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LPG Premier / LPG Premier HiFlow

Installation Guide

Red Jacket

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Notified Body:
LCIE
FONTENAY-AUX-ROSES
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Products:
Red Jacket LPG Submersible Pump Models P300V17-21 & P500V17-24

Harmonized Standards:
EN50014 (1992)
EN50018 (1996)
EN50019 (1996)

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Harold E. Findley

Harold E. Findley – Quality Manager

Introduction

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Introduction

Improvements and market demand have resulted in the development of the LPG Premier and LPG Premier HiFlow pumps for the Liquefied Petroleum Gas sector of the market place. These new pumps are the result of working with our customers and recognizing their needs.

The Red Jacket submersible LPG pump has twenty years of proven service throughout the world. All major oil and gas companies are using submersible technology. Red Jacket submersible LPG pumps are used in filling stations for bottles, automobiles, trucks and buses. In the industrial sector installations include, but are not limited to, loading facilities, foam, aerosol and paper mills.

The Red Jacket submersible LPG pumps are electrical motor-driven centrifugal types designed for use in petrol station flow metering systems. The pumps are installed in a separate manifold direct into the storage tanks and are approved for use in Autogas motor fuels. Pumps can be installed in vertical and horizontal applications. The pumps provide positive pressure at all times to the flow meters.

The pump installation consists of:

- A manifold including, overflow protector, shut off valve, equalization line, electrical junction box and an connection for a vapor return, pressure gauge and a separate connection for purge valve.
- A cable conduit mounted within the product line (column pipe).
- A motor and pump section with internal by-pass

The electric wires from the electrical junction box to the motor run through the conduit pipe. The conduit pipe is mounted inside the product line and is sealed against the pumped liquid. The electrical wires are mounted in a plug (pigtail) which provides a seal into the motor. The wires (color-coded) are provided with a LPG (propane and butane) resistant coating.

The pump-motor unit consists of two parts, the motor 50 Hz, 380/415 Vac (stator, rotor, electrical-connections and bearings) and the pump (multi-stage centrifugal). Motor and pump are enclosed in stainless steel shells.

The United States Patent Office has granted patent number 6,129,529 to the pump-motor unit design.

Safety Precautions

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

	**EXPLOSIVE** Fuels and their vapors are extremely explosive if ignited.		**FLAMMABLE** Fuels and their vapors are extremely flammable.
	**WARNING** Warning Alert - read message and follow instructions to avoid serious injury, death, or substantial property damage.		**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.
	**FENCE OFF WORK AREA** Fuels and their vapors are extremely explosive if ignited. Keep hazardous zone free of unauthorised personnel and vehicles. Put up fencing and/or barricades to safeguard work area.		**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.

⚠ WARNING

Portions of this product are to be installed and operated in the highly combustible environment of a LPG storage tank. It is essential that you carefully read and follow the warnings and instructions in this manual to protect yourself and others from serious injury, death, or substantial property damage.

Basic Principle of the Red Jacket Submersible LPG Pump

Red Jacket submersible LPG pumps are multi-stage centrifugal pumps. The advantage of the multi-stage technology is maximum performance by a minimum of energy, respectively 2.25 kW (3 hp) for the Premier pump and 3.75 kW (5 hp) for the HiFlow pump. The submersible pump is installed in LPG. During operation, the pressure increases with approximately 44 kPa (6.4 psi) or 49 kPa (7.1 psi) per stage up to the maximum design pressure of the pump respectively 920 kPa (133 psi) for Premier and 1175 kPa (170 psi) for Premier HiFlow.

Every stage consists of three parts; a. the diffuser, b. the diffuser plate and c. the impeller. The impellers are working on the floating principal. This means that during operation the impellers are floating in the liquid. Between the impeller and the diffuser and between the impeller and the diffuser plate there is a liquid film. This floating principle avoids any unnecessarily resistance in the pump.

As long as all the impellers are floating in the liquid, the pump runs on maximum capacity with a minimum of energy. All respectively, 21 or 24 diffusers are interlocked.

LPG is a mixture of gasses, primarily propane and butane which are vapors at atmospheric pressure. This means as long as the mixture is under sufficient pressure the mixture remains liquid. When LPG liquid vaporizes, its volume increases considerably (approximately 265 times its volume).

For all types of Red Jacket submersible LPG pumps, the minimum differential pressure can never be allowed to go below 400 kPa (58 psi).

This minimum required differential pressure of 400 kPa (58 psi) is to guarantee that during operation all respectively 21- or 24-stages are submerged in the LPG liquid.

Another basic rule for a centrifugal pump is that there must be sufficient liquid available by the inlet of the pump. The pump can only build differential pressure when the first stage of the pump is completely submerged in the liquid. This NPSH (Net Positive Suction Head) is for all types Red Jacket submersible LPG pumps 100 mm (3.9 in.) above pump inlet.

The motors provided in these submersible pumps are explosion-proof type (EEx ed IIB T3) designed to permit the LPG to flow through and around the motor. The pumped liquid flows from the impellers between the shell and the stator, upward to the column pipe. A calculated part of the liquid passes through the flame barrier of the motor, motor bearings and the motor for cooling and lubrication. After cooling, this amount of liquid passes through a non-adjustable by-pass back into the pumped liquid. A calculated part of the pumped liquid passes out to the manifold.

Submerged LPG System Explanation

Table 1.- LPG Pump Models

Premier	Premier HiFlow
Nomenclature: LPG300V17-21	**Nomenclature: LPG500V17-24**
50 hertz, 380 – 415 Vac, 3 hp	50 hertz, 380 – 415 Vac, 5 hp
Setting thermal switch on the switch board: 6.1 amp	Setting thermal switch on the switch board: 9.8 amp
70 liter/min by 680 kPa (18.5 gallon/min. by 98 psi) (max. efficiency)	130 liter/min by 810 kPa (34.3 gallon/min. by 117 psi) (max. efficiency)
Max differential pressure 920 kPa (133 psi)	Max differential pressure 1175 kPa (170 psi)
Capacity internal by-pass at max pressure: 20 liter/min. (5.3 gallon/min.)	Capacity internal by-pass at max pressure: 20 liter/min. (5.3 gallon/min.)
Minimum external flow - not required.	Minimum external flow - 25 liter/min. (6.6 gallon/min.)
Designed for 2 nozzles of 35 liter (9.2 gallon) simultaneously	Designed for 4-5 nozzle's of 35 liter (9.2 gallon) simultaneously or 150 liter (39.6 gallon) for one nozzle

All calculations assume atmospheric pressure is1013 mbar (14.7 psi) and outside temperature 15°C (59°F). Mixture is assumed to be 40% propane and 60% butane.

The pumps are approved for use with butane and propane and any mix of butane and propane. This may include up to 15% ethanol, 10% methanol or 15% MTBE. It has been assumed that Autogas includes toluene, benzene, xylene and iso-octane in varying percentages.

Temperature range - 40°C to + 40°C (-40°F to +104°F)

System pressure - Max. 2500 kPa (362 psi)

Electric connection and motor protection - according to local regulation, Or: NEN 1010 & NEN 3413 (Electrical components in Hazardous Areas), VDE 0100 & VDE 0165 (Electrical components in Hazardous Areas).

The pump-motor unit consists of two parts; the motor 50/60 Hz. 380 - 415 Vac (stator, rotor, electrical-connections and bearings) and the pump (21 or 24 impellers). Motor and pump are enclosed in stainless steel shells.

The stator is fitted with a containment shell of sheet metal and the windings are fully cast in epoxy. The section with the pigtail (discharge head) consist of a metal body (Ex 'd' flameproof enclosure) and electrical connections (Ex 'e' increased safety). The wires in the connectors are cast in epoxy.

The Electrical Conduit

The customer must supply the electrical conduit so that the wires can be sealed from the pumped liquid. The pipe must be Schedule 80 and threaded 1/2-14 inch NPTF per ANSI B1.20.3 a length of 16.2 to 19.9 mm (0.64 to 0.78 in.). This will result in a thread engagement of 5 to 7 threads. Measurement of the thread profile is specified in ANSI B1.20.5.

