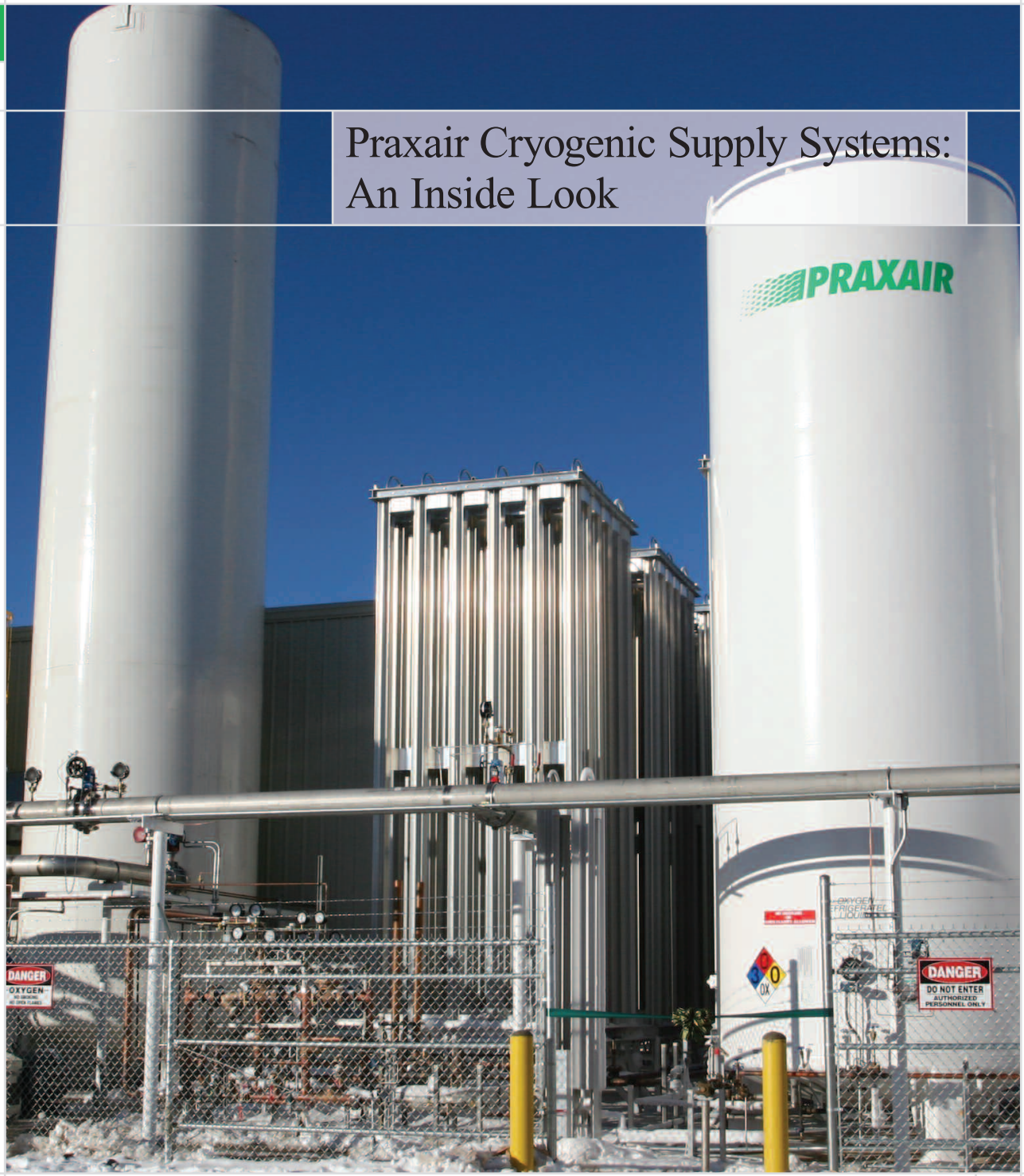
PRAXAIR

Praxair Cryogenic Supply Systems: An Inside Look



Commitment to Cryogenic Excellence

Praxair designs, installs and maintains its cryogenic systems to provide a reliable, consistent supply of argon, hydrogen, nitrogen, and oxygen. Our goal is to provide 100 percent supply reliability at the appropriate purity and pressure required. To help us meet this goal, we regularly monitor the supply system through a combination of real-time remote monitoring, periodic inspections by our technicians and driver checks at the time of each delivery. Our monitoring programs often allow us to prevent future problems from developing. In the rare event a problem does occur, our knowledge of the supply system and our experience diagnosing and alleviating issues with the supply system will allow us to quickly return service.

