



CryoWorks Phase Separator Product Manual
Model – APPS (Adjustable Pressure Phase Separator)



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1.0 LN2 CHARACTERISTICS

- ❖ Colorless
- ❖ Odorless
- ❖ Inert
- ❖ -320°F
- ❖ Expansion ratio of 700 to 1 (liquid expands 700x into gas)
- ❖ MSDS # 001040, UN 1977

2.0 SAFETY

2.1 GENERAL SAFETY

The main hazards associated with LN2 are, extremely cold temperature -320°F (-196C,77K), potential of causing oxygen depletion, potential of bursting sealed environments.

2.1.1 When working with or around LN2, severe burns and/or frostbite can occur if skin comes in contact with the -320°F liquid, cold gas, or non-insulated pipe components. Use PPE such as cryogenic rated gloves, a face shield, and a chemical apron. If cryogenic liquid or cold boil-off gas contacts skin or eyes, the affected tissues should be promptly flooded or soaked with tepid water (105-115°F; 41-46°C). **DO NOT USE HOT WATER.**

2.1.2 Due to LN2's high expansion rate (700 parts GN2 to 1-part LN2), any release of LN2 or GN2 into an enclosed environment will begin to displace the breathable air. When using LN2 in an enclosed environment, such as a room where portable LN2 tanks are filled, an oxygen monitor (see section 10.5) must be installed, and proper room ventilation provided. Individuals should be prohibited from entering areas where the oxygen content is below 19.5% unless equipped with a self-contained breathing apparatus. Persons suffering from lack of oxygen should be immediately moved to areas with normal atmospheres. A self-contained breathing apparatus may be required to prevent asphyxiation of rescue workers. See below for results of oxygen percent levels.

Oxygen percent at sea level (atmospheric pressure = 760 mmHg)	Effects
20.9	Normal
19.0	Some adverse physiological effects occur, but they are unnoticeable.
16.0	Increased pulse and breathing rate. Impaired thinking and attention. Reduced coordination.
14.0	Abnormal fatigue upon exertion. Emotional upset. Faulty coordination. Poor judgement
12.5	Very poor judgement and coordination. Impaired respiration that can cause permanent heart damage. Nausea and vomiting.
<10	Inability to perform various movements. Loss of consciousness. Convulsions. Death.
Notes: 1. Adapted from ANSI Z88.2, American National Standard for Respiratory Protection [34]. 2. These indications are for a healthy average person at rest. Factors such as individual health (being a smoker, etc.), degree of physical exertion, and high altitudes can affect these symptoms and the oxygen levels at which they occur. WARNING: Exposure to atmospheres containing 8% to 10% or less of oxygen brings about unconsciousness without warning so quickly that an individual cannot help or protect themselves. Lack of sufficient oxygen can cause serious injury or death.	

Table 1 – Oxygen Percentage at Sea Level and its Effects

- 2.1.3 Due to LN2's high expansion rate (700 parts GN2 to 1-part LN2), the possibility of an over-pressurization exists. Any configuration which allows a trapped volume of cryogenic liquid or cold gas must be protected by a pressure relief valve. As the cold liquid/gas gains heat, the contents will expand and increase in pressure. A section of pipe or components not protected by a safety relief valve (SRV) will experience high pressures. This expansion may result in a rupture of the pipe, component, or vessel.

3.0 OVERVIEW

3.1 AVAILABLE LITERATURE AND RESOURCES

CDMSER-00185 – Installation and Service Manual VIP – Provides detailed information regarding piping system design and installation.

3.2 PRODUCT DESCRIPTION

APPS – Adjustable Pressure Phase Separator

An APPS is a reservoir designed to maintain a set level of liquid nitrogen at a specified pressure. The fill control valve proportionally controls the incoming flow from the higher-pressure liquid nitrogen source to maintain the set liquid level. The vent control valve proportionally controls the gaseous nitrogen venting from the phase separator head space to maintain the set pressure.

4.0 RECEIVING AND UNPACKING

The phase separators are typically shipped via dedicated truck or shipped in wooden crates. They can be shipped individually, or part of an entire LN2 piping system. Sometimes the crates can be very large.