The Manifold

According to the regulations, a LPG submersible pump must be installed in a so-called pump well. This pump well (manifold) is designed so that the submersible pump can be installed and removed under any condition, i.e. when the storage vessel is either empty or (partly) filled.

A manifold is classified as an unfired pressure vessel, and is designed according the regulations for “Pressure Vessels”. The manifold must be suitable for the type of pump, to guarantee the above-described minimum requirements. Figure 1 illustrates a recommended manifold for the Red Jacket LPG pump and Table 2 contains an itemized material list for the Figure 1 manifold.

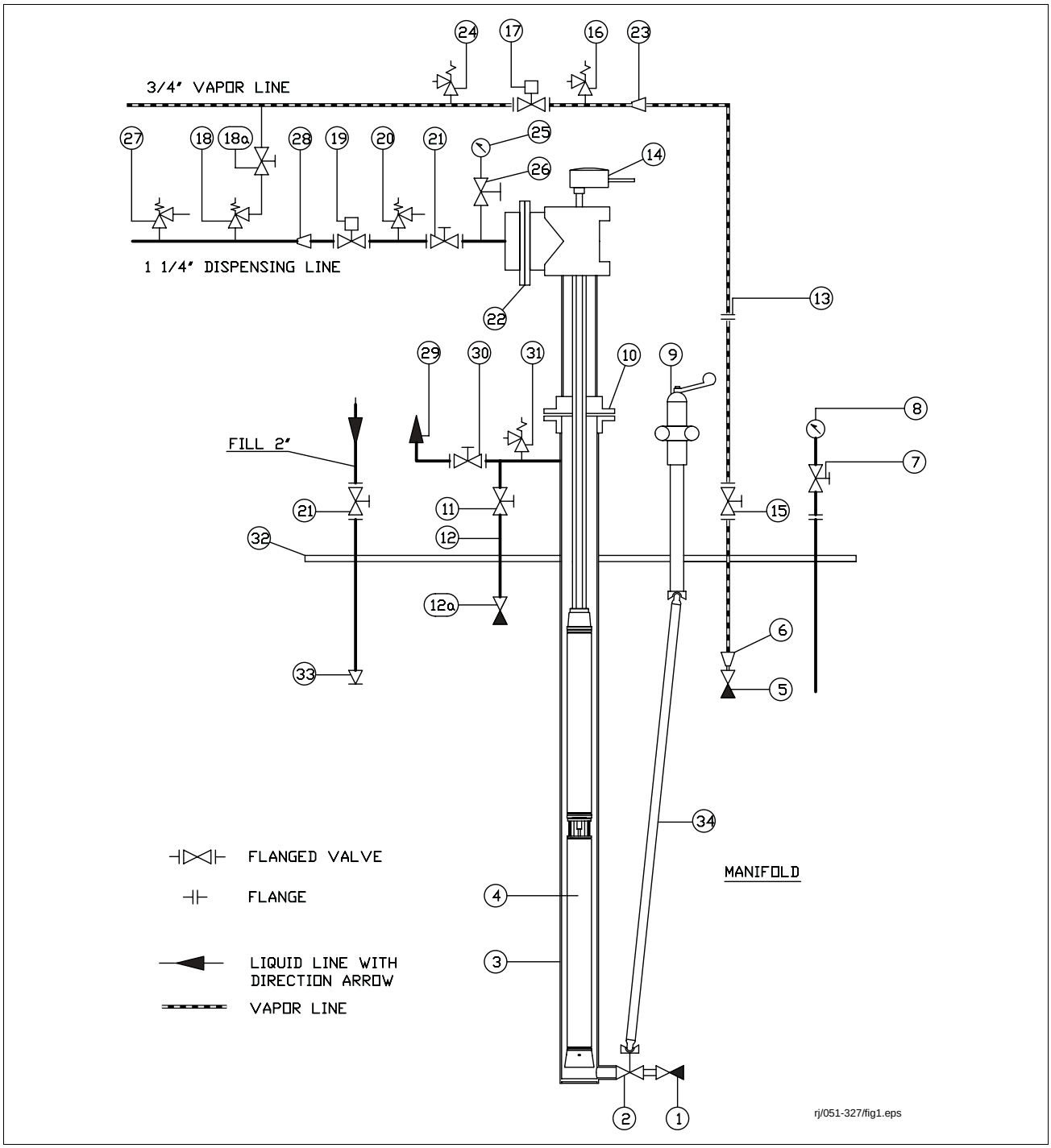

Figure 1. Manifold with Red Jacket LPG Pump

Table 2.- Recommended Material List for Manifold with Red Jacket LPG Pump (ref. Figure 1)

Item	Description	Size (inches)	Recommended Manufacturer	Type/Remark	Other
1	Excess flow valve	2	Rego	A3292 C (if applicable)	
2*	Ball valve	2	Worcester	A44	
3*	Manifold	5		acc. 8.5.2b Regulations	
4	Pump	4	Red Jacket	Premier/Premier HiFlow	
5	Excess flow valve	3/4	Rego	A3272 G (if applicable)	
6	Reducing socket	2 x 3/4		(if applicable)	
7	Ball valve	1/4	Argus	EK/71 (if applicable)	
8	Pressure gauge	1/4	Wika		
9*	Closing device	2		acc. 8.5.2h Regulations	
10*	Flange	5			
11*	Ball valve	1/2	Argus	EK/71	
12*	Equalization line			acc. 8.5.2c Regulations	
12a*	Excess flow valve	3/4	Rego	A3272 G (if applicable)	
13	Flange	2			
14*	Kit conduit box	1	Red Jacket	114-115-5	
15	Ball valve	2	Argus	EK/71	
16	Relief valve	1/4	Rego	3127 G	
17	Remote control valve	3/4	Argus	EK/71 (Pneu/Electrto)	
18	By-pass	3/4	Corken	B166 soft seat	Optional
18a	Ball valve	3/4	Argus	EK/71	Optional
19	Remote control valve	2	Argus	EK/71 (Pneu/Electrto)	
20	Relief valve	1/4	Rego	3127 G	
21	Ball valve	2	Argus	EK/71	
22*	Flange	2			
23	Reducing socket	2 x 3/4			
24	Relief valve	1/4	Rego	3127 G	
25	Pressure gauge	1/4	Wika		
26	Ball valve	1/4	Argus	EK/71	
27	Relief valve	1/4	Rego	3127 G	
28	Reducing socket	2 x 1-1/4			
29*	Vent of pump well	1/4		acc. 8.5.2b/c Regulations	

Table 2.- Recommended Material List for Manifold with Red Jacket LPG Pump (ref. Figure 1)

Item	Description	Size (inches)	Recommended Manufacturer	Type/Remark	Other
30*	Ball valve	1/4	Argus	EK/71	
31	Relief valve	1/4	Rego	3127 G	
32*	Manhole cover	NW 420 (ϕ525 mm)			
33	Check valve	2	Rego	A3186	
34*	Control rod				

*Part of Standard Manifold

NOTE: Regulations in this section refer to “Regulations for LPG Service Stations and Road Tank Trucks” in the Netherlands; Dutch Ministry of Housing, Physical Planning and Environment.

External By-pass

All Red Jacket pumps are equipped with an internal bleed (by-pass).

The Premier pump developed maximum pressure is 920 kPa (133 psi) differential pressure. The Premier HiFlow pump developed maximum pressure is 1175 kPa (170 psi) differential pressure. For pump technical reasons an external by-pass is not required.

According to the regulations. “An LPG pump shall be provided with a bypass to avoid overpressure when pumping against closed discharge. This bypass valve shall discharge into the LPG storage tank at a predetermined set pressure selected in relation to the pump operating pressure. This bypass valve shall be of sufficient capacity to handle the maximum flow at this pressure.” The internal bleed in the Red Jacket LPG pump is designed according to this regulation.