Supply System Overview

Praxair has four cryogenic supply systems (Figure 1) that are made available to customers for argon, hydrogen, nitrogen, and oxygen.

The primary components of the cryogenic supply systems are designed to meet customer flow, pressure and purity requirements. The entire system is designed to maintain consistent product pressure and purity. The primary components include:

Cryogenic storage vessels – sized to meet customer-stated requirements.

Vaporizers – convert cryogenic liquid to near ambient temperature gas and are sized for peak flow requirements.

Safety Systems – engineered to prevent over-pressure or low-temperature hazards.

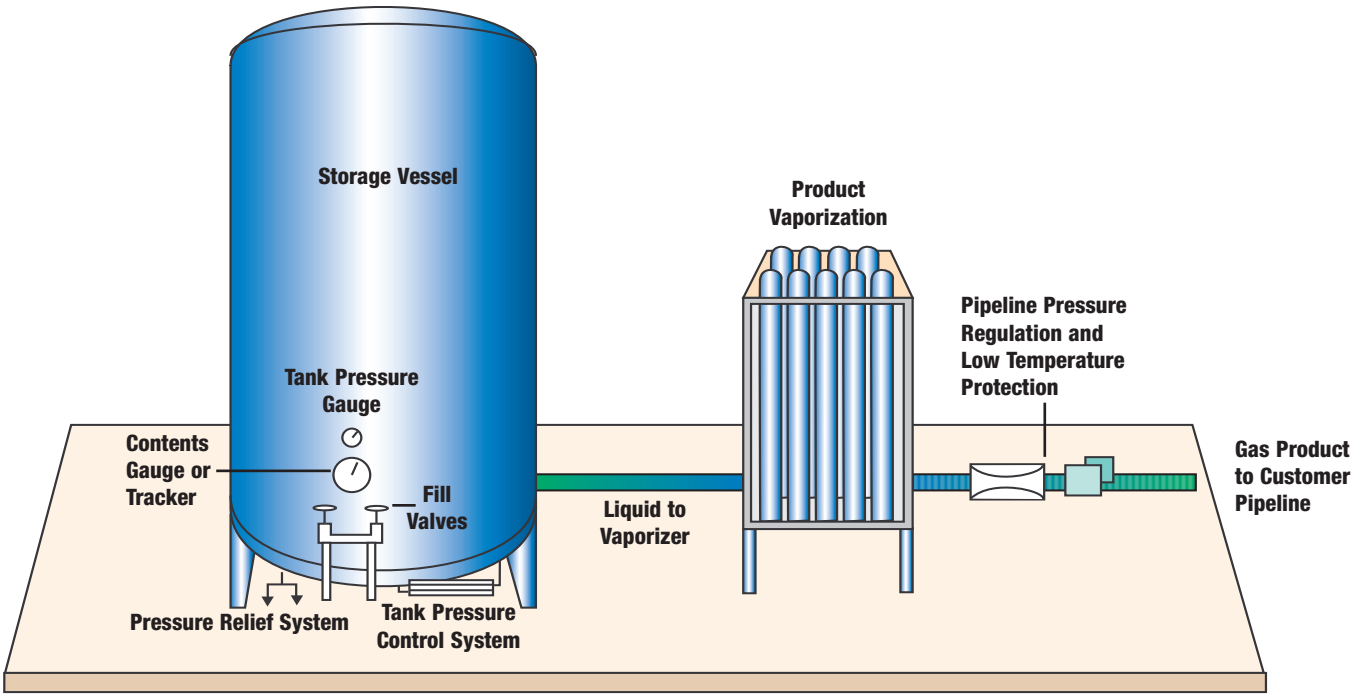


Figure 1: Overview of a Cryogenic Supply System

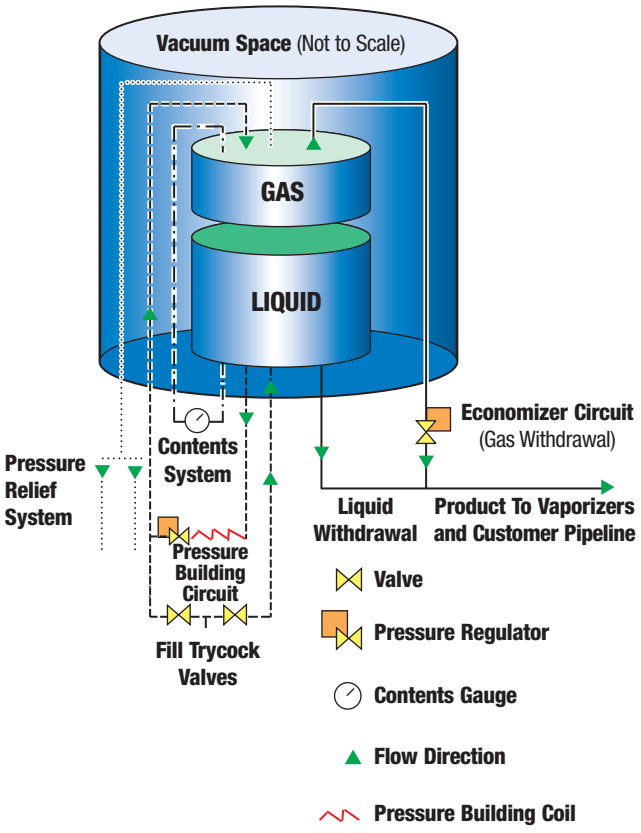


Figure 2: Cryogenic Storage Vessel

Cryogenic Storage Vessel

Tanks are used to store product and are specifically designed for cryogenic liquids. The vessels are a tank within a tank (Figure 2). The inner vessel contains the product and is American Society of Mechanical Engineers (ASME) coded and made from nine percent nickel carbon steel, stainless steel or aluminum. The space between the inner and outer vessels is filled with insulation and is under high vacuum to minimize heat transfer to the stored product.

