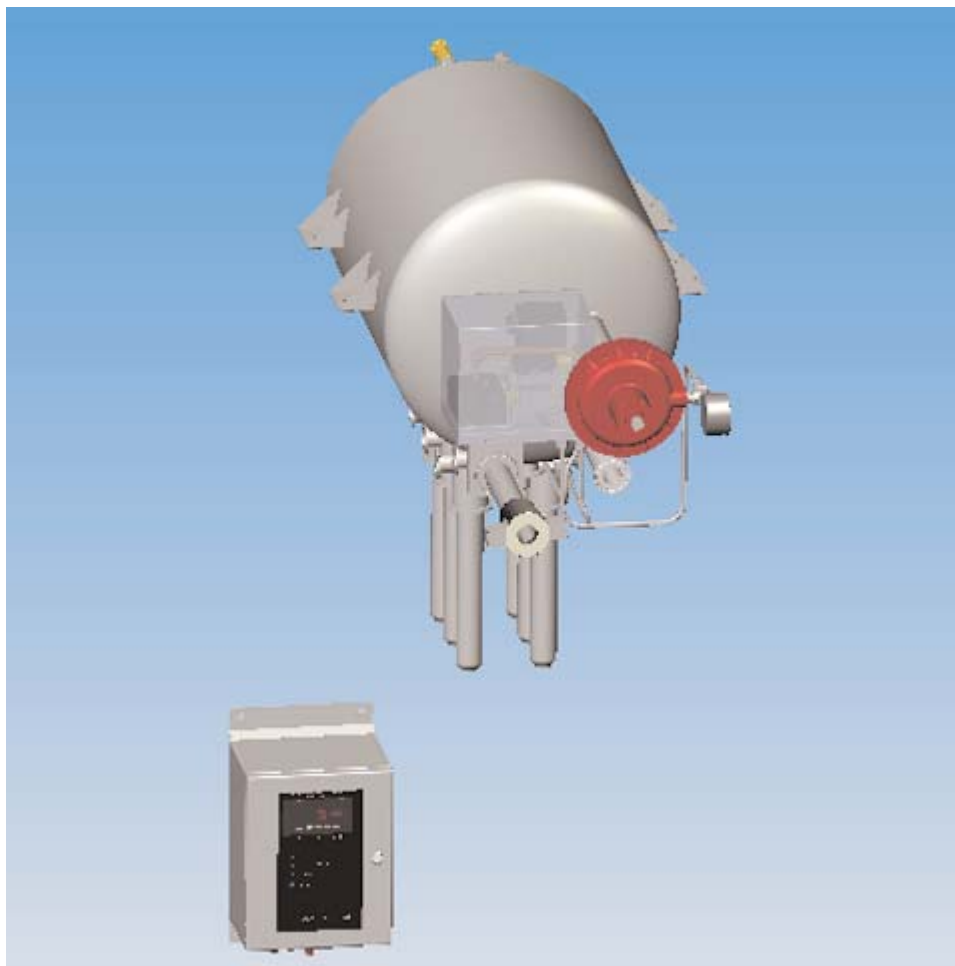


Phase Separator



Series 4000 Liquid Nitrogen Phase Separator System

Installation and Operation Manual



CRYOTECH
VBS INTERNATIONAL

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Series 4000 - Phase Separator System

Table of Contents

Section 1: Safety Information	
Safety Information .....	.04
Section 2: Cryotech Warranty Statement	
Warranty Statement .....	.06
Section 3: Receiving	
Unpacking .....	.08
Section 4: Overview and Utilities	
Overview .....	.10
Utilities .....	.13
Section 5: Installation	
Electrical .....	.15
Mechanical .....	.16
Phase Separator Vent .....	.17
Liquid Level Display .....	.18
Vacuum .....	.19
Pneumatics .....	.21
System Connections .....	.21
Section 6: Setup & Operation	
Setup & Operation .....	.23
Section 7: System Options	
System Features .....	.25
Section 8: Trouble Shooting	
Trouble Shooting .....	.27
Service Number .....	.27

Phase Separator

Section 1: Safety Information

Section 1: Safety Information

The main hazards associated with liquid nitrogen (LN2) are:

1. Extremely cold temperature (-320° F)
 2. Potential of causing oxygen depletion
 3. Potential of bursting sealed environments
-
1. When working around LN2, use personal protective equipment such as cryogenic rated gloves, a face shield, and a chemical apron. Any LN2 that comes in contact with skin may cause burns. Non-insulated LN2 pipe or fittings, such as a tank connection, will become extremely cold and can cause flesh to freeze upon contact.
 2. Due to LN2's high expansion rate, any release of LN2 into an enclosed environment will begin to displace the breathable air. When using LN2 in an enclosed environment, such as a small room where portable LN2 tanks are filled, Cryotech recommends that an oxygen monitor be installed and proper room ventilation be provided.
 3. Due to LN2's high expansion rate (700 parts GN2 to 1 part LN2), the possibility of a pressure burst exists. If LN2 is trapped in a pipe between two closed valves or in a sealed vessel, then the LN2 inside will expand and build up pressure. This expansion may result in a violent rupture of the pipe or vessel. To prevent this, a pressure relief valve must be installed wherever there is a potential to trap liquid.