When a local safety regulation or a typical station application requires an external by-pass this requirement must be applied.

By the use of an external by-pass the setting is 20 - 35 kPa (2.9 - 5.1 psi) below maximum pressure. By-pass must be of the type without internal bleed (VRS, soft seat).

Equalization Line

The function of the equalization line is to equalize the pressure in the vapor space of the tank and the pressure of the manifold, to overcome running dry of the submersible pump by low liquid level and to equalize the pressure during refill of the installation.

The design of the equalization line must be so that the outside temperature has no influence on the function of the equalization line. An internal equalization line is recommended. Note if liquid level is below internal bleed, the amount of liquid of the internal bleed will increase the pressure in the manifold if the equalization line is too small.

The equalization line is one of the most important parts of the installation. As described above the equalization line needs to be as short as possible and relatively large in diameter. The lower the level of the liquid in the storage tank the more important is the function of the equalization line.

The functionality of the equalization line can be tested very easily when the liquid level is below the internal by-pass of the pump.

- Let the pump run against closed valve.
- Measure the differential pressure of the pump.
- If the differential pressure remains the same after 10 or 15 minutes of pump run the equalization line is working.

- If the pressure drops, the pump is cavitating, and the pump will become vapor-locked. In this case, the equalization line is not sufficient.

System Protection

Red Jacket recommends a complete system built around the pump to ensure safety, reliability, stability, and performance. If the entire system is calculated and built according to accepted specifications, the installation will operate for many years without requiring any form of maintenance.

There are two pump characteristics that can be checked if performance deteriorates:

1. Its output - flow rate versus pressure.

2. Its electrical connections and amperage consumed under load.

Potential Problems

Table 3.- Potential Performance Problems

Problem	Solution
Dry run	A control box with low pressure detection can detect both of these performance problems.
Cavitation	
Equalization line in the manifold is too small	Red Jacket made the system fail-proof, which means that an external by-pass is not required. (Please, note that local authorities may regulate an external by-pass.) The Red Jacket LPG pump has an internal by-pass. A certain amount of LPG passes and cools the motor (self-maintaining principle) and exits the pump at the internal by-pass. The motor's heat is transferred to the liquid and is therefore warmer than the liquid in the tank. Also this liquid has a higher vapor pressure than does the liquid in the tank. The equalization line between the manifold and the tank is to balance both liquid levels. If this equalization line is too small or even closed, the manifold can be emptied through the manifold inlet and it can cause a dry run or even cavitation.
Dirt in the tank	Small parts of LPG dust or iron oxide, which can normally be found in LPG, will not hurt the system. During operation those particles can, however, block the flame-resistor at the inlet of the pump-motor, but when the pump is switched off a small amount of liquid will be pressurized back in the tank. This amount of liquid will clean the flame-resistor again. Of course, any form of dirt should be avoided and shortens the expected lifetime of the pump. It is recommended to install a strainer (100-micron) at the inlet of the storage tank to avoid dirt entering the tank during deliveries.

Red Jacket submersible LPG pumps are multi-stage (21 or 24) centrifugal pumps. The advantage of the multi-stage technology is maximum performance by a minimum of energy, respectively 2.25 kW (3 hp) for the 21 stage Premier pump and 3.75 kW (5 hp) for the 24 stage Premier HiFlow pump. During operation the pressure increases with approximately 44 kPa (6.4 psi) or 49 kPa (7.1 psi) per stage up to the maximum design pressure of the pump respectively 920 kPa (133 psi) for the Premier pump and 1175 kPa (170 psi) for Premier HiFlow pump.

For all types of Red Jacket submersible LPG pumps the minimum differential pressure can never be below 400 kPa (58 psi). This minimum required differential pressure is to guarantee that during operation all respectively 21 or 24 stages are submerged in the LPG liquid. Another basic rule for a centrifugal pump is that there must be sufficient liquid available by the inlet of the pump. The pump can only build differential pressure when the first

stage of the pump is completely submerged in the liquid. This so-called NPSH (Net Positive Suction Head) is 100 mm (3.9 in.) above pump inlet for all types Red Jacket submersible LPG pumps.

Cavitation is when the liquid flows with a velocity high enough to reduce the local pressure below vapor pressure forming a cloud of small gas-filled bubbles. These gas-filled bubbles exhibit complex dynamics and erosive action on nearby surfaces.

When the temperature of LPG increases, it can vaporize. Vaporized liquefied petroleum gas expands at a rate of approximately 265:1. Due to the liquid vaporizing, sections of the LPG pump staging tear and will be damaged.

The motor of the pump needs to be cooled. Red Jacket does this by using the LPG. When operating, the LPG runs through and around the motor to cool it. In addition, LPG is used to lubricate the bearings. The first impeller of the pump needs to be submersed, so that the LPG can cool the motor. If the product level is too low, the motor cannot cool itself and the bearings will not be lubricated. Eventually the motor will fail.

When the pump is installed in a manifold another potential problem may occur. The equalization line is important to balance the liquid levels in the tank and the manifold. As stated above, the LPG cools the motor. Hence, some of the warmth of the motor is transferred to the LPG. Through the internal by-pass approximately 20 liters/min. (5.2 gallon/min.) will be pumped back in to the manifold. If, for any reason, the equalization line does not operate well, the liquid in the manifold can warm up. Consequently, the pressure in the manifold increases and, because of a higher-pressure level in the manifold compared to the tank pressure, all the liquid can be forced back in the tank, emptying the manifold. With the pump running, this is also a form of dry run.

Low-pressure/Dry-Run Protection Unit (LPG Run Box)

Red Jacket LPG pumps must be installed in accordance with the minimum requirements and it is to be recommended to include in the installation a so-called Low-pressure/Dry-Run protection unit (preferably based on pressure technology.) When installed according to the specifications, the pump will perform for many years.

When a pump fails it is mainly due to one of two events: cavitation or dry run. Veeder-Root does not warrant these two failures. The LPG Run Box is a safety device available for the Red Jacket submersible LPG pump that is designed to avoid cavitation and dry run of the unit.

The LPG Run Box is a differential pressure based system. When cavitation is about to occur, the pump cannot build up differential pressure. Similarly, with a dry run the pump cannot build up pressure as well. Basically, the LPG Run Box constantly receives pressure information of the total system and with this data it ‘chooses’ to stop or start the pump. A pressure transmitter is needed to send this information to the LPG Run Box. A pressure transmitter is thus a vital device of this system.

Since the LPG Run Box controls the pump, the LPG Run Box sends a signal to start the pump when a nozzle is picked up. Immediately, the pressure in the discharge line is compared to the vapor (or rest) pressure. If the differential pressure is greater than 100 kPa (14.7 psi) the system is ok. During operation, the LPG Run Box continues to check the differential pressure. The differential pressure needs to be above 400 kPa (58.9 psi). If the pressure falls below this given set point the LPG Run Box will turn the pump off. The pump is being protected from low pressure and low liquid level/dry run (no differential pressure). The system automatically restarts, but if the differential pressure continues to remain outside the working range, it stops and sounds an alarm.

Prior to Installing or Replacing LPG Pump or Motor

Read This Section Before Proceeding

1. The Red Jacket submersible Liquefied Petroleum Gas (LPG) pump is designed to pump liquefied petroleum gas in the liquid state. This includes butane and propane and any mix of butane and propane. The vapor pressure of the liquid should not be more than 1380 kPa (200 psi) at 37.8°C (100°F). The density of the liquid should be less than 0.6 kg/l (37.4 lb/ft^3).
2. The pump should be installed according to local code requirements governing submersible LPG installations and also for ease in servicing. The motor is earthed (grounded) through the column pipe or the conduit pipe.
3. If manifold or pump well is used, the maximum flow velocity at any point in the suction line from the tank must not exceed 1.0 m/sec. (3.3 ft/sec.). The equalization line must be of sufficient size to equalize the manifold and supply tank.

