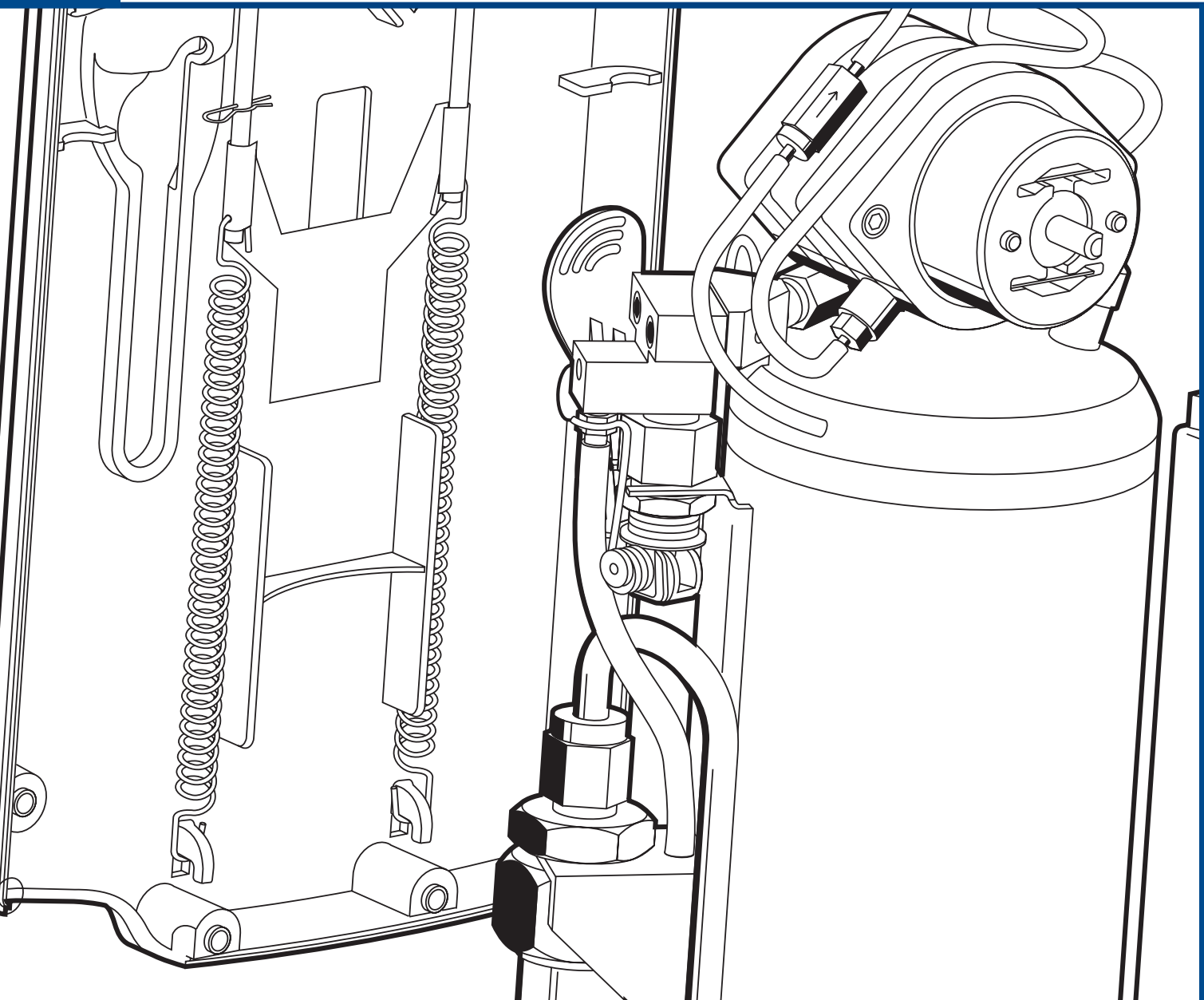
CAIRE®
A Chart Industries Company

HELiOS® Portables



Technical Service Manual

SERVICE MANUAL

HELiOS Portables

CAIRE, Inc.
2200 Airport Industrial Dr., Ste. 500
Ball Ground, GA 30107
www.cairemedical.com

Customer/Technical Service:
North and South America
Phone (US Only): 800-482-2473 Fax: 888-932-2473
US: 770-721-7759 Fax: 770-721-7758
Asia, Australia, Pacific Rim
Phone: 770-721-7759 Fax: 770-721-7758
Europe
Phone: +44 (0) 1189 367080 Fax: +44 118 9799245

For Customer or Technical Service needs (product assistance, ordering, part numbers, specifications, unexpected events, etc.) contact:
CAIRE Inc.
2200 Airport Industrial Dr., Ste. 500
1-800-482-2473
www.cairemedical.com

NOTE: CAIRE Reservoir and Portable units are intended only for the delivery of medical grade oxygen as prescribed by a physician.

NOTE: SI pressure values expressed in manual are referenced to atmosphere.
HELiOS™ and Companion® are trademarks of CAIRE INC.
SNOOP® is a trademark of the SWAGELOK Co.
Teflon® and Krytox® are trademarks of E. I. DUPONT DE NEMOURS & Co.
Kel-F® and Scotch-Brite™ are trademarks of the 3M Co.
Magnehelic® is a trademark of the DWYER INSTRUMENT Co.
QUICK-GRIP® is a trademark of the AMERICAN TOOL Co.
Sporicidin® is a trademark of SPORICIDIN INTERNATIONAL.

Disclaimer

This manual is intended for use by experienced personnel only. No attempt should be made to fill or maintain this equipment until both this manual and the Patient Operating Instruction booklet have been read and fully understood.

Abbreviations

FCV	Flow Control Valve
LED	Light Emitting Diode
LOX	Liquid Oxygen
LPM	Liters Per Minute
NER	Normal Evaporation Rate
POI	Patient Operating Instructions
N2	Nitrogen Gas
TF	Top Fill
DF	Dual Fill
DISS	Diameter Index Safety System
PRV	Primary Relief Valve
QDV	Quick Disconnect Valve
RMA	Return Materials Authorization
RP	Repair Procedure
RR	Removal and Replacement
SRV	Secondary Relief Valve
O2	Oxygen Gas
SF	Side Fill
PTFE	Polytetrafluoroethylene (“Teflon”)

Definition of Terms

WARNING	**Description of a condition that can result in personal injury or death.**
CAUTION	*Description of a condition that can result in equipment or component damage.*
NOTE	A statement containing information important enough to emphasize or repeat.
(ITEM)	Item numbers used throughout this manual are shown on the illustrations beginning in the Troubleshooting section.

Definition of Product Symbols

Table 1: Definition of Product Symbols

Symbol	Definition	Symbol	Definition
	Reservoir Full		Do not smoke near unit
	Reservoir Empty		Keep unit well ventilated at all times
	Portable Full		Do not touch frosted parts
	Portable Empty		Keep unit in upright position
IPX1	Drip Proof		Keep unit upright, flat on back, or any position in between
	Type BF (Electrical Safety)		

Table of Contents

Safety Guidelines and Operational Safety

Oxygen, as it exists at standard atmospheric pressure and temperature, is a colorless, odorless, and tasteless gas. Oxygen constitutes 21% of the atmosphere, by volume. Aside from its well-documented ability to sustain life, oxygen also supports combustion, even though it is nonflammable. Many substances which will burn in air, burn at a faster rate and at a higher temperature in an oxygen enriched atmosphere. Other materials that do not burn in air will burn as oxygen concentration increases. Additionally, many greases and liquid solvents become extremely hazardous materials when placed in an oxygen-enriched environment. In its liquid form, oxygen is still odorless and tasteless, but is pale blue in color. At an operating pressure of 1,4 bar /20 psig, the temperature of liquid oxygen is about -173°C/-280° F. Skin exposed to such a low temperature can become severely frostbitten.

Contraindications

While CAIRE, Inc. equipment is designed and built to the most rigid standards, no piece of mechanical equipment can ever be made 100% foolproof. Strict compliance with proper safety practices
is necessary when using any CAIRE unit. We recommend that our distributors emphasize safety and safe handling practices to their employees and customers. While safety features have been designed into the unit and safe operations are anticipated, it is necessary that all distributor personnel carefully read and fully understand WARNINGS, CAUTIONS, and NOTES throughout the manual. Periodic review of this information is recommended.

These hazards require certain safety precautions to be taken when working with or around gaseous and/or liquid oxygen.

WARNING: Never permit combustible substances such as greases, oils, solvents, or other compounds not oxygen compatible to contact any component of the unit exposed to higher-than atmospheric concentrations of gaseous or liquid oxygen. This especially applies to tubing, fittings, and valves.