Information on the size and type of the crate is available from CryoWorks ahead of time so one can prepare for any special equipment to offload and also to secure a staging area prior to installation. Keep in mind that the crate will need to be disposed of after the unit is uncrated.

Upon arrival of the product, immediately inspect the shipment for any signs of damage. If any damage occurred in shipping, claims must be filed with the shipping carrier immediately.

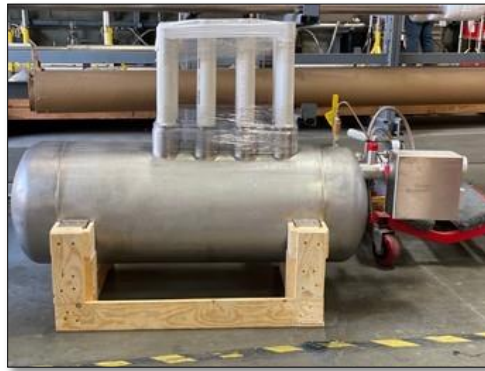
Note any damage with the driver while onsite, document damage by taking pictures, identify serial numbers and type of damage. Contact CryoWorks immediately to determine if the damage is severe enough that the unit will require rework, repair, or replacement.

Things to check upon arrival:

- ❖ Dents on the body, damage to vacuum gauge tubes, valves, safety relief valves, and misc. components. Make sure the protective covers are on male and female bayonets.
- ❖ When un-crating the product(s), caution shall be used to ensure the body is not damaged by the improper use of a hammer, pry bar, screwdriver, saw, razor knife or any other tool that may be used for un-crating. Remove any exposed screws/nails prior to removing the unit from the crate.

CAUTION: Do not damage, puncture, or pierce phase separator as this will void the warranty.

- ❖ Verify accuracy of packing list. Unpack any associated parts and verify that they match those parts itemized on the packing list. Verify that all parts are accounted for against a print or system drawing. Contact CryoWorks if there are any missing parts.



Picture 1 – Phase Separator Packaging for LTL Transport.

5.0 INSTALLATION

- Transport the phase separator to the installation location. Lift the product using the mounting brackets or a sling around the entire body, do not lift from the nozzles or other accessory piping. Staging should be in the horizontal orientation with bottom nozzles pointed to the side.
 - Install the phase separator to a predesigned and built mounting structure that utilizes the (4) side mounts. The support structure shall be designed to hold the phase separator weight when full of liquid while conforming to any codes and regulations that may apply. Minimize loads on the phase separator nozzles by properly supporting all connecting piping.
 - Connect the inlet control valve to the inlet connection. Refer to piping system drawing for any additional system details.
 - Connect the vent control valve to the vent connection.
 - Connect the vent heater or vent extension line to the outlet of the vent control valve. If vent line is utilized, connect the vent heater at the other end of the vent line.
 - Ensure vent line is exhausted to an environment that limits the risk of personnel exposure. For additional information refer to CryoWorks Vacuum Insulated Pipe Installation and Service Manual.
 - Connect the LN2 supply line to the inlet control valve.
 - Connect all liquid withdrawal lines to the bottom of the phase separator and ensure any un-used withdrawal bayonets are capped.
 - Connect the GN2 supply line to the “GN2 IN” port on the sensor box.
 - Install the pressure tubing from the inlet control valve actuator to the “Inlet Control GN2” port on the sensor box.
 - Mount the controller box at the desired indoor location. Location should be accessible for maintenance. It is advisable to be located in a visible location in order to view the user interface screen.
 - Connect the communication cable (standard is 32 ft. long) to the communication ports on both the sensor box and the controller box. Contact factory for other cable lengths.
 - Connect the power cord (standard is 12 ft. long) to the controller box and plug into the appropriate power supply. Plug in the vent heater or hard wire with the appropriate power supply.
- **Note:** Follow the instructions specified in the Vacuum Insulated Pipe Installation and Service Manual for bayonet connections