Praxair's standard tanks range in size from 500 to 13,000 gallons for argon, nitrogen and oxygen. Hydrogen tanks range in size from 1,500 to 18,000 gallons. Each tank has a mechanical contents gauge or an electronic *Tracker*™ device. These devices provide a visual indication of the tank level and are affected by many physical attributes.

The tanks have a full trycock, which is the only acceptable indicator for a full tank (i.e., a contents gauge is not an acceptable indicator). The full trycock valve is a physically fixed device set at the proper fill level. Transport drivers are instructed to open the full trycock at the correct time and keep it open during the remainder of the fill process. The driver terminates the fill when the trailer is empty or liquid begins to flow out of the full trycock valve.

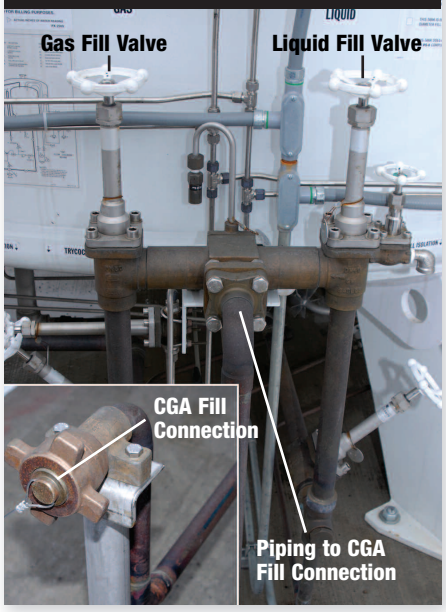
As the full trycock valve body warms up and expands to its normal size, it may develop a small hiss. If this happens, call **1-800-PRAXAIR**.