WARNING: Keep oxygen equipment away from open flames or electrical appliances such as heaters, stoves, toasters, and other devices with heating elements.

WARNING: Never permit smoking in an area where oxygen equipment is repaired, filled, or used.

WARNING: Always wear goggles, a face shield, and insulated gloves when working with or around liquid oxygen.

WARNING: These devices are not intended for life supporting applications nor do they provide patient monitoring capabilities.

WARNING: In certain circumstances, the use of non-prescribed oxygen can be hazardous. These devices should only be used when prescribed by a physician.

WARNING: Excess accumulation of oxygen creates an oxygen-enriched atmosphere (defined by the Compressed Gas Association as an oxygen concentration above 23%). In an oxygen-enriched atmosphere, flammable items may burn vigorously and may explode. Certain items considered noncombustible in air may burn rapidly in such an environment. Keep all organic materials and other flammable substances away from possible contact with oxygen; particularly oil, grease, kerosene, cloth, wood, paint, tar, coal dust, and dirt which may contain oil or grease. DO NOT permit smoking or open flame in any area where oxygen is stored, handled, or used. Failure to comply with this warning may result in serious personal injury.

WARNING: In the event a unit is dropped, tipped over, or unreasonably abused, immediately, but cautiously, raise the container to its normal operating position. If substantial container damage has occurred, remove the liquid oxygen from the vessel in a safe manner (RP3). Purge the unit with an inert gas (nitrogen) and promptly return it to CAIRE for inspection. The container should be prominently marked **"CONTAINER DROPPED, INSPECT FOR DAMAGE."** Failure to comply with these procedures may result in personal injury and can seriously damage the container.

WARNING: Personnel must remove liquid oxygen and depressurize the unit before removing parts or loosening fittings from a unit. Failure to do so may result in personal injury from the extreme cold of liquid oxygen and/or the pressure in the vessel.

WARNING: During transfer of liquid oxygen, components will become extremely cold. Care should be used to avoid any contact with these components, as serious frostbite may result.

WARNING: Extreme high pressure can rupture container or plumbing components. Be sure specified pressure relief devices are present, in the proper location, and functioning properly.

WARNING: The possibility of fire exists when the combination of a fuel, source of ignition, and oxygen is present. High concentrations of oxygen (air is approximately 21% oxygen) greatly enhance the possibility of combustion.

WARNING: Liquid oxygen vessels periodically release small amounts of oxygen gas that must be ventilated to prevent pressure buildup. Do not store liquid oxygen equipment in a car trunk, closet, or other confined area. Do not place bags, blankets, draperies, or other fabrics over the equipment when it contains liquid oxygen.

NOTE: Liquid oxygen at atmospheric pressure expands at a ratio of approximately 860:1 (at 0 bar/ 0psig) when vaporizing into a gas. This can occur very rapidly when exposed to the heat in the atmosphere. See Figure 1 for comparison.

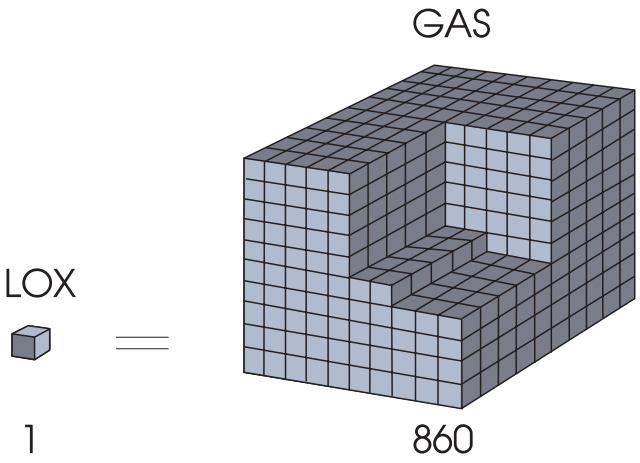


Figure 1: LOX to Gas ratio

WARNING: When using concentrated oxygen, the risk of fire is increased.

WARNING: When transporting the H300 or H850, position it horizontally, flat side down, to ensure that it does not tip over. Tipping over and falling off a transport surface could damage the portable or cause personal injury.

WARNING: Do not carry the H300 or H850 under clothing. These units normally vent oxygen. Placing a portable unit under clothing may saturate fabrics with oxygen and cause them to burn rapidly if exposed to sparks or flame. It may take several hours for oxygen levels in the fabric to return to normal.

WARNING: Do not open the vent valve during non-fill use. Do not put it in any position other than closed, upright, and vertical.

WARNING: Always keep oxygen tubing or cannulas away from the path of walking to avoid potential injury.

CAUTION: Consistent with the recommendations of the medical community on the use of conserving devices (which includes the nasal cannula), it is recommended that the H300 & H850 be qualified on patients in the situations it will be used (rest, exercise, sleep). Differences in nasal cannula design may vary the ability to trigger a conserving device.

NOTE: Figure 2 below is referred to as the fire/combustion triangle. This triangle describes the three factors required for fire/combustion to occur.

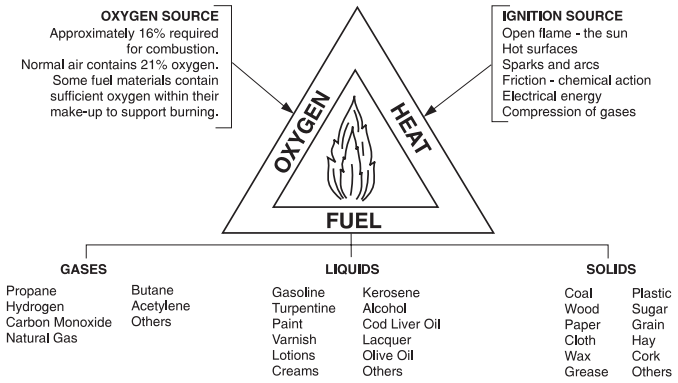


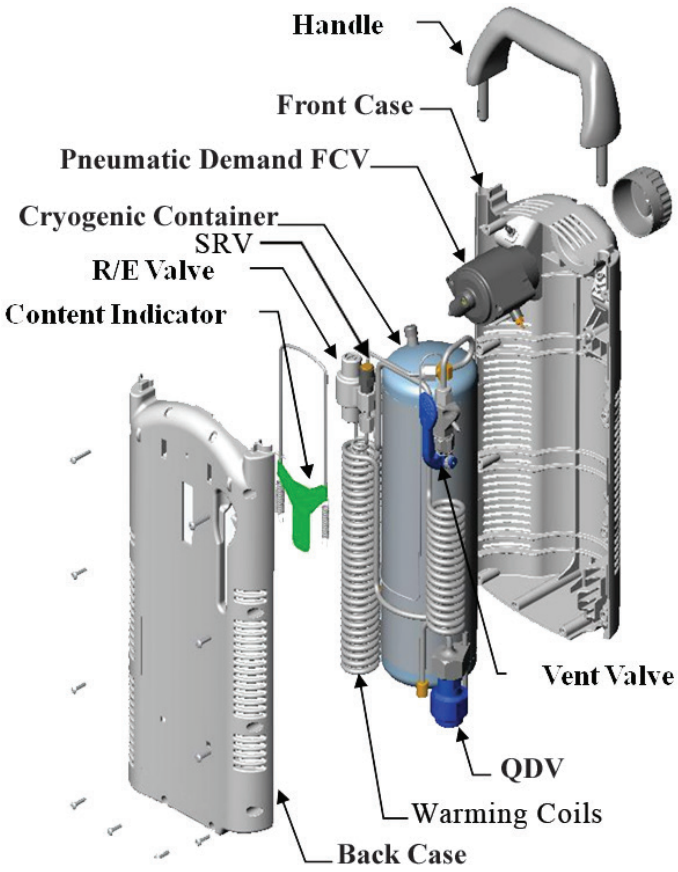
Figure 2: Fire/Combustion Triangle

NOTE: To reduce the risk of combustion/fire when dealing with LOX, please refer to the following suggestions

- Obtain all replacement parts for medical oxygen equipment from the manufacturer.
- Use only recommended oxygen compatible cleaning and leak detection products.
- Keep the reservoir upright at all times. Secure liquid oxygen equipment when transporting to prevent accidental tipover and spillage.
- If a liquid oxygen spill occurs indoors, open doors and windows to ventilate the area. Avoid sources of ignition and do not walk on or roll equipment over the affected area.
- Any clothing or porous material that is splashed with liquid oxygen or otherwise absorbs high concentrations of oxygen should be removed and aired for at least one hour away from any source of ignition.