Section 2: Warranty Statement

Section 2: Warranty Statement

Cryotech International warrants that the Phase Separator and its components are free from defects in material and workmanship, in the normal service for which the product was manufactured, for a period of one year from the date of shipment to the original purchaser.

To make a claim under this warranty, the purchaser must:

1. Give Cryotech written notice within ten (10) days after the discovery of a claimed defect
2. Immediately discontinue the use of the product, and
3. Return such product freight prepaid to the location specified by Cryotech for evaluation to validate the warranty claim.

If the claimed defect is confirmed by Cryotech inspection, Cryotech will, at its option and as the purchaser's sole remedy, repair or replace such product or any component part thereof or refund the original purchase price.

This warrant is voided by alterations or by repairs of others. Cryotech shall not be liable under this warranty, or otherwise, for defects or accidents caused by the purchaser's negligence, abuse/misuse or modifications to the product or for failures due to corrosion, fire, heat or the effects of normal wear. Proper installation by the purchaser of normal maintenance parts supplied by Cryotech shall not constitute modifications to the product. Any related components or other equipment manufactured by others which may be sold with Cryotech product are not covered by this warranty but may carry any applicable original equipment manufacturers' warranty.

This warranty is in lieu of any other warranties, expressed or implied, including any implied warranty of merchantability or fitness for a particular purpose.

The remedies set forth herein are exclusive. Cryotech shall not be liable for any consequential, special or incidental damages resulting from the delivery, use or failure of the product or from any other cause whatsoever. By accepting delivery of the product sold hereunder, the purchaser acknowledges that this limitation of remedies is reasonable and enforceable. In no event shall Cryotech's liability exceed the original purchase price of the product sold.

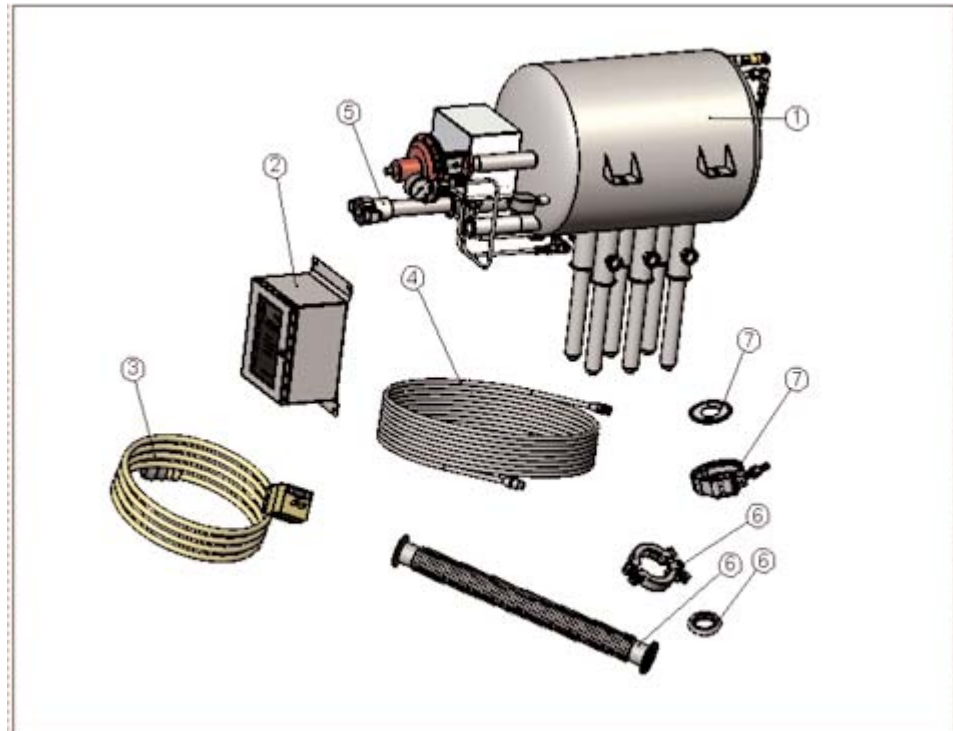
Phase Separator

Section 3: Receiving

Section 3: Unpacking

Contents

1. Phase Separator with pre-mounted electro-pneumatic control and proportional actuator.
2. Series 4000 liquid level display.
3. Power supply cable – 4 meter (13 foot).
4. Control cable (gray) 8 meter (26 foot).
5. Vent Heater (optional).
6. Vacuum jumper hose with clamp and o-ring for inlet bayonet (if dynamically evacuated).
7. V-Clamp and gasket for the inlet bayonet.
(2) KF-25 vacuum zone valves (if dynamically evacuated).



Section 4: Overview and Utilities

Section 4: Overview

Operation of Phase Separator

The purpose of a phase separator is to separate a two-phase flow of LN2 and end up with single phase, or pure liquid.

As LN2 is under pressure and flowing through a pipe, the liquid is actually a mixture of gas and liquid hence the term two phase. In some applications it would be undesirable to use this mixture so a phase separator is installed on the pipeline. The phase separator has a vacuum jacketed inlet that connects to a pipeline. The LN2 flows through a pneumatic valve into the internal reservoir of the phase separator. The liquid level is electronically controlled so that it will not rise to the top. The headspace at the top is continuously vented to atmosphere through a 1" tube. The result is a reservoir of LN2 that is at atmospheric pressure and is in single phase. Pipelines are attached to the bottom of the reservoir to allow LN2 withdrawal.