5.1 START-UP

- Before start-up, ensure that:
 - The phase separator is mounted securely, and all of the required connections have been made. The only open port on the phase separator will be the vent line which should be vented to a large open area that prevents any chances of oxygen depletion.
 - The GN2 source for the controls is between 50-150 psig.
 - The vent heater is plugged in and venting to a safe area.
 - The LN2 source pressure does not exceed 150 psig.
 - All customer/code required testing has been performed and documented.
 - The phase separator and any interconnecting piping has been purged with dry nitrogen. This may require using the manual over-ride buttons in the controller to open the fill and vent valve to allow flow through the unit.
- To begin cooling down the piping system and phase separator:
 - Slightly open the tank valve or LN2 supply valve to slowly flow LN2 into the newly connected piping system and phase separator.
 - Throttle the supply valve to cool the system down slowly. If the system is cooled down too quickly, boil off gas may over-pressurize the system and cause the safety relief valves to open.
 - As the system starts to cool down and vent less boil off gas, the supply valve can be opened fully.
 - The phase separator will vent more gaseous nitrogen than usual for the first couple hours as the unit and interconnected piping begin to cool down to cryogenic temperatures.
 - Once the phase separator liquid level and pressure stabilize, the use points connected to the liquid withdrawal ports are ready to fully operate.

5.2 OPERATION

- During normal operation, the phase separator will maintain its set level and pressure automatically.
- The liquid level sensor sends a signal to the controller, which actuates the fill valve to maintain liquid level.
- The pressure transducer sends a signal to the controller, which actuates the vent control valve to adjust the unit pressure.

5.3 ADJUSTMENT

- Liquid Level
 1. The liquid level is factory set to 7 inches of LN2 and should not be tampered with as changes to this level could result in low level or over-flow issues.
 2. Consult with factory if level setting varies from factory setting or adjustments are required.
- Pressure
 1. The pressure setting for the APPS models are factory set as ordered between 5-120 PSIG depending on the application.
 2. To adjust the pressure setting:
 - Contact CryoWorks to obtain a maintenance password.
 - From the controller home screen, press the menu button.
 - Press the Log-In button.
 - Enter the CryoWorks supplied maintenance password.
 - Press the home button to return to the home screen.
 - Click on the SP (Set Point) value for pressure (right side of screen).
 - Type in the desired pressure setting and hit enter.

- After the pressure is changed, go back to the menu, and select Log-Out so that the settings cannot be tampered with by other users.

Note: The controller will automatically start modulating the vent valve to achieve the set pressure. If the set pressure is higher than the original set pressure, it may take a while to build up pressure as the only way the pressure increases is through boil off gas build up or from filling pressure.

5.4 TROUBLESHOOTING

Trouble	Possible Cause	Remedy
Controller Does Not Power On	No power or incorrect incoming power	Check incoming power supply has power between 100-240 VAC (50-60 Hz).
	Power switch is turned off	Check that the power switch is turned to the "ON" position.
	Faulty or loose controller box wiring	Check wiring compared to wiring schematic in manual. If no wiring issues are found, contact a CryoWorks technical support representative by dialing +1 (951) 703-8662
Unit Overfills	Faulty or incorrectly adjusted level controller	Check that the SP (Set Point) value for level is at the factory setting of 7 in. of LN2. If not at the factory setting, contact a CryoWorks technical support representative by dialing +1 (951) 703-8662
	Pressure tap valves on differential pressure sensing lines have been tampered with (closed)	Pressure tap valves are set open at the factory and wire tied open. Confirm that the wire ties are in place and the valve is open. If one or both of the pressure tap valves are closed, open the valve and wire tie them in the open position to prevent tampering.
	A clogged high pressure or low pressure sensing line	To check the lines for flow, close the pressure tap valves and disconnect the lines from the sensor box. Direct the lines away from the sensor box or anything that could be harmed with LN2 coming from the lines and open the pressure tap valves. Press the manual fill switch and make sure that LN2 or GN2 flow from both lines. If one of the lines does not have flow, the unit will need to be drained, warmed, and purged with nitrogen to free the lines of any trapped moisture.
	A leak in the high pressure or low pressure tap sensing lines	Bubble leak check the pressure tap lines all the way from the tap on the phase separator to the location where the lines connect to the sensors inside the sensor box. Sensor box cover will need to be removed.
	A faulty differential pressure sensor	Close the low pressure and high pressure tap valves and disconnect the high pressure and low pressure tap lines from the back of the sensor box. The level display should go to 0 in. of LN2. If the level does not read zero, replace the differential pressure sensor.