   Installations utilizing a manifold must meet the design requirements detailed in this manual, particularly Figure 2 on page 11, Table 8 on page 18, and Table 9 on page 19, as applicable.
4. The pump and motor are cooled and lubricated by the product being pumped. The pump is designed to operate at or above minimum flow rate continuously, or with an intermittent duty cycle, not to exceed 30 on/off cycles per hour.
5. Never wire the 24-stage pump to operate continuously at less than 25 liters/min. (6.6 gallons/min.) flow rate or at less than 400 kPa (58 psi) differential pressure.

   Never wire the 21-stage pump to operate at less than 400 kPa (58 psi) differential pressure.
6. Red Jacket LPG pumps are designed to operate without a separate external by-pass for the pump. The motor contains a self-adjusting internal by-pass system. However, when local safety regulations require an external by-pass it should be set 20 to 35 kPa (3 to 5 psi) below maximum pressure. The by-pass must be of the type without internal bleed.
7. Red Jacket LPG pumps are not designed to handle abrasive or foreign particles in the product being pumped. Do not use a pump inlet filter without written approval from Veeder-Root prior to its use. Installation of a strainer 0.1 mm (100 micron) in the inlet to the storage tank is recommended.
8. Pumping fluids other than LPG will overload the motor and damage the pump.
9. Red Jacket LPG pumps are designed in accordance with CENELEC standards and the European Directive 94/9/EC “Equipment for Potentially Explosive Atmospheres.” (II2 G EEx IIB T3).
10. Never run a submersible pump dry.
11. The ambient temperature is to be -40°C to +40°C.

Electrical Service Information

Model No.	Stages	HP	kW	Phase	Volts		Hz	Service Factor amps	Locked Rotor amps	Winding Resistance (ohms)	I_N	I_A/I_N	T_E
					Min.	Max.							
P300V17-21	21	3.0	2.2	3	342	456	50	5.4	29	7.2 - 8.8	5.4	5.37	17
P500V17-24	24	5.0	3.7	3	342	456	50	8.7	49	3.6 - 4.4	8.8	5.63	6

Marking

The listee's name and address, the motor catalogue, serial number and date code and the electrical rating are stamped on the motor shell. The listee's name and address, the pump catalogue, serial number and date code is stamped on the pump shell.

All Red Jacket LPG motors and pumps are foreseen of the CE mark.

Installing a Red Jacket Submersible LPG Pump

General

These instructions must be read fully before putting a submersible turbine pump for LPG into operation.

This LPG submersible pump is designed to pump a mixture of liquid petroleum gasses consisting of butane and propane, used as fuel to power motor vehicles.

These instructions only relate to the installation and operation of the submersible pump and not to the dispenser, which measures and registers the actual sales of the product.

The installation of the Red Jacket submersible LPG pumps should only be conducted in the presence of an authorized technician.

System Description

The Red Jacket submersible LPG pump is fitted into the special developed manifold, which has to be installed into one of the manholes of the storage tank (see below and Figure 2 for dimensions within manifold).

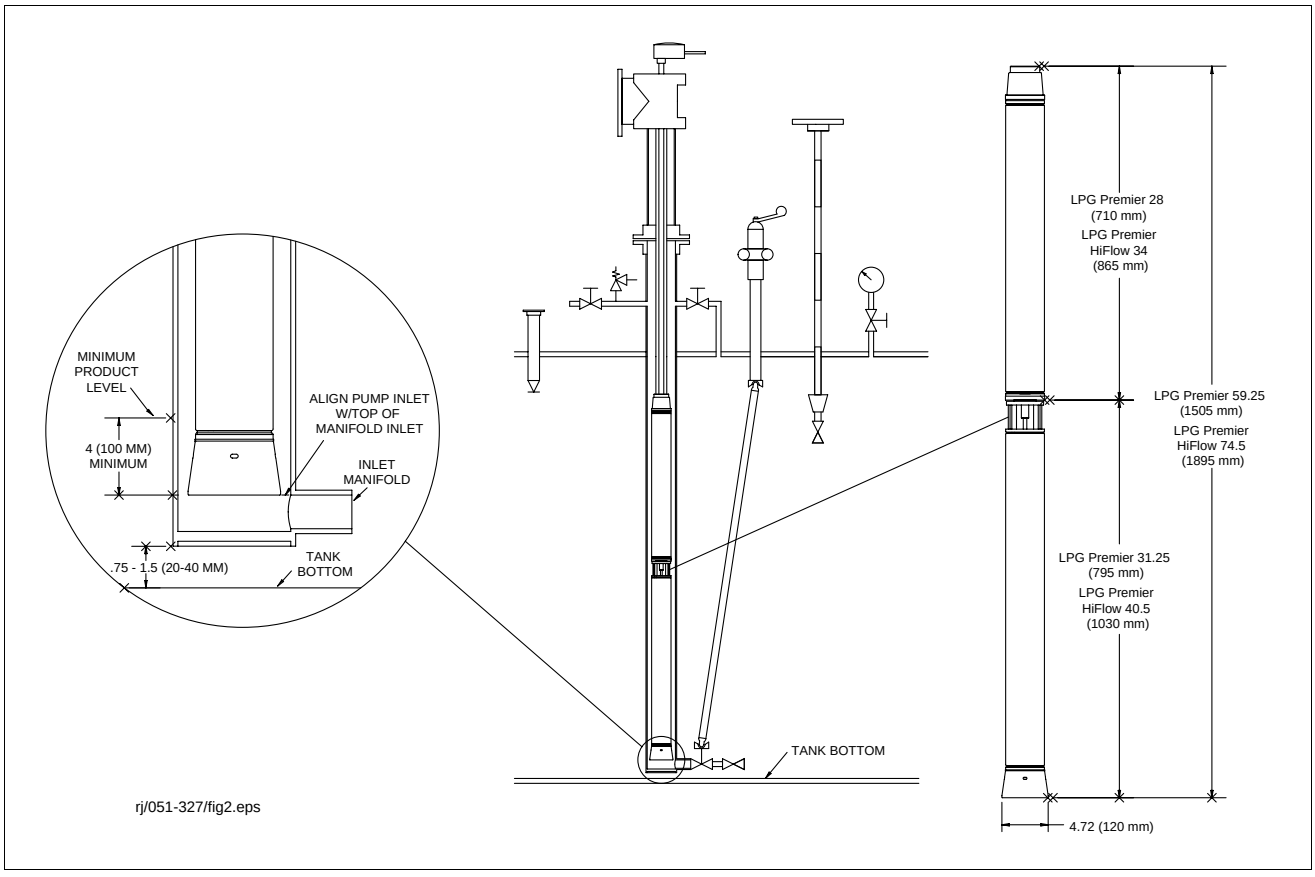

Figure 2. Example LPG pump installed position within manifold

At the bottom of the manifold a shut-off valve is installed, which can be operated from the outside above the storage tank, so the manifold can be closed. By closing this valve the pump can be separated from the stored fuel in the storage tank.

On the closing flange of the manifold a nitrogen connection is fitted. When nitrogen is admitted into the manifold, the LPG liquid is pressured back into the storage tank. When the shut-off valve is closed it is possible to safely remove or install the submersible LPG pump in a filled tank.

LPG Motor

Each package of new and replacement Red Jacket Premier and Premier HiFlow motors contain the parts listed in Table 4:

Table 4.- Motor Package Contents

Item	Qty
LPG motor	1
Discharge head with 2-inch NPT threads (1/2-14 NPTF)	1
Discharge head gasket	1
Pigtail connector, 14 AWG, 3 meter (10 feet), PVC sleeve	1
Socket screws and lock washers, 5/16-18 inch	4 of each
O-ring, Viton, 53.6 x 2.6 mm (2.11 x 0.103 in.)	1
Installation manual 051-327-1	1

If the discharge head is to be installed (see Figure 3), it must be connected to the piping before installing the pigtail connector and motor. The discharge head should be sealed with a blank fitting and the conduit pressure tested with nitrogen to 2000 kPa (290 psi). No leaks are allowed.