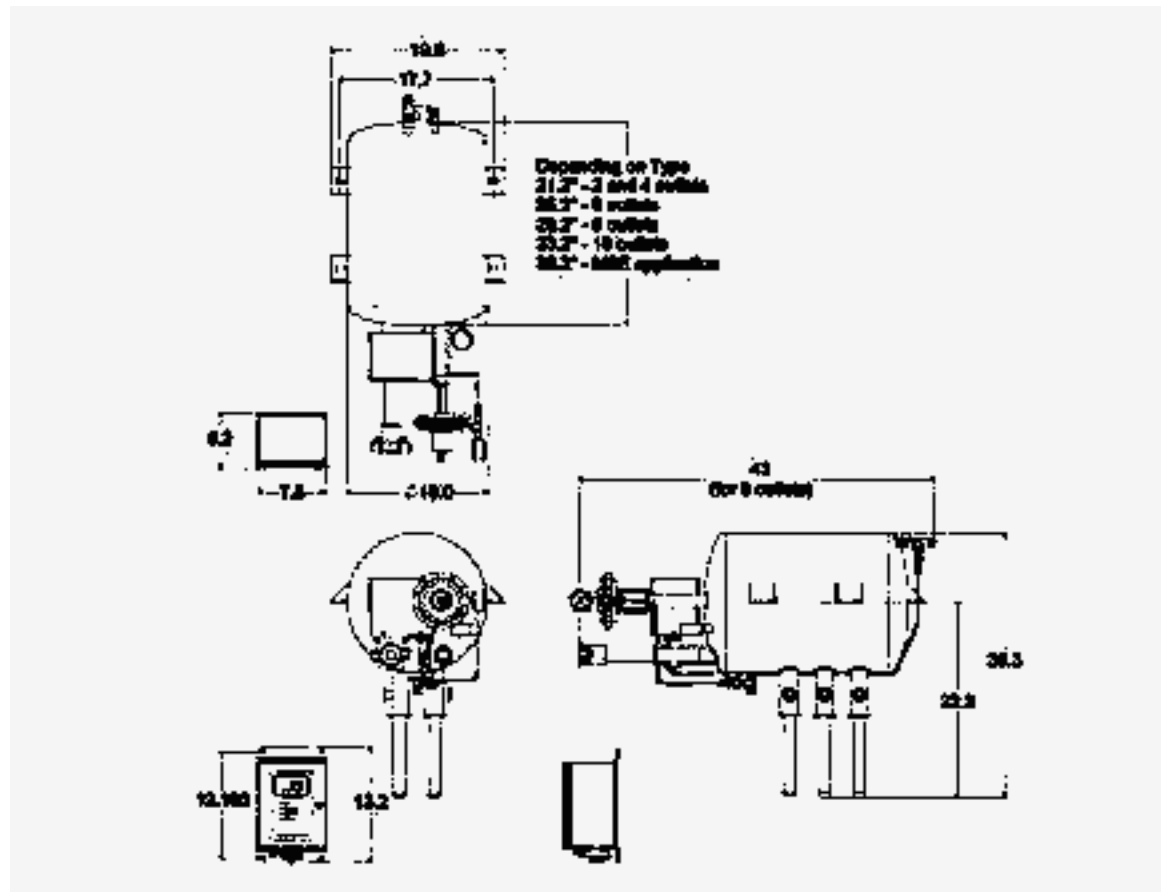
Operation of control

- 1. Pressure Taps:** The liquid level is controlled by a 4-20 milliamp, pressure differential system. There are two pressure taps on the phase separator. The high-pressure tap is connected to the bottom of the reservoir and measures the weight of the liquid. The low-pressure tap is connected to the headspace of the reservoir and measures the pressure of the headspace. These two taps are connected to tubes that connect to a pressure transducer.
- 2. Pressure Transducer:** The pressure transducer will measure the difference between the two taps and generate a 4-20 milliamp signal. When the phase separator is empty, a 4-milliamp signal will be generated and when the phase separator is full, a 20-milliamp signal will be generated. Proportional signals between 4 and 20 milliamps will be generated according to the liquid level.
- 3. Display Console:** The milliamp signal is fed to a display console that will show the level of the liquid in %. The display has a main power switch and an enable switch. This will allow one to see the level of the liquid while having the option to disable the pneumatic valve.
- 4. I-P (Current to Pressure)** The milliamp signal is then carried to a "current to pressure" device (I-P). The I-P has a minimum of 30 psi GN2 hooked up to one side of it. The I-P will take the milliamp signal and allow the GN2 to pass through it at a pressure that is proportional to the milliamp signal. The pressure will range from 6 psi to 30 psi. This pressure is delivered to a pneumatic valve that controls the flow of LN2 into the phase separator. At 6 psi (20 milliamps) the valve is shut and at 30 psi (4 milliamps) the valve is open.