Equipment Description

Figure 3: HELiOS portables components



The HELiOS 300 and HELiOS 850 are lightweight portable liquid oxygen units designed to deliver supplementary oxygen therapy to patients as prescribed by a physician. The units are filled from a liquid reservoir for ambulatory use, or used as a stationary conserving device when attached to a HELiOS reservoir using a flexible oxygen supply line. Enclosed in a durable plastic case, HELiOS portable units incorporate a stainless steel cryogenic container with the valves, plumbing, and associated hardware necessary to convert liquid oxygen to gaseous oxygen and deliver it to the patient at or near room temperature.

1. **Cryogenic Container** This assembly is a double walled vacuum insulated Dewar for storing liquid oxygen (LOX) at approximately -173°C/-280°F. The inner vessel is designed to safely hold liquid oxygen and is protected from over pressurization by the primary relief valve. Vacuum insulation between the inner and outer vessel keeps outside heat from causing the cold liquid inside to evaporate.

2. **Plumbing System** The plumbing system consists of the breathing (warming) and vaporizing coils, vent valve, R/E valve, SRV, and QDV. The plumbing is responsible for both filling the portable and drawing the liquid oxygen out of the cryogenic container so that it can be delivered to the patient.

3. **Case** The durable plastic case protects and encloses the cryogenic container, plumbing system, and flow control valve. The plastic case also contains vents to improve circulation of air and minimize icing.

4. **Liquid Content/Level Indicator** A mechanical spring-balanced indicator used to display the liquid oxygen contents of the HELiOS portable. It is built into the rear cover of the unit, and contains a viewing window. When the patient lifts the unit by its strap, the window displays a green bar whose height is proportional to the amount of liquid in the unit.

5. **Demand Flow Control Valve (FCV)** The flow control valve allows the patient to select either demand or continuous oxygen flow. It is a pneumatic demand valve that utilizes a dual lumen cannula to detect the negative pressure produced by a patient's inhalation and initiate flow.

Cryogenic Container

The H300 & H850 cryogenic container is designed to slow the transfer of heat from the atmosphere to the liquid oxygen contents.

The contents of H300 & H850 portables are contained within a double-walled, vacuum-insulated cryogenic container. The liquid oxygen is stored in an inner container that is suspended within an outer container. Air is removed from the space between the two containers to minimize heat transfer between the warm outer tank and the cold inner tank. This is achieved by applying a vacuum though the outer container's vacuum port.

In addition to the vacuum insulation, a molecular sieve is placed within the vacuum space against the inner container to absorb any moisture or gas molecules that remain in the vacuum space. Also, the inner containers of the H300 & H850 are wrapped in multiple layers of an aluminum foil and fiberglass paper insulation to reflect radiant energy and minimize heat transfer.

The unique design of cryogenic container and the location of the

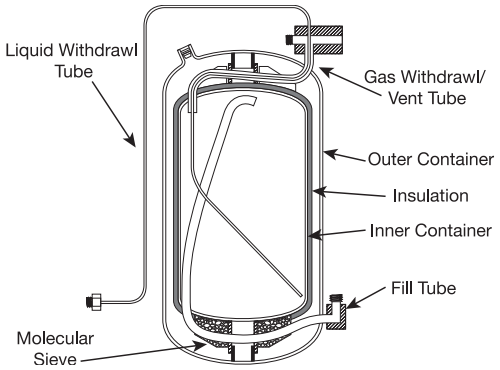


Figure 4: Cryogenic Container Design

gas withdrawal tube allow the unit to be operated safely on its back. If the H300 or H850 is laid flat on its back, liquid oxygen will not escape and be discharged. The unit can be operated upright, flat on its back, or any position in between.

Filling

The H300 & H850 potable units are designed to be filled from any top-fill (TF) reservoir with a standard Puritan Bennett male fill connector (QDV). Below is a list of CAIRE reservoirs that will fill the H300 & H850.

- Companion C21, C31, C41
- Liberator (TF/DF) 10, 20, 30, 37, 45, 60
- Low Loss (TF/DF) 31, 42
- HELiOS Universal U36, U46
- HELiOS Standard H36, H46

The H300 & H850 is filled by coupling its female quick disconnect valve (QDV) with the male QDV on the reservoir and opening the vent valve.

Once the QDV's have been connected, the vent valve on the portable unit must be opened to initiate flow of liquid into the unit. When the vent valve is opened, it vents the contents of the inner container to the atmosphere.

Venting the gas inside of the container creates a pressure drop inside of the H300 or H850. This pressure differential causes liquid oxygen to flow up the reservoir fill tube, through the coupled QDV's, and into the inner container of the H300 or H850.

At the beginning of a fill, the liquid oxygen that leaves the reservoir will vaporize into a gas because the inside of the H300 or H850 container is relatively warm. This gas is discharged through the vent valve. After a short time, the container cools and liquid oxygen is contained.

When the unit is full, liquid oxygen is expelled through the vent valve. The venting sound also changes and the liquid oxygen creates a dense vapor cloud coming from under the reservoir's shroud. Closing the vent valve and separating the H300 or H850 from the reservoir terminates the fill process.

Figure 5 is a diagram showing the filling process of a portable unit.

The saturation pressure (explained in Section VII of this manual) of the liquid oxygen can seriously affect the overall efficiency and operation of the H300 & H850.

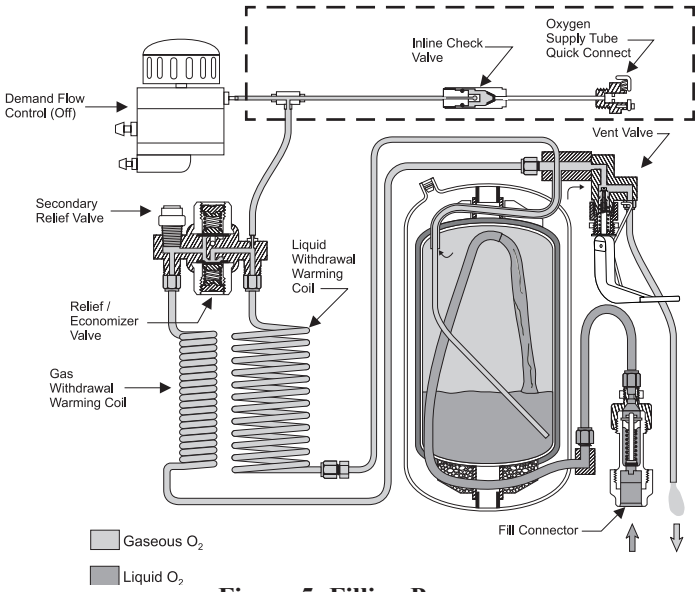


Figure 5: Filling Process

Please note that the section outlined in the above filling process shows a configuration of a unit equipped with an optional CPC Connector Kit.

Standby

When the H300 or H850 contains liquid oxygen, the vent valve is closed, and there is no flow demand, the pressure in the system will remain at or near its primary relief valve (PRV) pressure.

As with all vacuum-insulated cryogenic containers, the liquid oxygen in the H300 & H850 is always evaporating into a gas. The rate of generation of this gas (called head gas) is called the normal evaporation rate (NER). When the flow control knob is in the off position, this gas will build up pressure. When the pressure reaches the PRV setting, this gas is released through the primary relief valve into the atmosphere. Figure 6 gives and internal view of PRV when there is no oxygen flow demand.

Oxygen Withdrawal

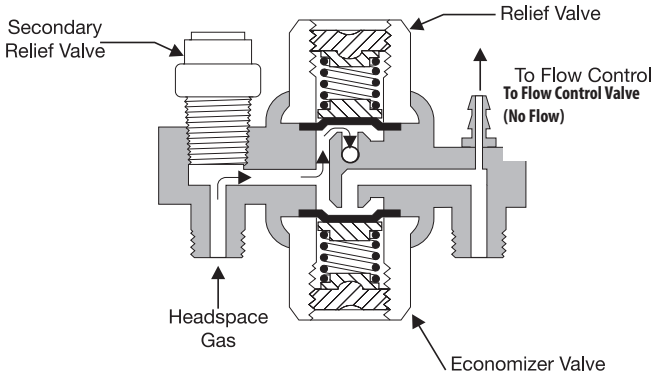


Figure 6: Standby (At Relief Valve Pressure)

When the flow selection knob is at any setting other than off and the pressure in the inner vessel is between the economizer valve pressure and the PRV pressure, the economizer valve is open.

When the economizer valve is open, gaseous oxygen is forced from the head space in the inner vessel, through the economizer valve, and to the conserver. This process "economizes" and conserves liquid oxygen by withdrawing the head gas first, rather than allowing it to escape through the relief valve. Figure 7 is a diagram of the economizer valve when it is open and head gas is being delivered to the patient.

