102 mm) Well Clincher for use with the F.A.P. Pump
	TR-766 Plus™	6 in (152 mm) Well Clincher for use with the F.A.P. Pump
Clamp Kit		
TR-753	(25) 1/2" in (13 mm) tube clamps (25) 3/8" in (9.5 mm) hose clamps (25) 1/2" in (13 mm) hose clamps (25) 3/4" in (19 mm) hose clamps (1) clamp pincher	

S P E C I F I C A T I O N S

Options	TR-704	Density Skimmer (not hydrophobic) for 4 in wells
	TR-706	Density Skimmer (not hydrophobic) for 6 in wells
	TR-712 wells	Density Skimmer (not hydrophobic) for 12 in
Cap Cop Well Protection Vaults	TC-730 mm	8 x 8 in (203 x 203 mm) steel vault; 8 in (203- skirt, Ship Weight: 16 lb (7.2 kg)
	TC-731 mm	11 x 11 in (279 mm x 279 mm) steel vault; 12 in x (305 skirt, Ship Weight: 28 lb (12.7 kg)
	TC-732 mm	17 x 17 in (432 mm x 432 mm) steel vault; 24 in (610 skirt, Ship Weight 80 lb (36.3 kg)
	TC-733 mm)	21 x 21 in (533 mm x 533 mm) steel vault; 22 in (559 skirt, Ship Weight 106 lb (48 kg)

LIMITED WARRANTY

Durham Geo-Enterprises, Inc. / Slope Indicator ("DGSi") warrants the products manufactured by DGSi to be free of defects of workmanship and material on a product basis. The products accompanied by this Warranty Statement are warranted for a period of ONE (1) YEAR from the date of delivery to the customer. If the customer is an authorized distributor of DGSi's products, the warranty shall be for a period of ONE (1) YEAR from the date of delivery to the authorized distributor's customer.

The obligation of DGSi is hereafter limited to replacement or, at its option, repair of products returned to it, should DGSi's examination disclose, to its satisfaction, that the products were not free from defects. Products repaired or serviced by DGSi are warranted against defects in workmanship and materials for a period of 90 days, or the remainder of the original warranty period, whichever is greater. **IN NO EVENT SHALL DGSi BE LIABLE FOR CONSEQUENTIAL OR SPECIAL DAMAGES, OR FOR INSTALLATION, ADJUSTMENT, LOST PROFITS OR OTHER COSTS WHICH MAY ARISE IN CONNECTION WITH SUCH PRODUCTS. THE APPLICABLE PRODUCT WARRANTY EXTENDS ONLY TO THE ORIGINAL CUSTOMER OF DGSi OR ITS AUTHORIZED DISTRIBUTOR, AS THE CASE MAY BE, AND IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, WHETHER OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE OR USE, AND OF ALL OTHER OBLIGATIONS AND LIABILITIES OF ANY KIND AND CHARACTER. EXCEPT FOR THE WARRANTY APPLICABLE TO THE SPECIFIC PRODUCT(S) PURCHASED, DGSi MAKES NO WARRANTY OF MERCHANTABILITY OF THE GOODS OR OF THE FITNESS OF THE GOODS FOR ANY PURPOSE. THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE DESCRIPTION ON THE FACE HEREOF.**

Any products, components or accessories that are not manufactured by DGSi and are supplied by other manufacturers are subject to their respective warranties. Certain products will carry their own warranties.

For further assistance:

Call 1-800-837-0864 (toll free) or +1 (770) 465-7557
e-mail info@durhamgeo.co