If using the existing discharge head, visually inspect the pigtail connector in the discharge head, replace if damaged. In addition examine the sealing surface of the discharge head - clean if necessary with fine emery paper.

The pigtail connector should be lubricated around its shell with petroleum-based jelly, PTFE lubricant or a suitable alternative. Assemble the pigtail connector in the discharge head making sure the key in the shell aligns with the notch in the discharge head.

The supplied o-ring (53.6 x 2.6 mm [2.11 x 0.103 in.]) is to be installed in the groove at the top of the pump if needed. It should be lubricated with petroleum-based jelly, PTFE lubricant or a suitable alternative.

Verify that the end of the motor coupling extends a minimum of 43 mm (1.7 in.) from the mounting face.

The pump should be carefully positioned to the bottom of the motor by first aligning the pump shaft with the motor coupling. Secure the pump to the motor by using the cap screws and lock washers supplied with the pump. Using a torque wrench, the screws should be tightened to 28 - 31 ft-lb. (37.8 - 41.9 N•m) each.

The supplied o-ring (25.4 x 1.8 mm [1.0 x 0.070 in.]) installed in the groove at the top of the motor should be lubricated with petroleum-based jelly, PTFE lubricant or a suitable alternative.

After fitting the gasket to the top of the motor, the motor should be carefully positioned snug to the discharge head and secured using the supplied socket screws and lock washers. Using a torque wrench, the screws should be tightened to 10 - 15 ft-lb. (13.5 - 20.3 N•m) each using a cross pattern.

Test the insulation resistance of each motor lead to the metal junction box. Repair if any reading is less than 2 Meg ohms.

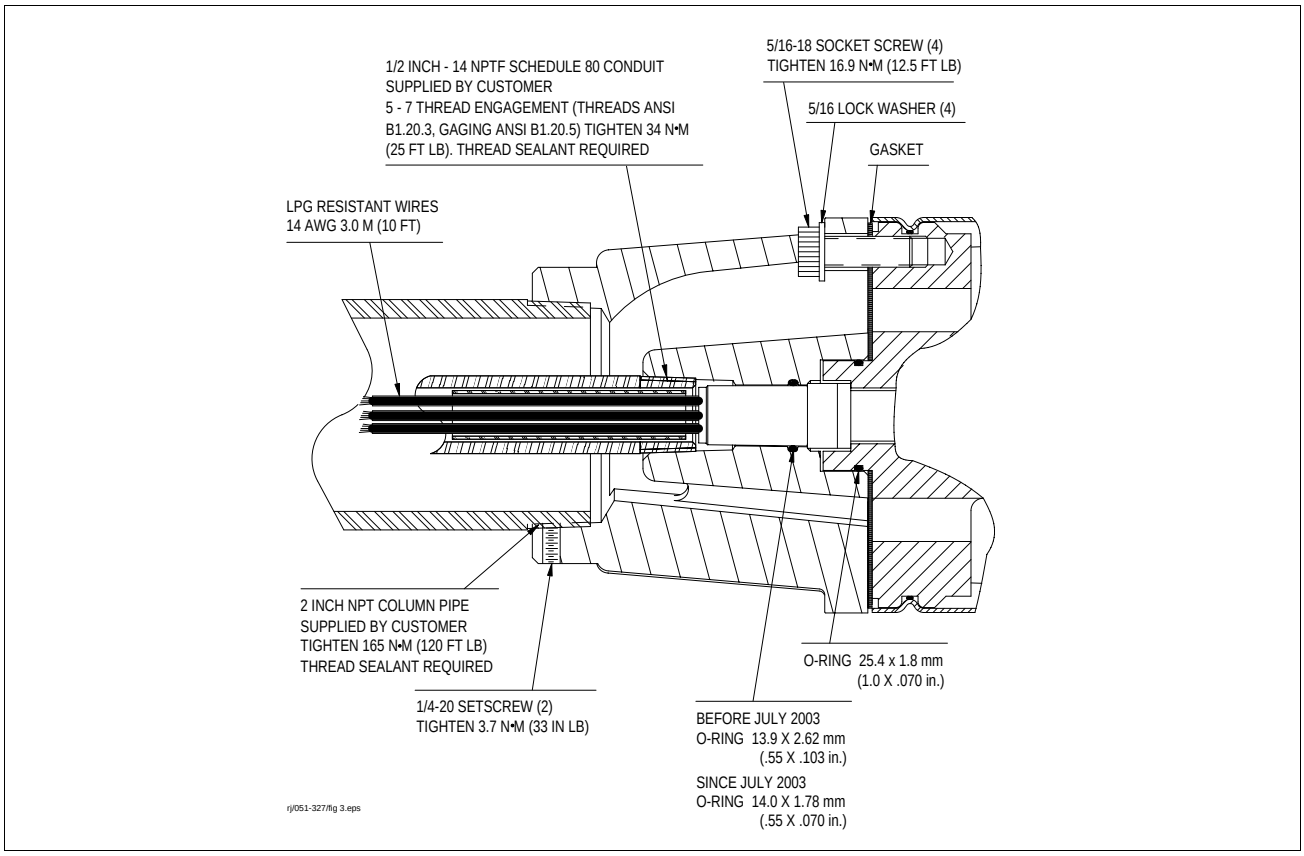

Figure 3. Discharge Head

LPG Pump

Each package of new and replacement Red Jacket Premier and Premier HiFlow LPG pumps contain the parts listed in Table 5:

Table 5.- Pump Package Contents

Item	Qty
LPG pump	1
Cap screws and lock washers, 5/16-24 inch	4 of each
Installation manual 051-327-1	1

The o-ring (53.6 x 2.6 mm [2.11 x 0.103 in.]) installed in the groove at the top of the pump should be lubricated with petroleum-based jelly, PTFE lubricant or a suitable alternative.

Verify that the end of the motor coupling extends a minimum of 43 mm (1.7 in.) from the mounting face.

The pump should be carefully positioned to the bottom of the motor by first aligning the pump shaft with the motor coupling. Secure the pump to the motor by using the cap screws and lock washers supplied with the pump. Using a torque wrench, the screws must be tightened to 37.8 - 41.9 N•m (28 - 31 ft-lb.) each.

Electrical Connection

The electrical path must include a vapor sealing device, such as a compound sealing Y-fitting or EEx cable entry between the pump and junction box as per local code regulations.

1. Shut off all power.
2. Connect the three-phase power supply from the master panel to terminals L1, L2, and L3 in the magnetic starter.
3. Using coded wires, connect a wire from terminal T1 in the magnetic starter to a pump wire in the junction box of the appropriate submerged pump. Connect another wire from starter terminal T2 to another pump wire and a third wire from T3 to the last pump wire.
4. Before running the pump, the tank and pump well must contain LPG and be purged of air.

Three-Phase Current Unbalance

Three-phase current unbalance is a factor that can result in premature motor failure. It causes reduced starting torque, excessive and uneven heating and excessive motor vibration. Therefore, it is important that the electrical load to the submersible motor be balanced. After the correct motor rotation is established, the amount of current unbalance among the three legs of the power supply should be calculated.

To prevent changing motor rotation when taking these readings, the wires to the pump should be moved across the starter terminals by always moving them in the same direction.

Percentage unbalanced = maximum current difference from average current divided by average current times 100.

As seen in the example in Figure 4, the third connection has the lowest percentage of unbalance and should be used to obtain maximum motor efficiency and reliability.