Whenever head gas is removed from the space above the liquid oxygen, the inner vessel internal pressure begins to slightly decrease. When the pressure drops to the economizer valve setting, the economizer valve closes. This causes liquid oxygen to flow up the withdrawal tube and through the warming coils, where it expands and warms into a gas. Figure 8 is a diagram of the economizer valve when it is closed and liquid withdrawal is the source of oxygen to the patient.

If the pressure in the container increases over the economizer valve setting, the economizer valve opens again and the cycle repeats. This maintains the correct gaseous oxygen flow to the patient at all times.

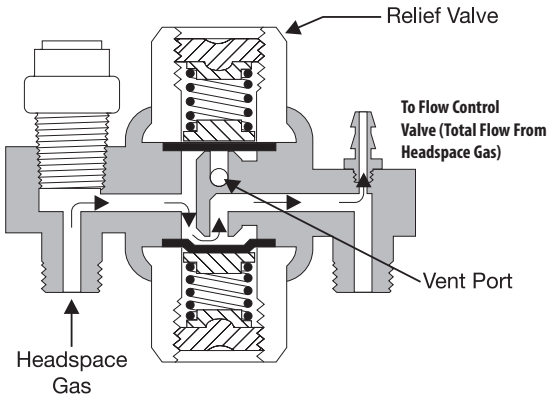


Figure 7: R/E Valve Head Gas Flow (Approaching Economizer Pressure)

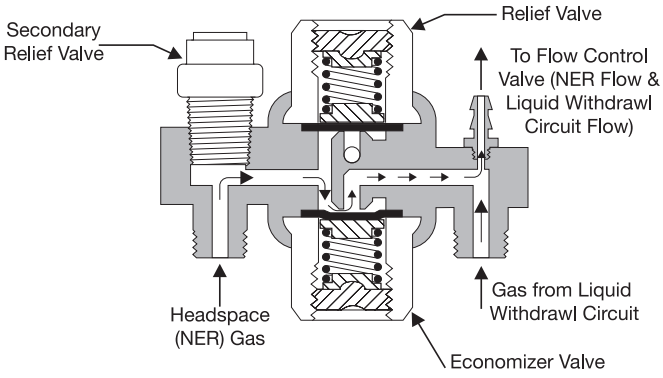


Figure 8: R/E Valve Liquid Withdrawl (At Economizer Pressure)

Oxygen Delivery

The H300 & H850 are equipped with a pneumatic demand flow control valve. Both have 12-position flow control knobs that allow the user to select their prescribed flow rate for delivery. The H300 has demand flow at a setting of 1.0 and above, and continuous flow at all settings below 1.0 LPM. The H850 has continuous flow (C) from 1-6LPM and demand (D) flow settings from 1-4.

The pneumatic demand valve contains a series of chambers, valves, and diaphragms that are shown below in Figure 9.

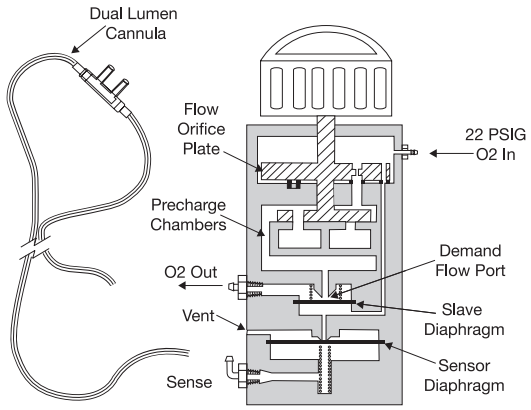


Figure 9: Demand FCV Internal Diagram

A dual lumen cannula provides the patient interface to the demand valve. The lower cannula port on the H300 or H850 is responsible for detecting an inhalation, and the upper cannula port is responsible for delivering the dose of oxygen.

CAUTION: A dual lumen cannula MUST be used on both continuous and demand flow settings.

NOTE: Oxygen will only flow from the top cannula port. This is normal behavior.

Demand Flow

When a patient inhales on a demand (D) flow setting, a negative pressure travels through the dual lumen cannula and the bottom cannula barb on the H300 or H850. This pressure acts on the bottom of the sensor diaphragm and combines with atmospheric pressure acting on the top of the diaphragm to push it downward. The lowering of the sensor diaphragm allows the pressure to bleed from under the slave diaphragm out of the vent, causing the slave diaphragm to push downward. This releases a stored volume of oxygen in the precharge chambers and delivers it to the patient through the upper cannula barb.

An initial volume of oxygen (called a bolus) is delivered immediately when a patient breathes in. The amount of oxygen that is delivered in this bolus is determined by the setting selected on the FCV. After the initial bolus, a smaller volume of oxygen, called a tail flow, is delivered continuously until the patient's inhalation stops. Figure 10 below is a graph showing the bolus delivery of oxygen when the H300 or H850 is in demand (D) mode.

When a patient stops inhaling, the sensor diaphragm raises upward and blocks the bleed flow from under the slave diaphragm. In turn, the slave diaphragm pushes upward and stops the tail flow to the patient.

Table 2: H300 Demand Flow Delivery

Demand Setting	Bolus Size (mL)	Tail Flow (LPM)
1	9.0	0.50
1.5	9.0	0.65
2	12.0	0.75
2.5	12.0	1.00
3	15.0	1.50
3.5	15.0	1.75
4	15.0	2.00

Table 3: H850 Demand Flow Delivery

Demand Setting	Bolus Size (mL)	Tail Flow (LPM)
D1.5	9.0	0.65
D2	12.0	0.75
D2.5	12.0	1.00
D3	15.0	1.50
D4	15.0	2.00

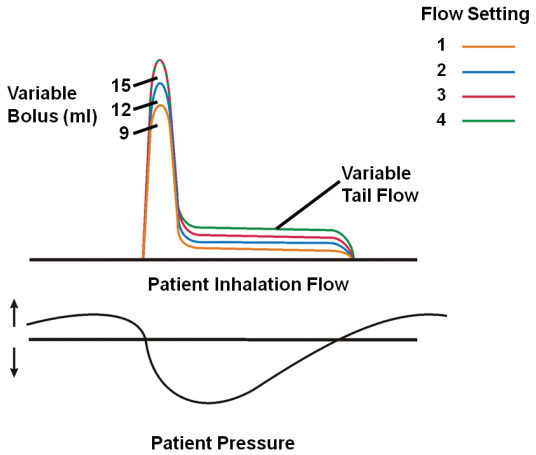


Figure 10: H300 & H850 Demand Delivery Curve

Theory of Operation

Continuous Flow

When the FCV is on continuous (C) mode, the oxygen flow is delivered in a continuous stream rather than a bolus and tail flow deivery. In these settings, the flow orifice plate blocks the gas supply to the area under the slave diaphragm. The negative pressure from the patient's first breath vents any residual pressure that may be present under the slave diaphragm and pushes it off of the demand flow port. This causes a continuous flow of oxygen.

It is important that the FCV still sense a breath periodically in continuous flow to keep the slave diaphragm pushed down. If a length of time passes without any negative pressure applied by a patient's breath, the diaphragm may close and continuous flow may stop.

Liquid Level Measurement

H300 & H850 units are equipped with mechanical spring scales for liquid measurement. The spring indicator is built into the rear cover. When the unit is suspended by its contents indicator strap and held perpendicular to the ground, a green bar is displayed in a window on the back of the unit. The height of the green bar is proportional to the weight of liquid oxygen inside the H300 or H850.

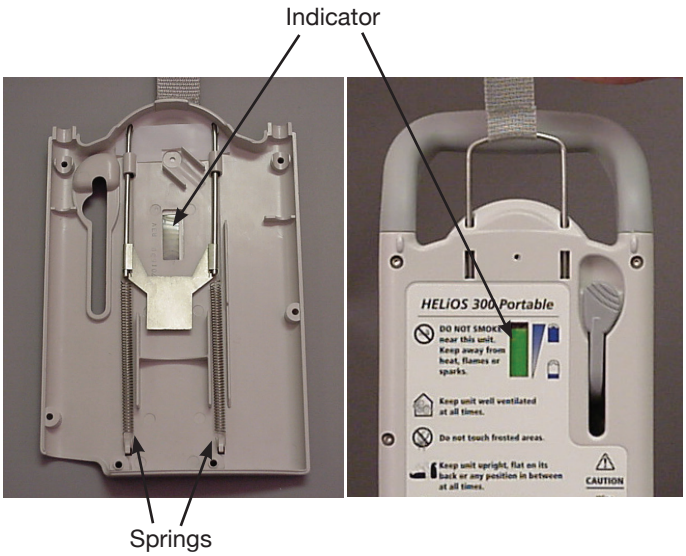


Figure 11: Contents Indicator

Serial Number Identification

1 Units manufactured prior to October 2010 are identified by unique 8-digit serial numbers shown in Figure 12. The serial number contains the year and calendar day of manufacture, as well as the unit's production number that day. The H300 & H850 serial number is etched on the cryogenic container and is visible through the contents indicator window on the back of the unit.