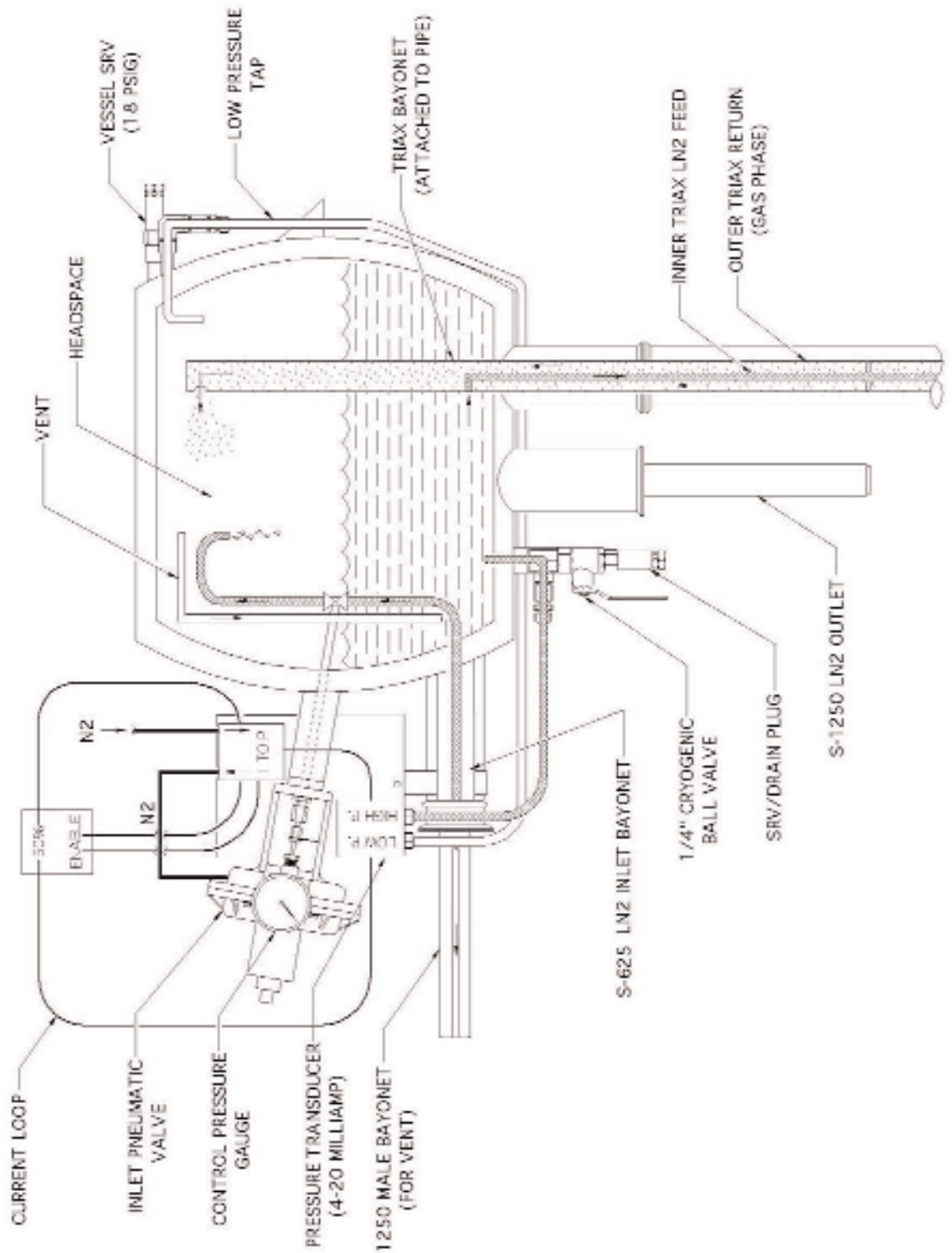
Section 4: Overview

Summary

When the phase separator is empty, there is no difference in pressure between the two pressure taps. The pressure transducer at this time delivers 4 milliamps through the display console and then on to the I-P. The I-P will then allow 30 psi of GN2 to flow through it and into the valve, which opens to let LN2 flow into the phase separator. As the level rises, the pressure transducer reads a pressure difference and delivers a higher milliamp signal proportional up to 20 milliamps, at which time the phase separator is full. Consequently the I-P will proportionally reduce the GN2 pressure down to 6 psi, at which time the valve becomes shut and the phase separator is full. With a slight fall in liquid level, the valve will start to open slightly. Because of this operation, the proportional valve keeps the phase separator at a steady level.



Section 4: Overview



Section 4: Utilities

Electrical: 80 VAC to 240VAC

Capacity: (non-MBE applications)

2 outlet – operational volume 5.85 gallons (23.40 liters)

4 outlet – operational volume 5.85 gallons (23.40 liters)

6 outlet – operational volume 7.73 gallons (30.45 liters)

8 outlet – operational volume 9.60 gallons (37.82 liters)

10 outlet – operational volume 11.48 gallons (45.21 liters)

Environmental:

NEMA, UL, CSA Type 4X compliant

Operational temperature: -20°C to 130°C

Ambient Humidity: Max. 95% RH (non-condensing condition)

Operational:

Maximum LN2 Inlet Pressure: 100 psi

Minimum GN2 pneumatic pilot pressure: 40 psi

Maximum back pressure: 12 psi (when using a back pressure regulator).