Product Fill Valve

Two main fill valves (Figure 3) are located directly in front of the cryogenic vessel and are labeled as "gas" and "liquid." The gas fill valve connects to the top of the tank and allows filling into the gas phase. The liquid fill valve connects to the bottom of the tank and allows filling into the liquid phase.

A Praxair driver connects the product delivery hose to the Compressed Gas Association (CGA) fill connection to deliver the product. The driver maintains correct tank pressure by filling into the appropriate gas or liquid phase.

Figure 3: Fill Zone



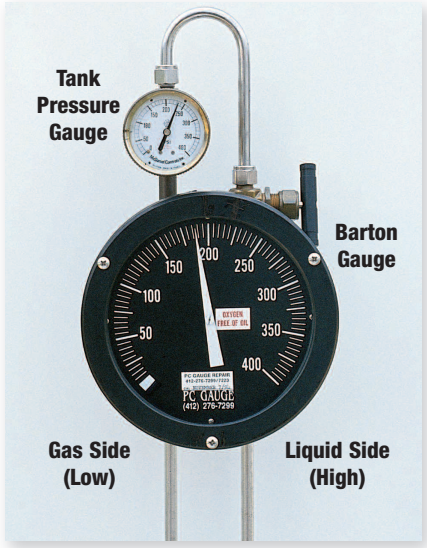


Figure 4: Contents Gauge

Tank Contents Monitoring System

Tank product level is measured with a contents gauge (Figure 4) or the *Tracker*™ remote telemetry unit. The contents gauge and the *Tracker* system determine the liquid level of the tank by measuring differential pressure between the top and bottom of the tank. The contents gauge is visually read. The *Tracker* unit can be visually read but also automatically transmits liquid levels to Praxair's North American Logistics Center in Tonawanda, NY.

There is a pressure gauge mounted near the contents gauge or *Tracker* unit that measures the gas pressure in the tank. Some pressure gauges may be liquid-filled and leak when damaged. If this happens, call **1-800-PRAXAIR.**

When the contents gauge and the Tracker unit are both installed on the same tank, it is normal for the readings on the two units to vary slightly because each has a different level of accuracy.

Tracker Units

There are two main types of *Tracker* units: wired and wireless. Wired units communicate over a dedicated analog phone line and require a 110 V power supply. Wireless units communicate via cellular communications and are powered by a battery, which is charged from a solar panel or a 110 V power supply.

Regardless of the type of unit used, it allows Praxair's Logistics Center to forecast when to schedule deliveries.

Tracker™ System Readings

The four common types of *Tracker* units are:

- Wired Unit 1
- Wired Unit 2
- Wireless Unit 1
- Wireless Unit 2

The following information describes how to obtain readings from each unit. **Wired Unit 1** (Figure 5) is a multi-channeled device that constantly scrolls through all active channels by first displaying the channel number (e.g., -1-) followed by the corresponding reading (e.g., 0186). To acquire a reading, wait for the appropriate channel to display. This unit is always powered; therefore displayed readings are always current.

Figure 5: Wired Unit 1

Wired Unit 2 (Figure 6) is a multi-channeled unit with one button on the bottom side of the unit. When in the correct display mode, this device scrolls through all active channels. If the readings are not automatically cycling, momentarily press the button. The unit should enter into the correct display mode and readings will start to automatically cycle.

Figure 6: Wired Unit 2

Wireless Unit 1 (Figure 7) has two buttons on the display screen, [FILL] and [MODE]. To acquire a tank level reading on this unit, press and hold [FILL] until display reads *FILL*.

The display of the unit can have a static reading for up to an hour; therefore, always press [FILL] to ensure a current reading.