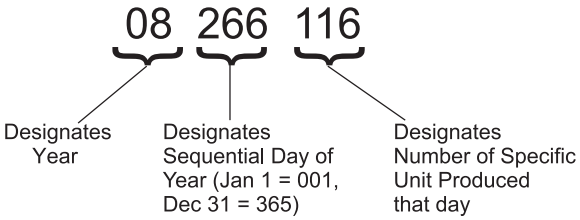


Figure 12: Serial Number Structure (Before 2010)

2 As of October 2010, H300 & H850 units are identified by differently structured serial numbers as shown in Figure 13. The number begins with the letters CB signifying the manufacturing location, followed by the reservoir product code B30, followed by digits signifying the year of manufacture, followed by a two digit number to signify the week of the year that the unit was manufactured and ends with digits signifying the unit's production number for that week. This serial number is found on a white, rectangular sticker placed on the outside of the cryogenic container. It can be seen thorough the vents on the side of the outer case.

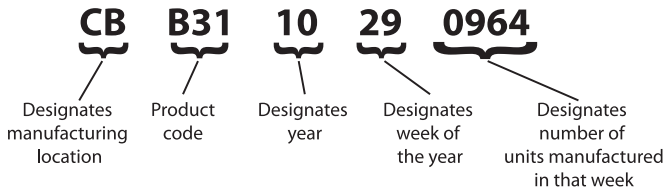


Figure 13: Current Serial Number Structure

Specifications

Table 4: Equipment Specifications

	HELiOS Plus (H300)	HELiOS Marathon (H850)
Volume of LOX (typical)	0.38 L	0.84 L
Weight of LOX at 24 psig (166 kPa) Saturation (typical)	0.9 lb (0.41 kg)	2.0 lb (0.90 kg)
Gaseous Oxygen Equivalent @ 1atm. and 70°F	308 L	685 L
Height	10.5 in (26.67 cm)	15.2 in (38.61 cm)
Dimensions (Footprint)	5.78 x 3.68 in (14.68 x 9.34 cm)	5.78 x 3.68 in (14.68 x 9.34 cm)
Empty Weight	2.7 lb (1.22 kg)	3.6 lb (1.63 kg)
Full Weight	3.6 lb (1.63 kg)	5.6 lb (2.54 kg)
Economizer Pressure	1.41-1.59 bar (20.5-23 psi)	1.53-1.71 bar (22.25 - 24.75 psi)
Primary Relief Valve Opening Pressure	≤1.90 bar (≤27.5 psi)	1.79-2.07 bar (26-30 psi)
Primary Relief Valve Reseat Pressure	>1.59 bar (>23 psi)	>1.72 bar (>25psi)
Secondary Relief Valve Opening Pressure	5.24-5.79 bar (76-84 psi)	5.24-5.79 bar (76-84 psi)
Secondary Relief Valve Reseat Pressure	>4.41 bar (>64 psi)	>4.41 bar (>64 psi)
Normal Evaporation Rate (NER) (typical)	0.85 lb/day (0.39 kg/day)	1.0 lb/day (0.45 kg/day)
Selectable Flow Rates	Continuous (LPM): .12, .25, .5, .75	Continuous (LPM): 1, 2, 3, 4, 5, 6
	Demand: 1, 1.5, 2.0, 2.5, 3, 3.5, 4	Demand: 1.5, 2, 2.5, 3, 4
Contents Indicator	Spring Scale	Spring Scale
Operating Temperature	-10°C to 40°C (14°F to 104°F) 95% max. relative humidity	-10°C to 40°C (14°F to 104°F) 95% max. relative humidity
Storage Temperature	-40°C to 70°C (-40°F to 158°F) 95% max. relative humidity	-40°C to 70°C (-40°F to 158°F) 95% max. relative humidity

VII Saturation Principles

Oxygen, in its normal state, is a colorless, tasteless, and odorless gas that is non-flammable, although it greatly accelerates combustion in high concentrations. It constitutes about 21% of the Earth's atmosphere by volume. Oxygen in higher concentrations is medically beneficial to patients suffering from certain respiratory diseases.

Oxygen, like most gases, will condense into a liquid with an increase in pressure or decrease in temperature. As a liquid, oxygen is pale blue in color and is about 860 times as dense as its gaseous form. At atmospheric pressure (14.7 psia), oxygen condenses into its liquid form at a temperature of about -297°F (-184°C). Liquid oxygen (LOX) is an efficient form of oxygen to meet a patient's portable, ambulatory oxygen needs. A volume of liquid oxygen, when vaporized, yields about 860 volumes of gaseous oxygen (Figure 1). As you can see, a relatively small volume of liquid oxygen provides a much larger volume of gaseous oxygen for a patient to use.

In medical liquid oxygen systems, liquid oxygen, and the gaseous oxygen resulting from its vaporization or boiling, is stored under pressure. The elevated pressure, typically 1.52 bar (22 psig), enables oxygen to flow to the patient at a selected, prescribed rate. To sustain this oxygen flow to the patient, the liquid oxygen must be in a state that allows vaporization to readily occur. In other words, the liquid oxygen must be in a state of saturation. Let's take a look at what liquid saturation is all about.

A saturated liquid is one that absorbs the maximum amount of heat possible at a given pressure without vaporizing into a gas. If additional heat is added, the saturated liquid begins to vaporize (boil) while remaining at a constant temperature until all of the liquid is vaporized. A common example of a saturated liquid is water at its boiling point of 212°F (100°C) at sea level. The constant addition of heat to the boiling water does not cause it to become hotter, but instead causes part of the liquid water to turn to water vapor (Figure 14).

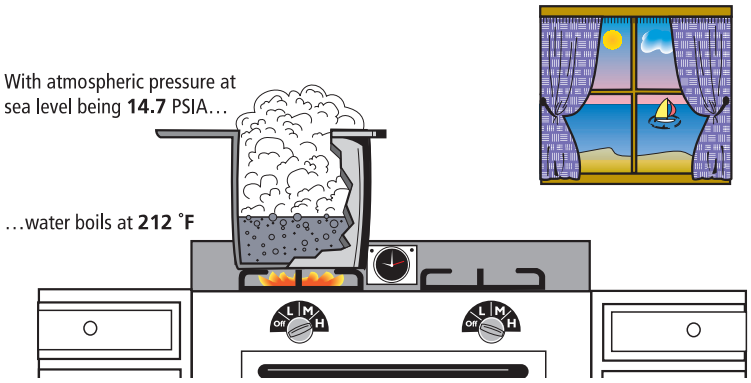


Figure 14: Saturated (Boiling) Water at Sea Level

The saturation (boiling) point of a liquid depends not only on temperature but also on pressure. If the pressure in a container of saturated liquid increases, the temperature required for saturation to occur will also increase. This leaves the liquid unsaturated, that is, capable of accepting more heat before it will boil (Figure 15).

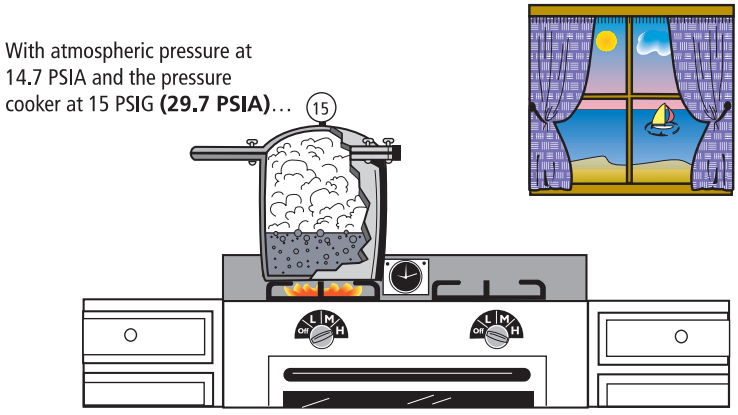


Figure 15: Saturated (Boiling) Water at Higher Pressure

Saturation Principles

If the pressure in a container of saturated liquid decreases, the temperature required for saturation to occur will decrease. This leaves the liquid "super saturated" or too warm. When this occurs, rapid boiling and vaporizing of some of the liquid occurs. The rapid boiling and evaporation of the liquid dissipates the excessive heat until the remaining liquid cools down to the new saturation temperature associated with the decreased pressure (Figure 16).