Materials:

304 SST, vacuum insulated using either dynamic or static designs

Section 5: Installation

Section 5: Installation Procedures

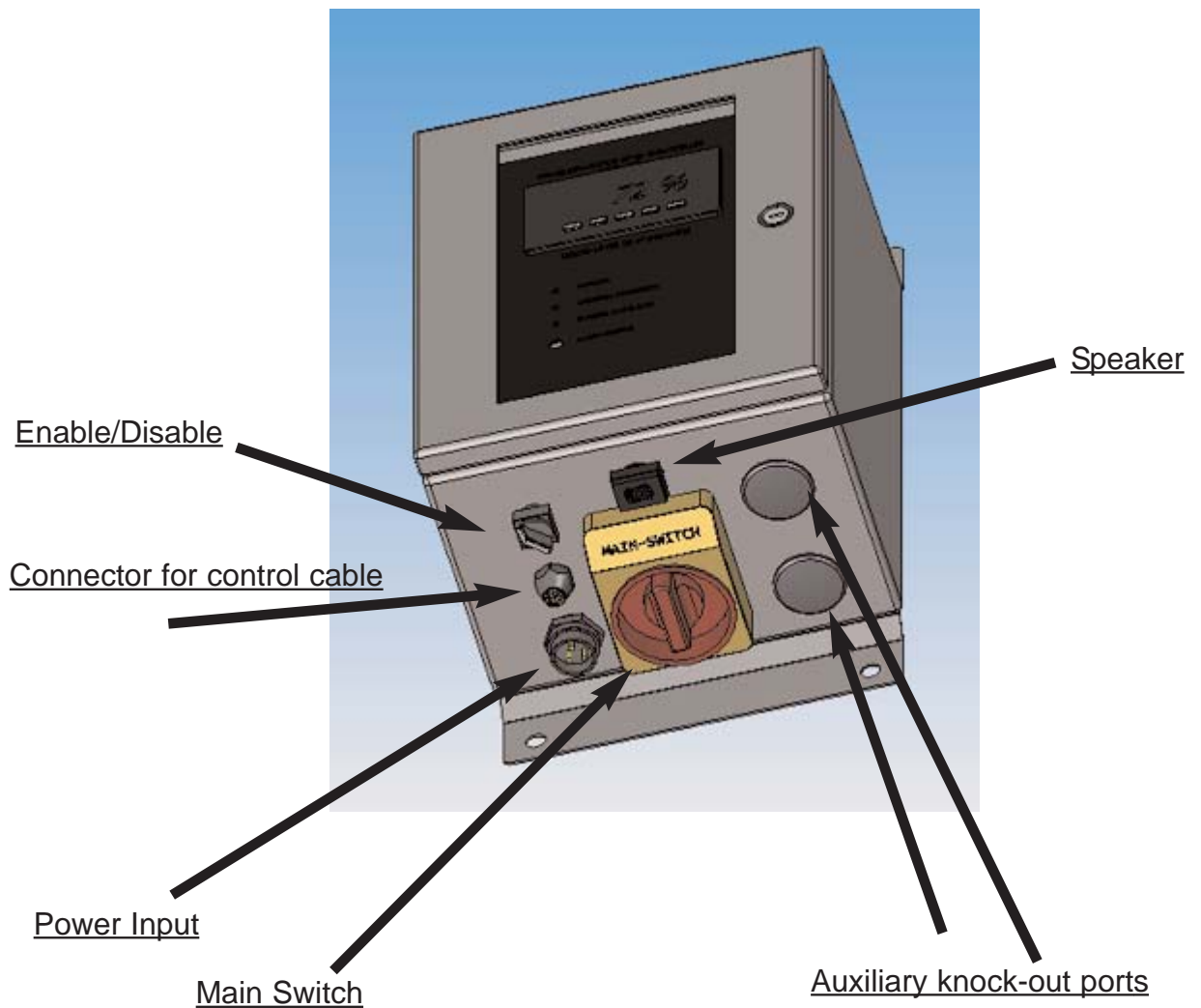
Electrical:

Phase Separator:

All electronics on the P/S are 24v and fed from the display through the gray control cable.

Display:

The phase separator liquid level display can accommodate between 80 VAC to 240VAC input power supply and comes with a standard u-ground plug/cord. The 24 foot long gray control cable interconnects the liquid level display to the P/S.



Section 5: Installation Procedures

Mechanical: Phase Separator:

The phase separator is a 16" diameter stainless steel all welded vessel and has mounting tabs welded on each side of the body. The phase separator must be securely installed in a level condition. Typical support materials are all-thread rod or metal channel. The weight of the phase separator empty is between 60 and 85 pounds (27 to 36.5 kgs), dependent upon the number of outlets. The weight full is from 100 to 163 pounds (45 and 74 kgs.) dependent on the number of outlets. Allow sufficient distance in front of the phase separator for the installation of the feed line. If the vent of the phase separator has a heater on it, allow at least three feet in front of the vent so that it will not exhaust cold gas onto a surface, otherwise condensation or ice may form.

When the phase separator is secure and level, install all female bayonet caps and branch piping sections to the outlets of the phase separator. Bayonet connections are thin walled stainless steel tubing and must be treated with care so that the bayonets are not dented during assembly. Bayonet gaskets should be properly seated in the bayonet flange grooves. The V-clamps should be tightened to approximately 20 ft/lbs.

All branch piping should be supported with metal channel, piping hangers, trapeze racks, J-hangers, clevis hangers etc. Use a continuous channel for supporting long runs that are more horizontal. Piping drops from the phase separator require a downward pitch from the phase separator towards the use point. Consult Cryotech International service for piping installation details.