Figure 7: Wireless Unit 1

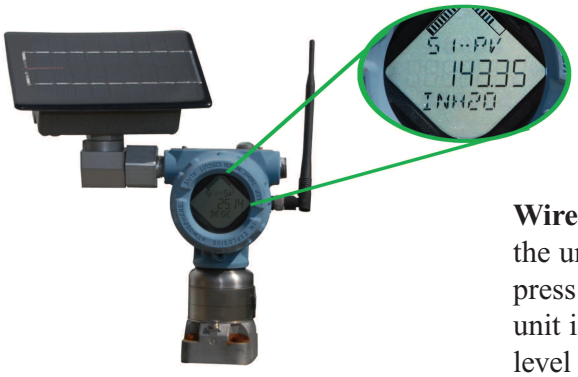


Figure 8: Wireless Unit 2

Wireless Unit 2 (Figure 8) has one button located either on the top of the unit or on the side of the solar panel support. To turn the unit on, press and hold the button for three seconds, and then release. After the unit is powered up, it scrolls through the different readings. The tank level should read with inches of water column (INH_2O) displayed below the reading.

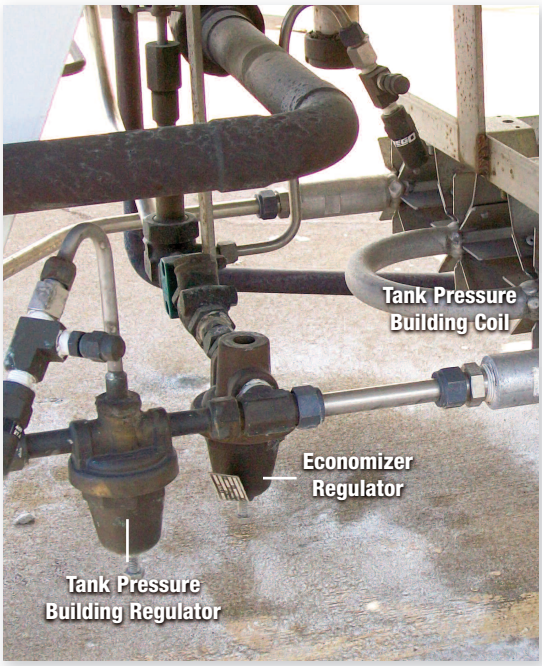


Figure 9: Tank Pressure Control System

Tank Pressure Control System

The tank pressure control system (Figure 9) is comprised of a pressure-building circuit and an economizer circuit.

Tank pressure decreases as product is used. When this occurs, to increase tank pressure:

1. The pressure-building regulator opens.
2. The liquid is withdrawn from the tank.
3. The liquid is vaporized in the pressure-building vaporizer.
4. The resulting gas is sent to the top of the tank, increasing the tank pressure.

During low-product usage, tank pressure may increase above the desired level. This is a result of heat transfer to the stored product.

When the product is being used, the economizer circuit can lower tank pressure and supply gas phase product directly to the pipeline. The economizer is only effective if product is being drawn from the system.

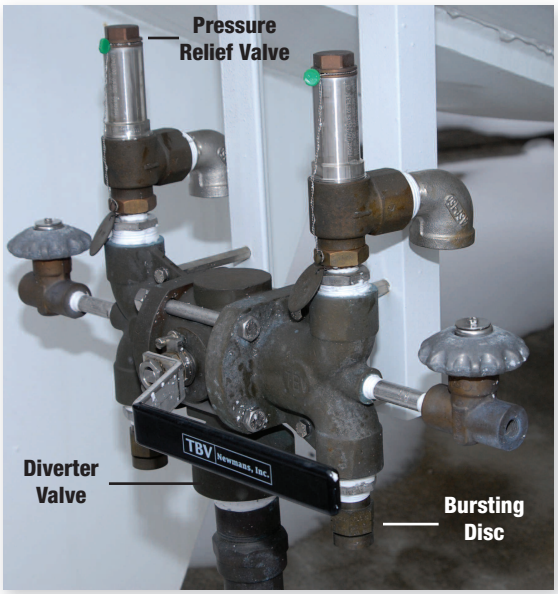


Figure 10: Pressure Relief System

Pressure Relief System

The pressure relief system (Figure 10) protects the tank from over-pressurization. Praxair installs a dual relief system to enhance reliability.