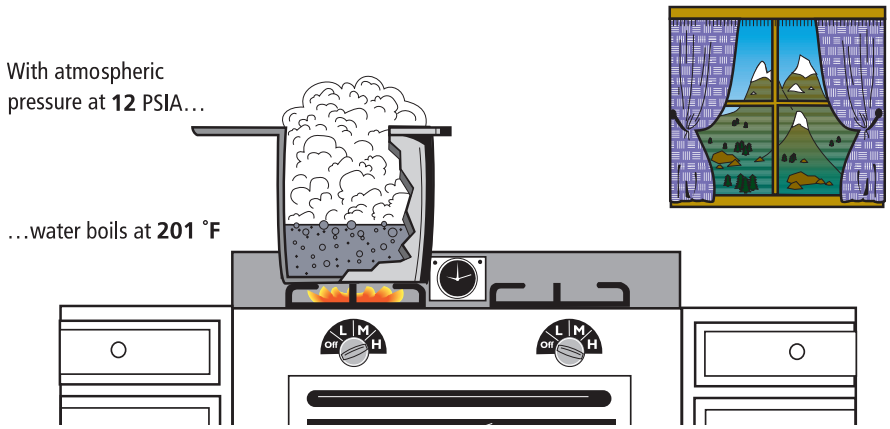


Figure 16: Saturated (Boiling) Water at Lower Pressure

Oxygen, which is normally a gas at atmospheric pressure, changes into liquid form when it is cooled to about -297°F (-183°C) at atmospheric pressure. It is saturated at this temperature (and pressure) which means it will remain a liquid as long as no additional heat is added. However, the large quantity of heat present in the atmosphere constantly enters the liquid oxygen and causes it to boil and vaporize back into a gas. Since it is virtually impossible to keep all of the heat in the atmosphere from entering the liquid oxygen, constant boiling and vaporization occurs.

Now when liquid oxygen is placed in a closed container, the vaporizing gas is trapped nd begins to build pressure. As pressure increases above atmospheric pressure, more heat is needed for boiling to occur at the higher pressure. The heat that is constantly available from the atmosphere warms the liquid to a higher temperature where boiling again occurs. The vaporizing gas builds pressure and the process continues. As the pressure on liquid oxygen builds, the related saturation temperature of the liquid increases proportionally (Figure 17).

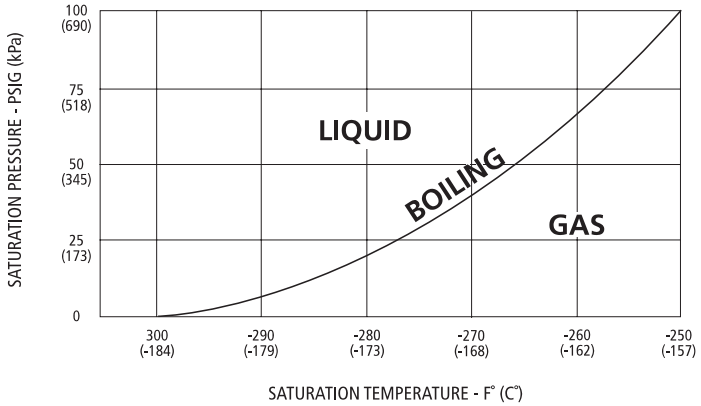


Figure 17: Liquid Oxygen Saturation Curve

It is important to maintain liquid oxygen saturation (boiling) at the specified operating pressure of the HELiOS portable. As an oxygen flow demand is put on the system, a slight decrease in pressure occurs due to oxygen withdrawal. The saturated liquid oxygen in the system vaporizes enough gaseous oxygen to maintain system operating pressure. This ensures proper oxygen flow to the patient. If the liquid oxygen saturation temperature is too low, the corresponding lower saturation pressure causes low oxygen flows to the patient.

VII Saturation Principles

If the saturation pressure of the liquid in the portable is greater than 1.93 bar (28 psi) the following symptoms may occur:

- Increased product loss and evaporation rate
- Decreased durations
- High flow rates
- Continuous flow on demand settings
- Venting from relief valves
- Relief valves frozen open

If the saturation pressure of the liquid in the portable is lower than 1.2 bar (18 psi) the following symptoms may occur:

- Decreased evaporation rates
- Low flow rates
- No oxygen flow
- Portable will not fill

The saturation pressure of the HELiOS portable will be equal to the saturation pressure of the reservoir it was filled from. These problems can be prevented by always ensuring that the reservoir is filled according to its respective service manual.

VIII Unpacking and Setup

Unpacking

1. Inspect carton for shipping damage. Report any damage to freight company before signing bill of lading.
2. Check description on carton against your order.
3. Unpack unit, including all accessories and documentation.
4. Set aside packing materials in case unit must be returned to the factory.

Setup

1. Record the serial number of the unit.
2. Visually inspect the unit for damage from improper handling. Note any dents, cracks, or missing parts.
3. Ensure the vent valve is in the closed position. Be sure its lever opens and closes smoothly.
4. If possible, connect the H300 or H850 to a reservoir to check for smooth coupling.
5. Hold the unit on a table and carefully pull up on the contents indicator strap. Verify that the mechanism moves smoothly.
6. Verify that the unit has all its warning/caution labels. Check labels for damage.
7. Wipe away any dust on the unit with a clean, dry, lint-free cloth.
8. Verify that a standard dual lumen cannula will attach to the unit. It should be rated at least 6 LPM in flow and should be a maximum of 7 ft (213.4 mm) in length.

Filling

1. Dry the male QDV on the reservoir using a clean, dry, lint-free cloth.

2. Dry the female QDV on the H300 or H850 using a clean, dry, lint-free cloth.

WARNING: The fill connectors must be clean and dry before filling the H300/H850. Moisture on the fill connectors can lead to leakage of liquid oxygen. Moisture can also cause the units to freeze together, and can lead to malfunctions of the portable and reservoir.

WARNING: Keep the H300 or H850 upright while drying its fill connector. Do not turn upside-down.

3. Check the reservoir contents indicator to make sure there is enough liquid oxygen for the filling process.

4. Make sure the H300 or H850 FCV is in the off (0) position.

5. Hold the H300 or H850 upright with one hand and position its female QDV over the male QDV on the reservoir.

WARNING: Do not depress or disturb the plastic poppet in the center of the reservoir's fill connector. This will cause an uncontrolled release of liquid oxygen from the reservoir.

6. Place one or both hands on top of the H300 or H850 and press straight downward. This will lower the unit and properly engage the QDV's.

NOTE: Do not depress the release button on the reservoir when engaging the portable unit.

7. While holding the unit firmly in this position, pull the vent valve lever downward into its open position. A hissing sound will be heard.

8. Maintain a downward pressure on the H300 or H850 with one hand during the entire filling process.

9. Approximately 20-30 seconds into a fill, close and reopen the vent valve one or more times to prevent the vent valve from freezing open.

WARNING: Do not leave the HELiOS portable unattended during the filling operation. Excessive liquid oxygen discharge can occur.

10. The unit is full when the hissing sound changes in tone and a dense white vapor is seen coming from the under the shroud of the reservoir. When this is observed, close the vent valve by releasing and raising its lever.

11. Hold the handle on the H300 or H850 and push the release button on the reservoir down until the fill connectors separate.

NOTE: If the H300 or H850 does not separate easily, do not use force. The units may be frozen together. Allow the units a few minutes to warm up and they should separate easily.

WARNING: Should there be any leakage from either the reservoir or the portable after separation, engage the fill connectors again immediately. Engaging and disengaging the connectors will help to dislodge any ice crystals that are present. If major leaking and discharge continues, open the vent valve of the reservoir to stop the release of liquid oxygen.

WARNING: Do not touch frosted parts.

12. Check the contents indicator scale to make sure that the unit is filled to the desired level.

Liquid Level Measurement

1. Lift the H300 or H850 by the contents indicator strap.

2. Push the bottom backside of the unit forward to that it is straight up and down.

3. Observe the green indicator bar that displays the liquid oxygen contents level inside the clear window on the back of the unit. The window is completely filled with the green bar when the unit is full.

Operation (Filled with Liquid Oxygen)

1. Push one of the tubes from the dual lumen cannula onto the top cannula barb on the H300 or H850. Place the other tube onto the lower cannula barb.

2. Properly position the nasal cannula on the patient.

WARNING: Do not use a single lumen cannula or a cannula longer than 7 ft (213.4 cm).

3. Turn the flow control knob on the top of the unit to the prescribed flow setting. Oxygen flow will begin when a breath is detected.