For **DynaFlex** systems, connect all vacuum ports together through the use of the supplied vacuum hoses, o-ring assemblies, and clamps. Tighten all port connections before starting the start-up procedure described in this manual. Connect the Milli Torr vacuum pump to the phase separator with 1" ACR copper. Keep the distance of the copper manifold to less than 50 feet. Minimize the numbers of bends in the manifold and the overall dimensional length of the manifold. The shorter and straighter the manifold, the better the pumping system will perform. The copper joints must be brazed not soldered. Purging the manifold with an inert gas during the brazing process is mandatory.

Section 5: Installation Procedures

Phase Separator Vent:

The venting of the phase separator removes evaporated (gaseous) nitrogen from the phase separator. Venting of the phase separator is handled in two different ways:

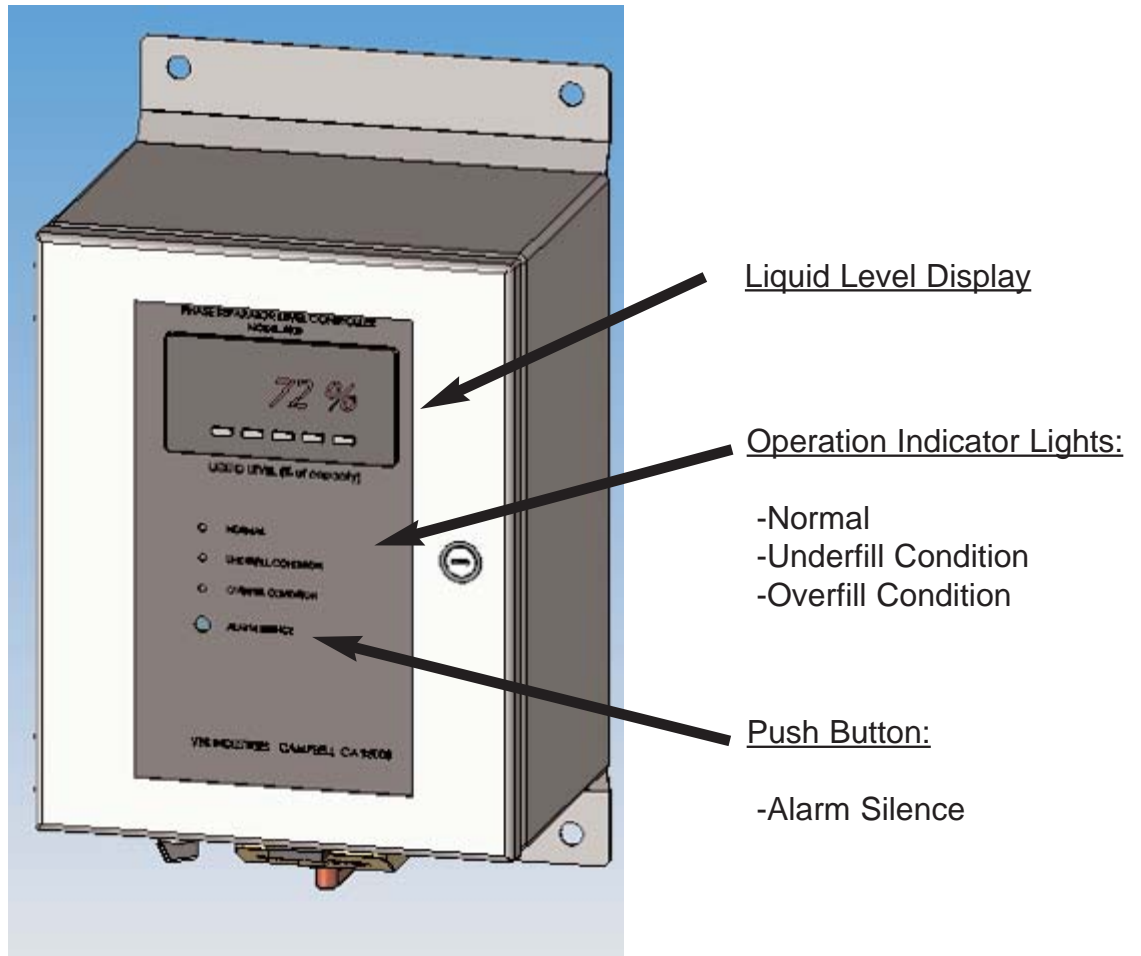
The first method uses StatiFlex(TM) vacuum insulated pipe to transfer the gas from the phase separator to a suitable location for release. The vacuum insulated line prevents condensation on the exterior of the vent line. This method is recommended for application where the phase separator is installed in either a clean room, or a confined space. The overall length of this type of vent line can be up to 50 feet. Typically there is 1" MPT at the end of the vent pipe. Install "goose neck" out of copper or brass fittings to keep rain from falling down into the pipe. See the diagram on venting for more installation instructions.

The second method uses a Vent Heater device. This method incorporates a 24v heater element that is clamped to the male vent bayonet of the phase separator. The electrical cable is plugged into the bottom of the pneumatic control box (located on the phase separator). The vent heater warms up the discharge point and prevents formation of an ice ball. When using a vent heater on a phase separator, be careful that the gaseous discharge is not exhausted into a confined space.