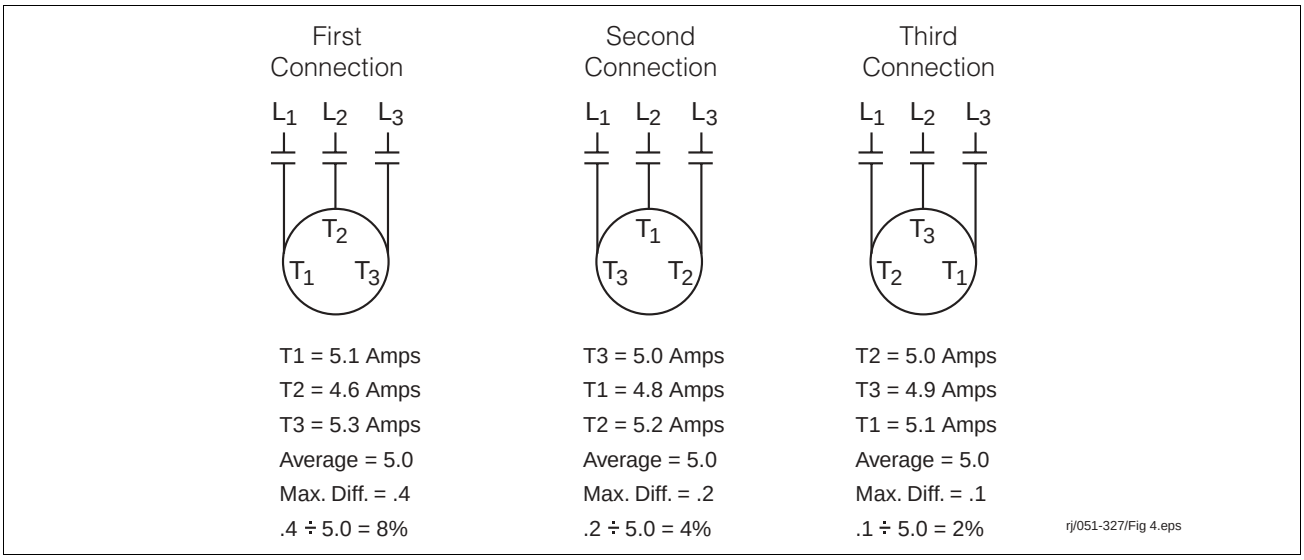

Figure 4. Example percentage of unbalance calculation

Typical System Schemes with Submersible LPG Pump

General

There is always a certain risk involved in the handling of “Liquefied Petroleum Gas” (LPG or Autogas). The risk of occurrence of the most serious hazard, a “BLEVE” (Boiling Liquid Expanding Vapor Explosion) of the storage vessel, is practically eliminated by installing the storage tank underground or by coverage with a mound of sand.

In spite of technical safety measures specified in this manual other hazards remain possible. In order to reduce the risk, each person who is involved in any way with operation, installation, maintenance or repair must read and apply the safety instructions fully.

All national and local applicable safety regulations must be applied.

When and where the LPG installation has displayed additional safety regulations should be followed.

Although great care has been taken in the preparation of this manual, Veeder-Root. shall not be liable for any misunderstanding, errors and/or loss or defects arising from the use of this manual.

Design codes and local regulations must be followed.

LPG storage vessels and manifolds are classified as unfired pressure vessels, which are subject to the inspection and acceptance of the inspection agency. LPG manifolds shall be designed, fabricated and tested as a minimum in accordance with the ASME section VIII Boiler and Pressure Vessel Code division 1, or with BS 5500, both supplemented with requirements of these “Regulations”.

Design and Test Pressures

The design pressure shall be equal to the maximum vapor pressure of commercial grade propane at an ambient temperature of 323°K (50°C) that amounts to approximately 1780 kPa (258 psi).

The hydrostatic test pressure shall be 1.4 times the design pressure = 2500 kPa (363 psi).

Material

LPG vessels shall be manufactured from carbon steel or low alloy-steel, e.g., ASTM A-285C, A-515Gr.55 or 60, DIN 17155H or similar material.

Flanges

All nozzles shall have welding neck flanges, pressure rating PN 40, in accordance with DIN 2635, BS-4504 or equivalent. Flange material; carbon steel c22 as per DIN 17200 or equivalent.

Name Plate

Each manifold has to be provided with a stainless steel name plate containing the data in Table 6.

Table 6.- Required Data on Manifold Name Plate

*a-	The registration number
*b-	The name of the product
*c-	The maximum operating pressure
*d-	The maximum test pressure

Table 6.- Required Data on Manifold Name Plate

*e-	The minimum and maximum allowable operating temperature in °C
*f-	The date of the latest acceptance test
*g-	Type and model of pump
*h-	Manufacturer's name, address, year of fabrication and serial number

System Components

List of appurtenances as shown on the typical schemes of LPG service station (underground and aboveground storage tank with submersible pump).

Table 7.- Example System Components

Item	Description	Size (inches)	Remarks
1	Blow-off valve	1/2	
2	Angle valve	2	
3	90% Ullage valve	1/2	
4	Check valve	2	
7	Ball valve	2	
8	Ball valve	1-1/4	
9	Ball valve	3/4	Optional
10	Ball valve	1/2	
11	Excess flow valve	2	
12	Excess flow valve	1-1/4	
13	Excess flow valve	3/4	
14	Remote control valve	2	
15	Remote control valve	3/4	
16	Relief valve	1/4	
17	Safety valve	-	
18	Excess flow valve - if design required	-	Optional
19	Excess flow valve - equalization line	3/4	Optional
20	Insulation joint	2	
21	Insulation joint	1-1/4	
22	Insulation joint	3/4	
23	Filling hose	3/4	

Table 7.- Example System Components

Item	Description	Size (inches)	Remarks
24	Filling nozzle	3/4	
25	Break-away coupling	3/4	
26	Hose connection with cap	3-1/4	
27	Overflow/relief valve (by-pass)	3/4	Optional
28	Level indicator	-	
29	Pressure gauge	1/2	
30	Pressure control valve	1/4	
31	Ball valve	2	
32	Connection rod	-	
33	Red Jacket submersible pump	125 mm (5 in.)	Minimum opening
34	Vent of pump well + equalization line		

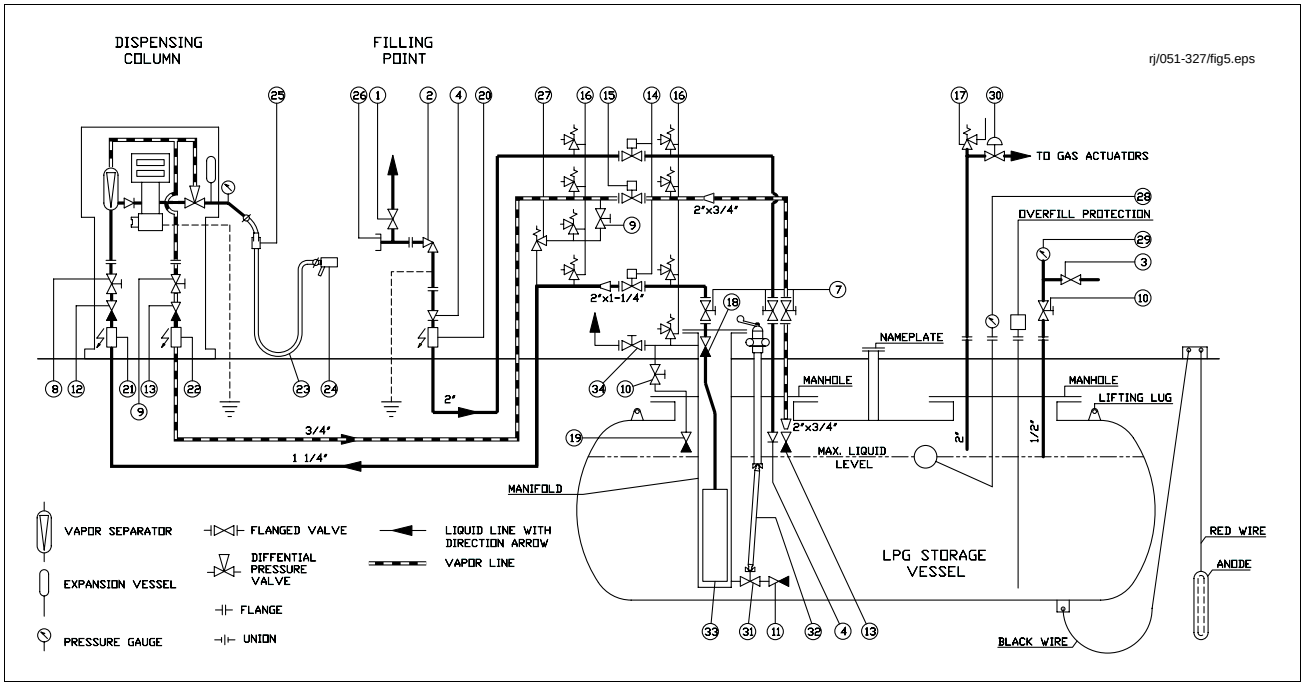

Figure 5. Typical scheme for an underground LPG storage tank with vertical submersible pump