Trouble	Possible Cause	Remedy
Unit overfills Cont.	A stuck open or bad fill valve	Perform the above steps for testing the differential pressure sensor so that the level displays 0 in. of LN2. After these steps, the fill valve should close and no more LN2 should flow into the unit. If LN2 continues flowing into the unit, there is an issue with the fill valve. The issue could be debris or moisture in the line causing leak-by. The unit and all interconnecting piping should be purged with dry nitrogen to free the line of any moisture and then started up and retested. If the problem persists, the valve could be faulty and you should contact a CryoWorks technical support representative by dialing +1 (951) 703-8662
Unit Does Not Fill	No incoming LN2	Ensure that all upstream LN2 valves are open and the incoming LN2 line has pressure.
	Incoming GN2 pressure to sensor box is incorrect	Check that the incoming GN2 pressure is between 50-150 PSIG.
	Lack of pressure to fill valve actuator	Check that when the unit is trying to fill, the actuator is receiving 30 PSIG to the actuator. The GN2 line going from the sensor box to the fill valve actuator will need to be disconnected so a gauge can be adapted to the line to check for pressure.
	Faulty or incorrectly adjusted level controller	Check that the SP (Set Point) value for level is at the factory setting of 7 in. of LN2. If not at the factory setting, contact a CryoWorks technical support representative by dialing +1 (951) 703-8662
	Pressure tap valves on differential pressure sensing lines have been tampered with (closed).	Pressure tap valves are set open at the factory and wire tied open. Confirm that the wire ties are in place and the valve is open. If one or both pressure tap valves are closed, open the valve and wire tie them in the open position to prevent tampering.
	A clogged high pressure or low pressure tap line.	To check the lines for flow, close the pressure tap valves and disconnect the lines from the sensor box. Direct the lines away from the sensor box or anything that could be harmed with LN2 coming from the lines and open the pressure tap valves. Press the manual fill switch and make sure that LN2 or GN2 flow from both lines. If one of the lines does not have flow, the unit will need to be drained, warmed, and purged with nitrogen to free the lines of any trapped moisture.
	A leak in the high pressure or low pressure tap lines.	Bubble leak check the pressure tap lines all the way from the tap on the phase separator to the location where the lines connect to the sensors inside the sensor box. Sensor box cover will need to be removed.

Trouble	Possible Cause	Remedy
Unit Does Not Fill. Cont.	A faulty differential pressure sensor	Close the low pressure and high pressure tap valves and disconnect the high pressure and low pressure tap lines from the back of the sensor box. The level display should go to 0 in. of LN2. If the level does not read zero, replace the differential pressure sensor.
	A stuck closed or bad fill valve	If the level set point is correct at 7 in. of LN2 and the displayed level is lower than 7 in. of LN2 then the fill valve should be in the open position and flowing LN2. If LN2 is not flowing into the unit, there is an issue with the fill valve. The issue could be debris or moisture in the line causing the valve to stick open. The unit and all interconnecting piping should be purged with dry nitrogen to free the line of any moisture and then started up and retested. If the problem persists, the valve could be faulty, and you should contact a CryoWorks technical support representative by dialing +1 (951) 703-8662
Over-Pressurization	Incoming GN2 pressure to sensor box is incorrect	Check that the incoming GN2 pressure is between 50-150 PSIG.
	Lack of pressure to vent valve actuator.	Check that when the unit is trying to vent, the actuator is receiving 30 PSIG to the actuator. The GN2 line going from the sensor box to the vent valve actuator will need to be disconnected so a gauge can be adapted to the line to check for pressure.
	Faulty or incorrectly adjusted pressure controller	Check that the SP (Set Point) value for pressure is set to the desired pressure. If not at the desired setting, see the adjustment procedure to change the setting.
	Low Pressure tap valve has been tampered with (closed)	Pressure tap valves are set open at the factory and wire tied open. Confirm that the wire ties are in place and the valve is open. If one or both of the pressure tap valves are closed, open the valve and wire tie them in the open position to prevent tampering.
	A clogged Low pressure tap line	To check the line for flow, close the pressure tap valve and disconnect the line from the sensor box. Direct the line away from the sensor box or anything that could be harmed with LN2 coming from the line and open the pressure tap valve. Press the manual fill switch and make sure that LN2 or GN2 flow from the line. If the line does not have flow, the unit will need to be drained, warmed, and purged with nitrogen to free the lines of any trapped moisture.