NOTE: On the H850, Continuous flow settings are designated by the letter "C," and demand flow settings are designated by the letter "D." On the H300, all settings of 1.0 and above are demand flow only.

4. To stop oxygen flow, turn the flow control knob to a setting of "0."

Operation (Using the Oxygen Supply Line)

1. Verify that there is adequate liquid oxygen in the reservoir.

2. Insert the flexible oxygen supply tube connector (P/N B-701656-SV) into the quick connect on the front of the H300 or H850 and snap it into place.

3. Locate the DISS nut and tailpiece assembly attached to the opposite end of the flexible oxygen supply tube.

4. Thread the nut and tailpiece assembly onto the HELiOS reservoir oxygen outlet connector until secure.

Figure 18: HELiOS Supply Line Connection

NOTE: If a hissing sound is heard, tighten the connection until the hissing stops.

5. Push one of the tubes from the dual lumen cannula onto the top cannula barb on the H300 or H850. Place the other tube onto the lower cannula barb.

6. Properly position the nasal cannula on the patient.

7. Turn the flow control knob on the top of the unit to the prescribed demand flow setting.

WARNING: Use only the recommended flexible oxygen supply tube and oxygen gas source. Connecting the unit to an incorrect gas source can cause inhalation of hazardous substances.

CAUTION: Connect the portable only to a reservoir or other gaseous oxygen source that operates at pressures between 1.41 to 1.62 bar (20.5 and 23.5 psi). Oxygen sources outside of this range can cause the unit to operate improperly or damage the unit.

NOTE: The H850 must be used in demand (D) flow settings when operating from the oxygen supply line.

Exterior Cleaning & Disinfecting

The H300 or H850 external case should be cleaned whenever dirt or grime is visibly evident. It can also be disinfected in accordance to local regulations and/or the schedule of the individual DME provider. The below procedure should be followed for both cleaning and disinfecting the outer case of the H300 or H850.

1. Verify that the unit is empty and contains no liquid oxygen.

2. Apply a mild cleaning solution and/or disinfectant to a clean cloth. Wipe the exterior case using this cloth. Table 5 below is a list of recommended cleaners and disinfectants.

Table 5: Recommended Cleaning & Disinfecting Agents

Cleaning	Disinfecting
Household Glass Cleaner	Sporicidin Disinfectant Solution
Mild Solution of Dish Washing Detergent & Warm Water	Household Bleach (1:10 Dilution With Water)

3. Buff out any scuff marks using a Scotch-Brite adhesive pad with detergent.

4. Wipe the case completely dry with a towel.

Interior Cleaning

The H300 and H850 plumbing can be cleaned lightly if necessary. Follow the below procedure for cleaning the internal components of the unit.

1. Remove the cover (RP4).

2. Apply a mild solution of detergent and water to a clean cloth. Wipe the interior case and plumbing with this cloth.

3. Use a cotton swab to dust and clean in tight places.

4. Dry all components thoroughly with a dry towel and oil-free compressed gas.

End of Life

At the end of the unit's service life, all reservoir units must be returned to a recycling facility in compliance with applicable codes and regulations. Alternatively, CAIRE may be contacted for disposal information.

X Maintenance

There are two schedules for routine maintenance which the home health care distributor may follow. These schedules allow the distributor maximum flexibility while assuring that the equipment is operating properly. CAIRE suggests a continuous (as needed) and biennial (24-month) schedule for routine maintenance of the H300 and H850. The distributor may follow either schedule, or a combination of the two schedules. Maintenance checklists are provided for each schedule. See Below.

NOTE: All test procedures are numerically designated "RP#" and can be found in the Troubleshooting section of this manual.

Schedule A – Biennial (24-Month) Schedule

A. Introduction

The Biennial schedule is a series of tests that should be performed at a minimum of once every 2 years to ensure that the equipment is functioning properly.

1. If the unit fails a given test, one of two things may be done:

   Refer to the Troubleshooting section of this manual

   -or-

   Return the unit to CAIRE, Inc. for repair

2. Schedule – Maximum of two years between routine maintenance testing. The unit should be tested whenever a problem is suspected.

A. Procedure

Follow the steps in order listed. If the unit fails any step, refer to Troubleshooting section of this manual.

1. Visual Inspection:
   a. Remove any LOX prior to maintenance (RP3).
   b. Inspect the case, flow knob, and vent lever for cracks, warping, or discoloration.
   c. Verify that the label on the rear cover is present and legible.
   d. Verify that the fill connector poppet is not worn or broken.
   e. Verify that the lip seal in the fill connector is not cracked.
   f. Move the vent lever down to the open position. Verify that it moves smoothly when opening and closing the vent valve.
3. Clean and Disinfect the Exterior Case
4. Gaseous Oxygen Functional Tests
   a. Primary Relief Valve Test (RP7)
   b. Secondary Relief Valve Test (RP8)
   c. Liquid Leak Detector Test (RP2)
5. Fill the unit full of liquid oxygen.
   a. Verify that the spring scale reads full.
   b. Inspect the outer container for cold sweaty conditions and excessive venting from the relief valve.
   c. NER Test (RP22)
   d. Economizer Test (RP9)
   e. Demand Flow Control Valve Test (RP19)
6. Prepare For Use
   a. Empty the liquid oxygen from the unit.
   b. Verify that the contents indicator scale reads empty.

Schedule A (Biennial) Maintenance Checklist

Unit Serial Number:

Step	10 Year Service Life			Year 2	Year 4	Year 6	Year 8	Year 10
1	LOX Purged From Reservoir (Repair Procedure RP3)	Performed or Verified By/Date						
2	Inpection for Damaged/Missing Parts	Performed or Verified By/Date						
3	Contents Indicator Reads Empty and Spring Scale Moves Freely	Performed or Verified By/Date						
4	Remove Cover (Repair Procedure RP4)	Performed or Verified By/Date						
5	Perform Liquid Leak Detector Test (Repair Procedure RP2)	Performed or Verified By/Date						
6	Perform PRV Test (Repair Procedure RP7)	Performed or Verified By/Date						
	PRV Crack Pressure							
	PRV Reseat Pressure							
7	Perform SRV Test (Repair Procedure RP8)	Performed or Verified By/Date						
	SRV Crack Pressure							
	SRV Reseat Pressure							
8	Liquid Contents/Level Indicator Test (Repair Procedure RP6)	Performed or Verified By/Date						
	Contents Indicator Window Shows No Green When Empty And Completely Green When Full							
9	Pressure Retention Test (Repair Procedure RP12)	Performed or Verified By/Date						
	Internal Pressure after 10 Minutes							
	Internal Pressure after 60 Minutes							
10	Replace Case (Repair Procedure RP5)	Performed or Verified By/Date						
11	Flow Rate Test (Repair Procedure RP19) (C=continuous; D=demand)	Performed or Verified By/Date						
		H300	H850					
	Flow Rate at:	OFF	Off					
	Flow Rate at:	0.12 (C)	1.0 (C)					
	Flow Rate at:	0.25 (C)	2.0 (C)					
	Flow Rate at:	0.5 (C)	3.0 (C)					
	Flow Rate at:	0.75 (C)	4.0 (C)					
	Flow Rate at:	1.0 (D)	5.0 (C)					
	Flow Rate at:	1.5 (D)	6.0 (C)					
	Flow Rate at:	2.0 (D)	1.5 (D)					
	Flow Rate at:	2.5 (D)	2.0 (D)					
	Flow Rate at:	3.0 (D)	2.5 (D)					
	Flow Rate at:	3.5 (D)	3.0 (D)					
	Flow Rate at:	4.0 (D)	4.0 (D)					
12	Inspect for Cold or Sweaty condition/ Excessive Venting from RV	Performed or Verified By/Date						
13	Perform NER Test (Repair Procedure RP22)	Performed or Verified By/Date						
	NER Results							
14	Empty Contents from Portable (Repair Procedure RP3)	Performed or Verified By/Date						
15	Clean and/or Disenfect Outside of Unit	Performed or Verified By/Date						

Schedule B – Continuous (As Needed) Schedule

A. Introduction

Continuous maintenance is a set of tests and inspections to be done periodically to ensure that the equipment is functioning properly. It can be done while the equipment is in service by drivers or other personnel.

1. If a unit fails a given test, it should be taken out of service and sent to the repair center/department for further inspection.
2. Schedule – The continuous schedule should be performed every time the driver visits a patient or when their reservoir is filled or replaced. It should also be performed when equipment is transferred between patients.