Section 5: Installation Procedures

Liquid Level Display:

The Series 4000 liquid level display is a wall-mounted, weather tight unit that is installed remotely up to 500 feet away from the phase separator (standard assembly comes with an 8 meter cable). It is important that the liquid level display be mounted in a location where the display can be easily seen and where the users of the phase separator can hear the audible alarm. The liquid level display also has remote alarm contacts that can be used by the user for remote monitoring of the alarm conditions.



Section 5: Installation Procedures

Vacuum:

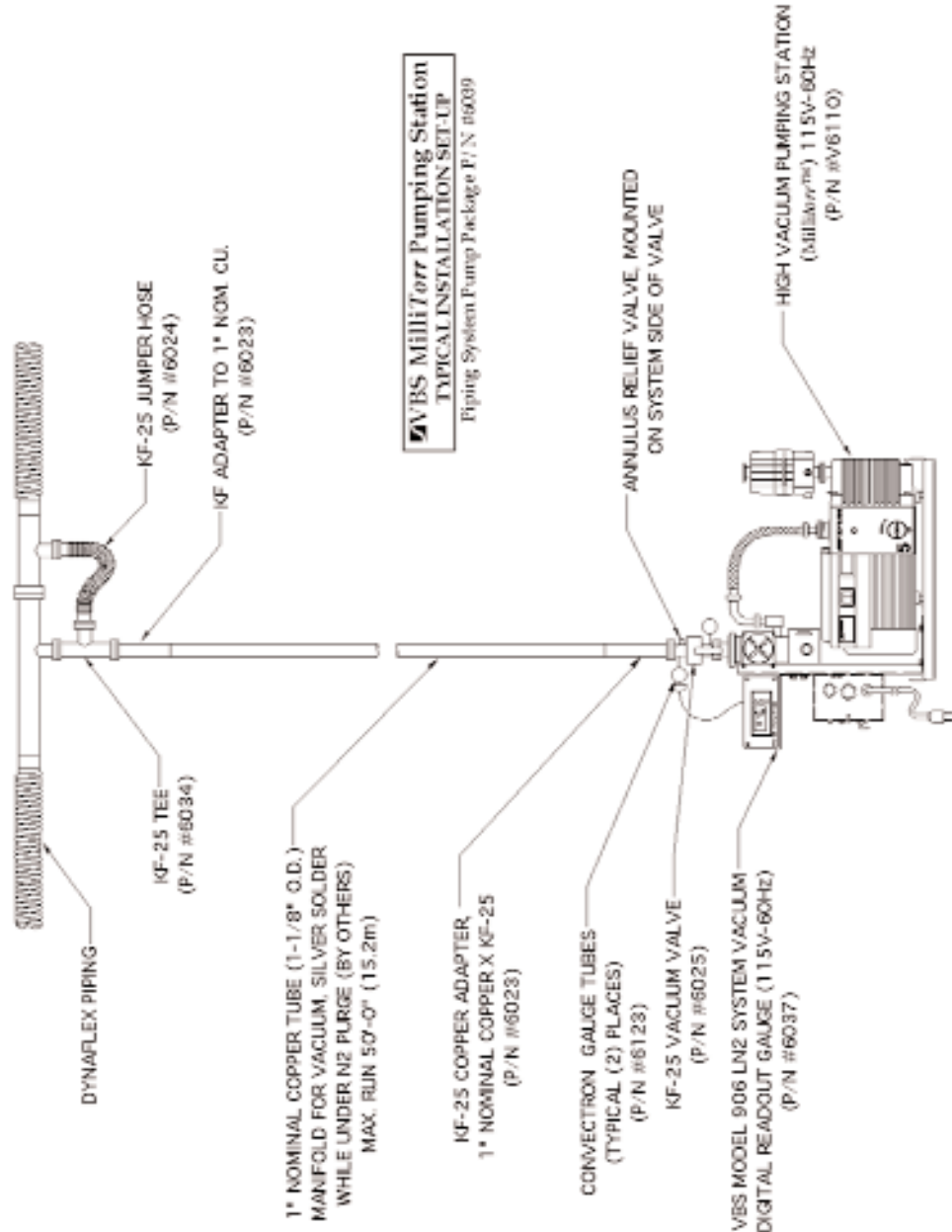
DynaFlex phase separators:

Two KF-25 vacuum valves are provided with the system. One vacuum valve is installed on the inlet bayonet to the phase separator and the second vacuum valve installed on the lower vacuum port of the phase separator. Install a 1" I.D. type ACR copper vacuum manifold to connect the vacuum valve located on the bottom of the phase separator to a Milli Torr vacuum pump system. (The pump should have a vacuum valve on it with thermocouple gauge tubes and a vacuum display). Keep the distance of the copper manifold to less than 50 feet. Minimize the numbers of bends in the manifold and the overall dimensional length of the manifold. The shorter and straighter the manifold, the better the pumping system will perform. The copper joints must be brazed not soldered. Purging the manifold with an inert gas during the brazing process is mandatory. Reference the Appendix for the drawing of the vacuum manifold installation. Connect all vacuum ports together through the use of the supplied vacuum hoses, o-ring assemblies, and clamps. Tighten all port connections before starting the start-up procedure described in this manual

Cryotech International recommends that the installer test the integrity of the vacuum manifold piping by closing the vacuum valve on the phase separator and pumping on the manifold with the Milli Torr vacuum pump. The Milli Torr vacuum pump system is a two-stage system that incorporates a mechanical vacuum pump and an oil diffusion vacuum pump. Turn on the mechanical pump first and monitor the reading on the vacuum display at the pump. When the pressure level in the vacuum manifold has decreased to below 100 Milli Torr, turn on the power to the diffusion pump. The vacuum level should read between 3.0 and 1.0 Milli Torr after 20 minutes.