The system is comprised of a diverter valve and two parallel pressure relief paths (one active and the other is in reserve). Each path includes a pressure relief valve and bursting disc. The pressure relief valve opens at the tank's maximum allowable working pressure (MAWP, which is on the order service decal) and safely vents gas to the atmosphere. This valve closes after relieving excess pressure. Sometimes the valve does not reset and causes the gas to vent and ice to build up around the valve.

If the pressure relief valve fails to open, the bursting disc ruptures to release excess pressure. When this occurs, you may hear gas venting and see a vapor cloud as the pressure drops to zero. If the pressure relief valve sticks open or the bursting disc ruptures, call **1-800-PRAXAIR.**

Vaporizers

Atmospheric vaporizers (Figure 11) exchange heat with ambient air, and do not require external power. Steam or electrically heated vaporizers are sometimes used in high-flow applications. Liquid product flows from the tank through the vaporizer where it is heated and converted to a gas.

Figure 11: Atmospheric Vaporizers

Vaporizers are sized to match customer flow requirements to avoid low-temperature gas from entering the product pipeline. Ice on a vaporizer is normal as cold cryogenic liquid condenses and freezes moisture in the air. The greater the moisture content in the air or product use rate, the greater the potential for ice buildup. Normally, one-half to two-thirds of the aluminum fins of an atmospheric vaporizer are covered with ice. If more than three quarters are covered, your flow rate may be approaching the vaporizer's rated capacity.

Low-Temperature Pipeline Protection System

A low-temperature pipeline protection system is installed downstream of the vaporizers to protect the customer pipeline from exposure to low temperatures (less than -40°F).

This information is not applicable for Medical Supply Systems or NFPA 86 Systems.

Low-temperature conditions can result from insufficient vaporizer capacity. Praxair uses many types of low-temperature pipeline protection systems depending on customer need, flow rate and pressure requirements. These systems are designed to limit, reduce or shut off when product usage exceeds the vaporizer capacity. Also, weather conditions can affect the temperature of the pipeline. Contact **1-800-PRAXAIR** to evaluate site conditions and determine if an upgrade or modification is necessary.

Pipeline Product Pressure Regulation

The pipeline product pressure regulator maintains pipeline pressure within a set range. If the setpoint of the regulator occasionally drifts and causes a low or high-output pressure, contact **1-800-PRAXAIR** to correct the problem.

Medical Gas Systems

There are many differences between a standard cryogenic system and a medical gas system (Figure 12). Although the system components operate the same as a standard cryogenic system, additional equipment is added to improve the reliability and comply with necessary industry codes.

Figure 12: Medical Gas System

Main Tank and Vaporizers

The main tank is the larger of the two tanks from which product to the system is normally supplied. The main tank normally has its own set of vaporizers (usually atmospheric) for converting product from liquid to gas.

Reserve System

The reserve system for the medical gas system provides a secondary source of product when the primary source (Main System) is not functioning. The reserve system is designed to operate when the main system fails so product is rarely drawn from the reserve system.

Usually the reserve system is a smaller liquid tank with its own vaporizers that provides product flow to the system when the main tank runs empty or malfunctions. In some cases, where the normal use rate is very low the reserve system may be a cylinder bank. Praxair delivery drivers monitor the reserve system, and fill as necessary. Although code requires a minimum of a 24-hour reserve system supply, Praxair normally provides a reserve system that exceeds 24 hours.

The Praxair medical gas system is designed to utilize the gaseous product from the reserve system that would otherwise be vented by feeding this product into the product use line. This keeps the tank pressure at the desired level to prevent loss of product.

It is possible for the product in the reserve system to be consumed and potentially trigger an alarm (low reserve level) even though the system is properly functioning.

Alarm System

The system includes a series of alarms that are required by code. These alarms allow you to monitor the condition of the system and be alerted when abnormal conditions occur. An alarm annunciator is required inside a medical facility at a location where it is monitored at all times. The alarms and conditions are listed in Table 1. If you experience any alarms, contact Praxair at **1-800-PRAXAIR**.