Table 8.- Minimum Design Requirements Vertical Manifold

Premier	Premier HiFlow
Nomenclature: LPG300V17-21	**Nomenclature: LPG500V17-24**
Excess flow valve (Inlet) minimum 462 liter/min. (122 gallon/min.) liquid	Excess flow valve (Inlet) minimum 462 liter/min. (122 gallon/min.) liquid
Ball valve 2”	Ball valve 3” or 2” limit restrictions
Pump well or opening: 5 in. (125 mm) minimum	Pump well or opening: 5 in. (125 mm) minimum
Outlet: 1-½” - 2”	Outlet: 1-½” - 2”
Equalization line: length: as short as possible diameter: minimum 8 mm (0.31 in.)	Equalization line: length: as short as possible diameter: minimum 8 mm (0.31 in.)
Excess flow valve (If design required in equalization line): minimum 78 liter/min. (20 gallon/min.)	Excess flow valve (If design required in equalization line): minimum 78 liter/min. (20 gallon/min.)

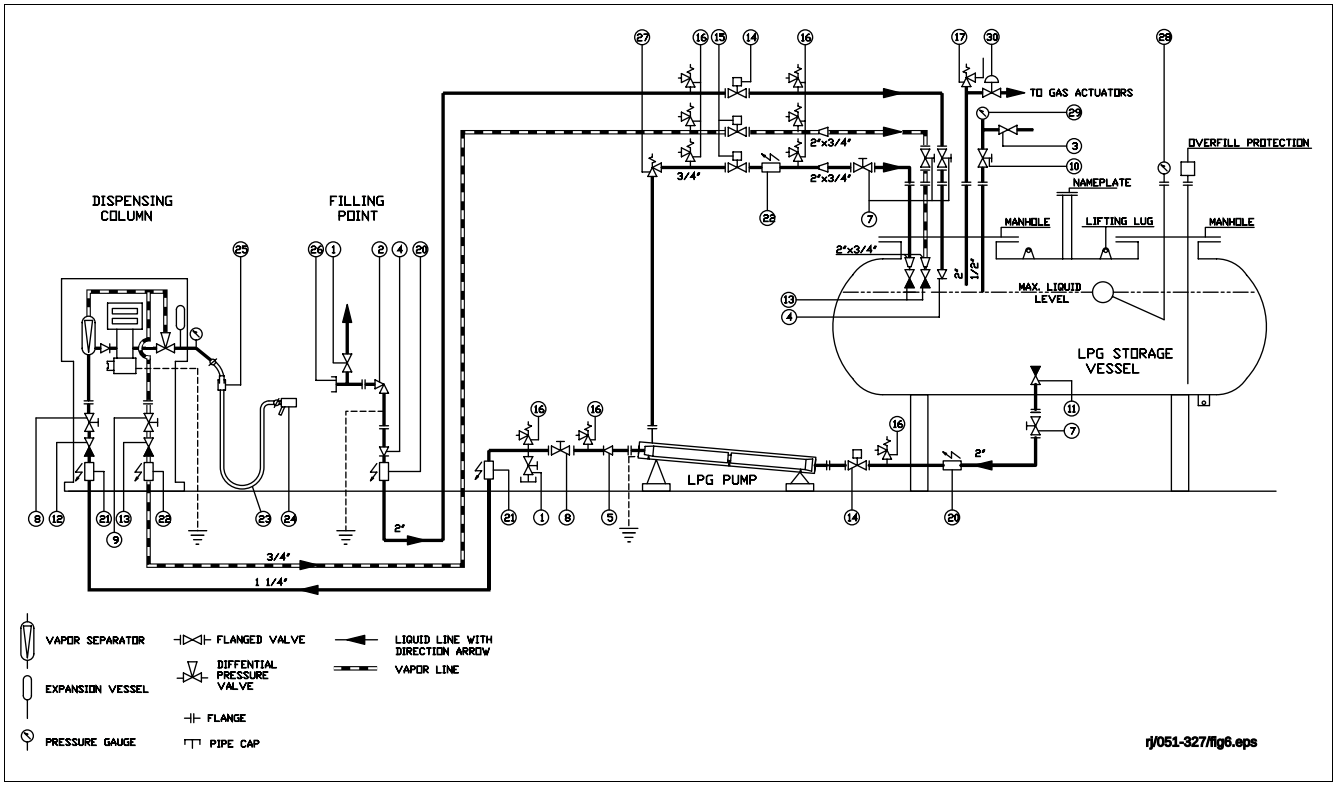

Figure 6. Typical scheme for an aboveground LPG storage tank with horizontal submersible pump

Table 9.- Minimum Design Requirements Horizontal Manifold

Premier	Premier HiFlow
Nomenclature: LPG300V17-21	**Nomenclature: LPG500V17-24**
Excess flow valve (Inlet) minimum 462 liter/min. (122 gallon/min.) liquid	Excess flow valve (Inlet) minimum 462 liter/min. (122 gallon/min.) liquid
Ball valve 2"	Ball valve 3" or 2" limit restrictions
Manifold: 5 in. (125 mm) minimum	Manifold: 6 in. (150 mm) minimum
Outlet: 1-½ - 2 in.	Outlet: 1-½ - 2 in.
Vapor return line ¾ in.	Vapor return line ¾ in.
Excess flow valve (Vapor return line): minimum 78 liter/min. (20 gallon/min.)	Excess flow valve (vapor return line): minimum 78 liter/min. (20 gallon/min.)
Pump unit must be supported by three support-arms: a. the inlet, b. discharge-head, and c. at the pump flange	Pump unit must be supported by three support-arms: a. the inlet, b. discharge-head, and c. at the pump flange
Manifold : must be installed 4 - 5° upwards to avoid vapor lock in manifold	Manifold : must be installed 4 - 5° upwards to avoid vapor lock in manifold

Gas Filling

Gas Filling Requirements

- Operation installation must be done by at least two duly trained engineers, of whom one is responsible for following up the safety regulations and procedures.
- Gas filling and degassing of the installation has to be done with regard to the hazardous area zone of the Autogas tank and filling point.
- All parts need to be checked to ensure they are installed correctly before the installation is placed in operation.
- During installation it is not allowed to have open fire or flammable materials within a radius of 15 meters (49 feet), or heated objects with surface temperature exceeding 300°C (572°F) or other sources of ignition.
- During fog or windless weather installation should be avoided, as gasses may not be able to evaporate quickly enough.

- Working area should be fenced and electricity shut off.
- Two (2) portable powder extinguishers of at least 6 kg (13.2 lbs) should be present for immediate use.

Gas filling procedure

1. Verify that the gas filling requirements above have been met. Make sure all fittings are tight to prevent leaks.
2. Fill the tank and manifold with nitrogen until pressure reaches 100 kPa (14.7 psi). Relieve pressure until it reduces to 15 kPa (2.1 psi).
3. Repeat the filling with nitrogen until it reaches 100 kPa (14.7 psi). Relieve the pressure until it reduces to 15 kPa (2.1 psi).