If the manifold does not achieve this level of pressure, it can be assumed that there is a leak in the manifold. Turn off the pump and fix any leaks that are found (Always turn off the diffusion pump for about 10 minutes prior to turning off the pump). The manifold can be pressurized to find where leaks are. Re-do the vacuum process. Once the manifold is found to be vacuum tight, turn off the diffusion pump. After 10 minutes, open the vacuum valve on the phase separator. When the phase separator and the piping system reach 100 Milli Torr, turn on the diffusion pump. The phase separator and the piping system are ready for use when the level is under 3 Milli Torr.

Section 5: Installation Procedures



Section 5: Installation Procedures

Pneumatics:

Gaseous nitrogen at a minimum of 40 psi is required for the pneumatic control of the phase separator. The pneumatic inlet location (1/4" compression fitting) is on the bottom of the pneumatic control box mounted on the phase separator. This pneumatic inlet port is appropriately labeled and can accommodate any 1/4" tubing.

System Connections:

Once the phase separator and the display are mounted, make the following connections:

1. Connect the StatiFlex or DynaFlex main feed line to the inlet of the Phase Separator
 - a. This is accomplished by mating the main feed line male bayonet to the phase separator inlet female bayonet
 - b. Verify that the white silicone gasket is on the male bayonet before insertion into the phase separator. Use the supplied clamp to physically secure the bayonet connection
 - c. If a dynamically evacuated system, install the KF-25 vacuum valve and vacuum jumper hose at the inlet bayonet
2. Connect 40-200 psi GN2 to the pneumatic control box on the phase separator.
 - a. The pneumatic connection is on the lower panel of the pneumatic control box.
3. Connect the 8 meter control cable from the Phase Separator to the liquid level display.
 - a. Both connectors are keyed and are weather tight, once secured.
4. Connect the 120 VAC to the liquid level display through the use of the 4-meter yellow power cable.

Section 6: Setup & Operation

Section 6: Setup & Operation

Set-up and Operation

The Series 4000 phase separator liquid level display has the following indicators:

1. Phase Separator Level Indicator. A digital display showing the percentage level of liquid in the phase separator. 65% - 80% is normal.
2. Overfill Alarm Indicator – A red light is illuminated whenever the phase separator is filled to more than 90%. The audible alarm is activated whenever an overfill condition is detected.
3. Normal Condition Indicator. This green indicator is illuminated whenever the phase separator level is between 30% and 90 %.
4. Underfill Condition Indicator. This yellow LED is illuminated when the level in the phase separator is below 30%. An audible alarm is activated whenever an underfill condition is detected.

The series 4000 phase separator has the following controls:

1. Main Power. Located on the bottom of the liquid level display
2. Valve Enable toggle switch. Located on the bottom of the liquid level display. Label markings display '0' for disable and '1' for enable.
3. Alarm Silence Button. This is a manual over-ride feature that silences the audible alarm. The alarm will remain silenced for a period of 30 minutes after each depression of the alarm silence button.
4. Remote alarm contacts. Located inside the liquid level display, these are provided to allow remote monitoring of alarm conditions on the phase separator liquid level display. Sets of contacts are provided for both the Underfill and Overfill condition.
5. Verify that the LN2 source is turned on. With the main power and enable switches on, the phase separator will fill with liquid and maintain a constant level automatically. It is normal to have fluctuations on the display during an initial fill.

Section 7: System Options

Section 7: System Options

System Options

1. Back Pressure Regulating Valve (BPRV)

- a. Used on the vent of the phase separator to add up to 12psi of pressure to the phase separator. This is used with long horizontal pipe drops or when the pipe drops are not sloping downward. Some applications may also require a slightly higher pressure.
- b. BPRV's can be vacuum jacketed (Located directly onto the vent bayonet of the phase separator)
- c. BPRV's can be non-vacuum jacketed (Located on the end of vent pipes outside of buildings. Ice formation is normal on this style.

Section 8: Trouble Shooting

Section 8: Trouble Shooting

Symptom	Possible cause	Action
P/S inlet valve opens but does not fill.	Source valve not open or is empty.	Open source valve and verify available LN2.
	Pipe and/or P/S has lost vacuum.	Reinstate vacuum.
P/S inlet valve does not open.	Main power switch and/or enable switch is turned off.	Turn switches on.
	Interconnecting cable is not connected or damaged.	Check cable connections at display and P/S.
	Pneumatic pressure is low or shut off.	Check for minimum of 40 psi at inlet to pneumatic control box.
	Diaphragm of pneumatic valve is leaking.	Replace diaphragm.
	Pneumatic controller is damaged.	Replace controller.
	High-pressure tap connection is loose.	Tighten connections.
P/S overflows LN2 out of vent.	High-pressure tap is clogged.	Drain P/S and blow out tap into P/S with GN2.
	Pneumatic controller damaged. (Valve is constantly open)	Replace controller.
P/S level is too high or low.	Preload bolt on the pneumatic valve head is maladjusted.	Turn bolt clockwise to lower level, counterclockwise to raise level.

Cryotech Service Number: (408) 371-4932