Alarm	Probable Cause	Action
Main Tank Low Level	• Tank has reached the low level point • Gauge / *Tracker*™ device malfunction	• Check the tank level • Verify/schedule delivery or service
Reserve In Use	• System switched over to the Reserve System • Main tank is empty • Main tank malfunctioned • Reserve System or alarm malfunctioned	• Check tank levels and pressure in both main and reserve tanks • Verify/schedule delivery or service
Reserve Tank Low Level	• Reserve System reached a remaining supply of 24 hours • Gauge / *Tracker* device malfunctioned • Alarm malfunctioned	• Check tank level • Verify/schedule delivery or service
Low Reserve Pressure	• The Reserve System is about to run empty. **TAKE IMMEDIATE ACTION** • Alarm malfunction	• Check the reserve and main tank levels and pressure. If the alarm is valid, take immediate action • Verify/schedule delivery or service
Abnormal Line Pressure or High/Low Line Pressure	• Facility line pressure (use pressure) dropped to 20 percent below the normal pressure or rose 20 percent above the normal pressure • Alarm malfunction (medical facility responsibility)	• Check the reserve and main tank levels and pressure • Check the line pressure • Arrange for service/repair

Table 1: Medical Facility Alarm System

Order Information

Every Praxair cryogenic supply system has several information decals attached to the unit. The order information decal (Figure 13) provides valuable information to the customer, driver and technician. Table 2 explains each decal item.

Item Name	Description
ORDER LEVEL	Dynamic and changes with use rates (may or may not be on decal)
TANK FILLS AT	Level at which the tank is full, and varies as the density of the cryogenic liquid changes
DRIVER MAINTAIN PRESSURE AT	The pressure the driver is to maintain while filling
TANK M.A.W.P.	Maximum allowable working pressure by design and industry code
FILL SYSTEM TYPE	Informs the truck driver how to fill the tank
PIPELINE PRESSURE	Pressure of the pipeline
PRESSURE BUILDER SET AT	Pressure at which pressure-building circuit activates
ECONOMIZER SET AT	Pressure at which economizer is set to activate
INSPECTION DATE	Date of last unit inspection

Table 2: Information Decal

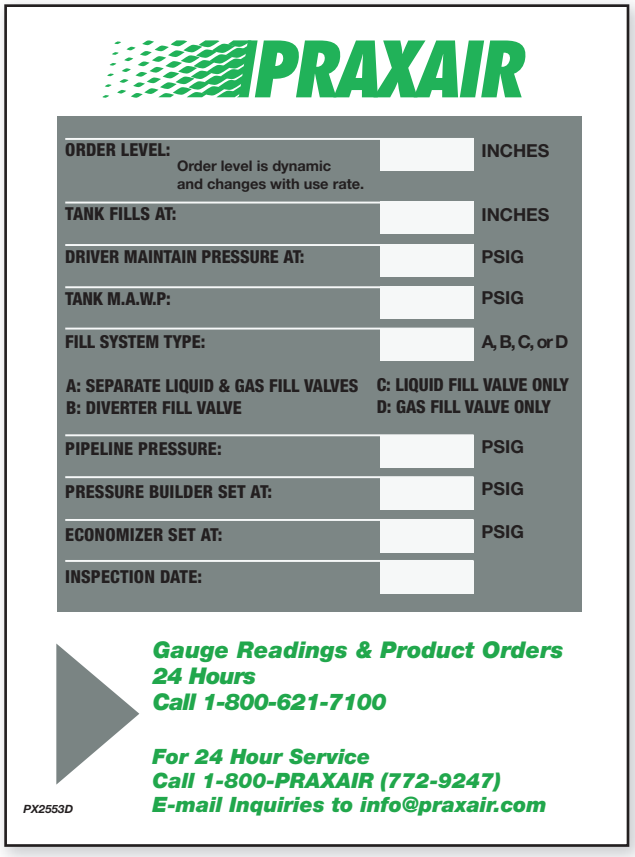


Figure 13: Order Information Decal

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