4. Fill the tank and manifold with LPG until it reaches 100 kPa (14.7 psi). Relieve the LPG pressure until it reduces to 15 kPa (2.1 psi). Note: Pressurizing the LPG tank is only allowed through the vapor nozzle of the tank truck.
5. Fill the tank and manifold with LPG until it reaches 100 kPa (14.7 psi). Relieve the LPG pressure until it reduces to 15 kPa (2.1 psi).
6. Fill the tank and manifold with LPG until it reaches 100 kPa (14.7 psi). Relieve the LPG pressure until it reduces to 15 kPa (2.1 psi).
7. Fill the tank and manifold with LPG until it reaches 100 kPa (14.7 psi). Relieve the LPG pressure until it reduces to 15 kPa (2.1 psi).
8. After Step 7. , there is maximum 1.7% air in the gas mixture, of which the oxygen concentration can be measured. The tank and manifold are now ready to be used and can be filled up to maximum 80%.
9. Check the manifold fittings by applying a mix of water and soap on all the fittings.
10. The pipe lines of the installation and dispenser should now be tested and flushed with nitrogen.

Degassing a Manifold and Replacing a Red Jacket LPG Pump

Prior to Starting

- These instructions must be followed when replacing a submersible LPG pump.
- These instructions only relate to the degassing of the manifold and the replacement of the submersible pump, and not to the dispenser which measures and register the actual sales of the product.
- The degassing of the manifold and the replacement of the Red Jacket submersible LPG pumps should only be conducted in the presence of an authorized technician.

Degassing Procedure

Degassing is the procedure by which the gas concentration in the manifold and/or related piping system is safely reduced to (and then maintained at) a level which is not higher than 10% of the lower explosion limit (LEL).

1. Disconnect the power supply of the submersible pump on the switchboard in the kiosk. (Secure the switch against switching on).
2. Close ball valve in the liquid line.
3. Connect the nitrogen cylinder to the purge connection of the manifold.
4. Close the ball valve in the equalization line.
5. Open the purge connection and fill the manifold with nitrogen (pressure max. 1000 kPa [145 psi]) until you hear the nitrogen bubbling from the inlet of the manifold.
6. Close the inlet ball valve and purge connection, secure the inlet ball valve against opening.
7. Disconnect the nitrogen cylinder.
8. Relieve the pressure of the manifold by opening the purge connection.
9. Disconnect the power cable from the junction box (mark the wires).
10. Disconnect liquid line.
11. Disconnect manifold cover.
12. Lift the pump.

Replace the pump and restart the installation

1. Disconnect the pump/motor from the discharge head by unscrewing the four socket head screws.
2. Examine flange connections for corrosion roughness or small parts of old gasket. If so, smooth with fine emery paper.
3. Examine discharge head for corrosion roughness or small parts of old gasket. If so, smooth with fine emery paper.
4. Assemble the pump to the motor, and then the motor to the discharge head following the instructions contained in the section entitled ' Installing a Red Jacket Submersible LPG Pump on page 11'.
5. Disconnect the pressure gauge of the liquid line.
6. Re-install the new LPG pump into the manifold.
7. Make sure the flange gaskets are in place.
8. Tighten all bolts.

CAUTION: Make sure all fittings are tight to prevent possible leaks.

Filling the manifold and pump with liquid

Avoid any risk of fire.

1. Open the purge connection.
2. Open the ball valve of the pressure gauge in the liquid line.
3. Open the ball valve of the manifold to 10% of full.
4. Close the purge connection when LPG vapor comes out.
5. Open the equalization line.
6. Open the ball valve to 40% of full.
7. Close the ball valve of the pressure gauge in the liquid line when LPG vapor comes out.
8. Open the ball valve of the manifold and secure the ball valve against closing.
9. Connect the pressure gauge.
10. Connect the power cable into the junction box and switch the power supply on.
11. Open the ball valve in the liquid line.
12. Installation is ready to start-up. If the pump makes a lot of noise during the start-up there is still compressed air in the pump. If so, stop the pump and remove the air by opening the ball valve of the pressure gauge in the liquid line and go back to Step 7.

CAUTION: Make sure all fittings are tight to prevent possible leaks before starting up the installation. Never run an LPG pump dry and avoid running a LPG pump with compressed air in the pump, this will damage the pump.

Maintenance of the Red Jacket Submersible LPG Pump

A Red Jacket pump is not repairable. However, with the split-design models, if a pump fails you can replace the broken motor or pump section instead of the complete pump.

Table 10.- Service Parts List

Part Number	Qty.	Description
136-357-5	1	Discharge head kit - contains gasket, screws, lock washers, disharge head
031-337-1	1	Gasket
026-673-1	4	Socket head screw (5/16 -18 inch)
026-435-1	4	Lock washer (5/16 inch)
072-725-1	1	O-ring, motor (25.4 x 1.8 mm [1.0 x 0.070 in.])
144-210-1	1	Pump fastener kit - contains (4) hex head screws and (4) lockwashers
072-660-1	1	O-ring, pump (53.6 x 2.6 mm [2.11 x 0.103 in.])
213-166-1	1	Pigtail connector, 14 AWG, 3 meter (10 ft.), PVC sleeve
410109-001	1	Discharge head o-ring kit

Troubleshooting

Troubleshooting Guide

The table below lists suggested troubleshooting procedures for pump related problems.

Symptom	Cause of Trouble	What to Check	How to Correct
Vehicle Does Not Fill	AFL valve in vehicle tank not open	Contents gauge	AFL valve is faulty if tank is not full
	Blockage in discharge line to vehicle	Compare flow rate on other lines	Clear blockage
	Blocked filter in dispenser or nozzle	Compare flow rate on other lines	Clean filters
	Differential pressure low	See SYMPTOM	
	Dispenser is not authorized	Power to dispenser	Re-establish power to dispenser
		Nozzle connection to vehicle	Correct connection
	High pressure in vehicle tank	Vehicle tank temperature	Cool tank or reduce number of open nozzles
	Inadequate product in supply tank	Liquid level in supply tank	Fill supply tank
	Pump not running	See SYMPTOM	
	Vehicle tank is full	Contents gauge	No problem exists
Differential Pressure Low	Discharge head or pump is loose, creating pressure leak	Pump assembly	Pull pump, check condition of O-rings and gasket. Assemble and re-tighten screws properly.
	External bypass is set incorrectly or is faulty	Bypass	Correct if necessary
	Internal bypass in motor is faulty	Open external bypass	If pressure returns to normal, internal bypass is faulty
	Pump is running in wrong direction	Reverse two pump wires at the contactor	Proper connection will always provide highest pressure
	Pump is single phased	Amperage or voltage to pump	If one leg is zero, contactor or power supply is faulty
	Pump staging has failed	Have filters been clogged?	Clean filters and service pump
	Restriction into pump well	Ball valve and excess flow valve	Open ball valve
	Too many open nozzles per pump	Single pump installation	Limit number of nozzles per pump
		Dual pump installation	Are both pumps running?
	Vapor balance line between supply tank and pump well is restricted	All valves in line	Open valves or clear obstruction

Symptom	Cause of Trouble	What to Check	How to Correct
Low Flow Rate	Blockage in discharge line to vehicle	Compare flow rate on other lines	Clear blockage
	Blocked filter in dispenser or nozzle	Filters	Clean tank or service pump
	Differential pressure low	See SYMPTOM	
	Discharge valve not fully open	Differential pressure	Replace valve if pressure is correct
	Excess flow valve in line is shut	Return nozzle to dispenser and wait for valve to reset	Service nozzle if necessary
	High pressure in vehicle tank	Vehicle tank temperature	Cool tank or reduce number of open nozzles
Pump Not Running	Contactor coil is not engaged	Emergency stop, dispenser switch and contactor wiring	Close all switches, replace contactor or coil if faulty
	Contactor faulty	With coil engaged, is there voltage to pump?	Replace contactor
	No power	Voltage into run box	Check circuit breakers
Pump Is Noisy	Pump staging has failed	Have filters been clogged?	Clean filters and service pump
	Pump is single phased	Amperage or voltage to pump	If one leg is zero, contactor or power supply is faulty
	Motor bearings have failed	Pressure and amperage	Service motor

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