Trouble	Possible Cause	Remedy
Over-Pressurization. Cont.	A leak in the low pressure tap line	Bubble leak check the low pressure tap line all the way from the tap on the phase separator to the location where the line connects to the sensors inside the sensor box. Sensor box cover will need to be removed.
	A faulty pressure sensor	Close the low pressure tap valve and disconnect the low pressure tap line from the back of the sensor box. The pressure should display 0 PSIG. If the pressure does not read zero, replace the pressure sensor.
	A stuck closed or bad vent valve	If the pressure set point is correct, and the displayed pressure is higher than the set point, then the vent valve should be in the open position and venting GN2. If GN2 is not venting from the unit, there is an issue with the vent valve. The issue could be debris or moisture in the line causing the valve to stick open. The unit and all interconnecting piping should be purged with dry nitrogen to free the line of any moisture and then stated up and retested. If the problem still persists, the valve could be faulty, and you should contact a CryoWorks technical support representative by dialing +1 (951) 703-8662
Unit Does Not Build Pressure	Faulty or incorrectly adjusted pressure controller.	Check that the SP (Set Point) value for pressure is set to the desired pressure. If it's not at the desired setting, see the adjustment procedure to change the setting.
	Low Pressure tap valve has been tampered with (closed)	Pressure tap valves are set open at the factory and wire tied open. Confirm that the wire ties are in place and the valve is open. If one or both of the pressure tap valves are closed, open the valve and wire tie them in the open position to prevent tampering.
	A clogged low pressure tap line	To check the line for flow, close the low pressure tap valve and disconnect the line from the sensor box. Direct the line away from the sensor box or anything that could be harmed with LN2 coming from the line and open the low pressure tap valve. Press the manual fill switch and make sure that LN2 or GN2 flow from the line. If the line does not have flow, the unit will need to be drained, warmed, and purged with nitrogen to free the lines of any trapped moisture.

Trouble	Possible Cause	Remedy
Unit Does Not Build Pressure. Cont.	A leak in the low pressure tap line	Bubble leak check the low pressure tap line all the way from the tap on the phase separator to the location where the line connects to the sensor inside the sensor box. Sensor box cover will need to be removed.
	A stuck open or bad vent valve	If the pressure set point is correct, and the displayed pressure is lower than the set point, then the vent valve should be in the closed position and not venting GN2. If GN2 is venting from the unit, there is an issue with the vent valve. The issue could be debris or moisture in the line causing the valve to stick open or to allow leak by. The unit and all interconnecting piping should be purged with dry nitrogen to free the line of any moisture and then started up and retested. If the problem still persists, the valve could be faulty, and you should contact a CryoWorks technical support representative by dialing +1 (951) 703-8662
Ice Formation on The Vent Heater.	Loss of power to heater.	Check incoming power supply has power between 100-120 VAC (50-60 Hz). Note: Vent heaters can have issues with wiring through GFI units. Please consult with CryoWorks if the heater keeps tripping a GFI unit.
	Failed vent heater element.	Disconnect the power from the heater and check the resistance across the heater element. The resistance should be 40-80 Ohms. Replace heater element if outside of this range.
Phase Separator Unit Icing or Forming Condensation.	Loss of Vacuum or bad vacuum.	Contact a CryoWorks technical support representative by dialing +1 (951) 703-8662

6.0 WARRANTY

6.1 WARRANTY STATEMENT

See CryoWorks Doc. No. CDSSAL-00127 for our full Terms and Conditions of Sale.

<https://cryoworks.net/cryoworks-resources/>

7.0 SERVICE

CryoWorks, Inc. has installation and service technicians to help. If service or installation is desired, please call the field service line at +1 (951) 703-8662 or email service@cryoworks.net.