B. Procedure

1. Ensure the unit is empty of liquid oxygen contents.
2. Visual Inspection
   a. Inspect the case, flow knob, and vent valve lever for cracks, warping, or discoloration.
   b. Verify that the label on the rear cover is present and legible.
   c. Verify that the fill connector poppet is not worn or broken.
   d. Verify that the lip seal in the fill connector is not cracked or showing signs of wear.
   e. Move the vent valve lever down to the open position. Verify that it moves smoothly when opening and closing the vent valve.
3. Clean and disinfect the unit if necessary using the procedures described in the Operations section of this manual.
4. Fill the H300 or H850 with LOX.
5. Post-Fill Inspection
   a. Verify that the QDV poppet is closed and not leaking.
   b. Verify that the Vent Valve is closed and not leaking.
   c. Carefully pull up on the contents indicator strap. Verify that it moves smoothly and reads accurately.
   d. Flow Control Valve Test (RP19)

Schedule B (Continuous Pre and Post Fill Inspection) Maintenance Checklist			
Unit Serial Number:			
Pre Fill Visual Inspection			
1	Cracking, Discoloration or Warping	Verified By/Date	
2	QDV Deformation	Verified By/Date	
3	Liquid Contents/Level Indicator Functionality	Verified By/Date	
4	Cryogenic Reservoir Damage (Dents,Dings)	Verified By/Date	
5	Visible Dirt or Contamination	Verified By/Date	
6	Presence of All Required Labels	Verified By/Date	
7	If LOX is present in Unit, Inspect for Heavy Frost or Condnesation on the Exterior of the Unit	Verified By/Date	
8	Vent Valve Functionality Ensuring that All Parts are Present and the Valve Functions as it Should	Verified By/Date	
9	FCV knob moves smoothly and encounters a detent at each setting.	Verified By/Date	
Post Fill Visual Inspection			
1	QDV Poppet is Closed and Not Leaking	Verified By/Date	
2	Vent Valve is Not Leaking	Verified By/Date	
3	No Heavy Frost or Condensation is Present on the Exterior of the Unit	Verified By/Date	
4	Liquid Level Contents/Indicator Reads the Accurate Amount	Verified By/Date	

XI Troubleshooting & Repair Procedures

Table of Contents

Introduction

1. These procedures are designed to be performed only by qualified personnel with proper equipment.

2. Any failure during routine maintenance checks will refer you to this section. See troubleshooting chart for appropriate procedure.

XI Troubleshooting & Repair Procedures

Table 6 below provides troubleshooting procedures for the HELiOS portables. This guide is not all-inclusive but is intended to serve as a general outline for solving operational problems. The table describes symptoms, identifies probable causes, and suggests corrective actions.

When more than one probable cause is identified, the causes are listed in order of most likely to least likely reasons for the problem.

Table 6: Troubleshooting

Symptom		Probable Cause		Corrective Action
1)	Unable to start fill or excessively long fill times	a)	QDV not properly engaged on the reservoir	Make sure the QDV on the portable and reservoir are properly aligned and ensure that a downward force is being applied to the portable.
		b)	Reservoir is empty	Swap or re-fill the reservoir
		c)	Vent valve not open	Ensure that the vent valve lever is fully in the open position. The lever must be open to begin a fill.
		d)	FCV is open	Be sure that the FCV knob is in the off (“0”) position. If the valve is open, fill times can increase.
		e)	Reservoir saturation pressure is too low	Swap reservoirs or allow the reservoir time to stabilize and build pressure
		f)	Vent valve is obstructed	Inspect the vent tubes for blockages. Clean by blowing out with compressed gas or replace parts if necessary.
		g)	Leak in the system	Check the portable for leaks (RP2) and repair if needed.
		h)	QDV damaged or faulty	Inspect the QDV and be sure the poppet opens properly and smoothly. If necessary, replace the QDV assembly (RP17)
		i)	Faulty vent valve	Replace the vent valve (RP15)
2)	Liquid leaks from the coupled QDVs during the fill	a)	Worn or damaged lip seal	Replace the QDV lip seal (RP18)
3)	Unable to disconnect the portable from the reservoir	a)	Pop-off assembly not being utilized	Ensure that the pop-off assembly on the reservoir is being used. Do not use force to separate the QDVs.
		b)	QDVs are frozen together	Leave the units coupled with the vent valve closed and let them sit until they warm up enough to disconnect. Always ensure that male and female QDV’s are cleaned and dried prior to each fill.

Table 6 (cont.)

	Symptom		Probable Cause	Corrective Action
4)	Liquid leaks from the QDV poppet after filling	a)	Ice crystal preventing the QDV from closing properly.	Engage and disengage the portable onto the reservoir several times to dislodge the ice crystal. Always be sure that the male and female QDVs are wiped clean and dry before filling.
		b)	Dirty or damaged QDV poppet	Replace the QDV assembly (RP17)
5)	Liquid leaks from the vent valve tube/outlet	a)	Vent valve is not fully closed	Ensure that the vent valve lever is fully in the closed position.
		b)	The portable has been transported or laid in an improper operating position	Return the portable to an upright or acceptable operating position and allow several minutes for stabilization.
		c)	Vent valve is frozen open	Allow the portable to warm until the vent valve can close. After the warm up, allow up to 60 minutes for the portable to stabilize and build pressure before operating.
		d)	Faulty vent valve	Replace the vent valve (RP15)
6)	Excessive venting from relief valves (hissing sound)	a)	The portable has been transported or laid in an improper operating position	Return the portable to an upright or acceptable operating position and allow several minutes for stabilization.
		b)	Saturation pressure too high.	Inspect the saturation pressure of the reservoir used for filling. Allow at least 30 minutes at no flow for the portable to saturate properly.
		c)	Relief valve frozen open	Allow the portable to warm and thaw. Attempt to re-fill the portable.
		d)	Faulty relief valve	Test the relief valve (RP7 & RP8) and replace if necessary (RP10 & RP11)
		e)	Partial or complete loss of vacuum	Conduct the NER test (RP22) and return the unit to CAIRE, inc. if necessary.
7)	No Flow	a)	Portable is empty	Check the contents indicator/level gauge and fill the portable if needed.
		b)	Flow control valve turned off	Ensure the flow control knob is not in the off (“0”) position.
		c)	Nasal cannula kinked or disconnected	Ensure proper nasal cannula functionality and positioning
		d)	Saturation pressure is too low	Inspect the saturation pressure of the reservoir used for filling. Allow at least 30 minutes at no flow for the portable to saturate properly.
		e)	Leak in the system	Perform a leak check on the plumbing (RP2). Repair leaks as necessary.

Table 6 (cont.)

Symptom			Probable Cause	Corrective Action
		f)	Vent valve is open	Ensure that there is no venting from the vent valve outlet/tube. If there is refer to the corrective actions for "Liquid leaks from the vent valve tube/outlet"
		g)	FCV inlet filter is obstructed	Clean or replace (RP21) the filter screen.
		h)	Blockage in the liquid withdrawal circuit	Check the warming coils and withdrawal tubes for blockages. Replace if necessary.
		i)	FCV Faulty	Replace the FCV (RP20)
8)	Low flow at all LPM settings	a)	Nasal cannula kinked or leaking	Inspect the functionality of the nasal cannula.
		b)	Saturation pressure is too low	Inspect the saturation pressure of the reservoir used for filling. Allow at least 30 minutes at no flow for the portable to saturate properly.
		c)	Leak in the system	Perform a leak check on the plumbing (RP2). Repair leaks as necessary.
		d)	Flow control valve inlet filter screen dirty	Clean or replace (RP21) the filter screen.
		e)	Economizer valve faulty	Test the economizer (RP9) and replace (RP10) if necessary.
		f)	Blockage in the liquid withdrawal circuit	Check the warming coils and withdrawal tubes for blockages. Replace if necessary.
		g)	FCV faulty	Replace the FCV (RP20)
9)	Unit stops pulsing in demand mode	a)	Cannula is disconnected	Ensure the nasal cannula is firmly attached to the barb(s).
		b)	Cannula is blocked or kinked	Inspect the cannula for kinks, bends, or water droplets. Replace the cannula if necessary.
		c)	Cannula tips not positioned properly in the nose	Ensure the cannula remains in the nostrils and do not slide to one side.
		d)	Patient is breathing with their mouth open.	Patient must inhale through their nose to initiate pulse/demand flow.
		e)	Saturation pressure is out of specification	Reference symptom 14). Inspect the saturation pressure of the reservoir used for filling. Allow at least 30 minutes at no flow for the portable to saturate properly.
		f)	Leak in the system	Perform a leak check on the plumbing (RP2). Repair leaks as necessary.
		g)	Faulty FCV	Test the FCV (RP19) and replace if necessary.

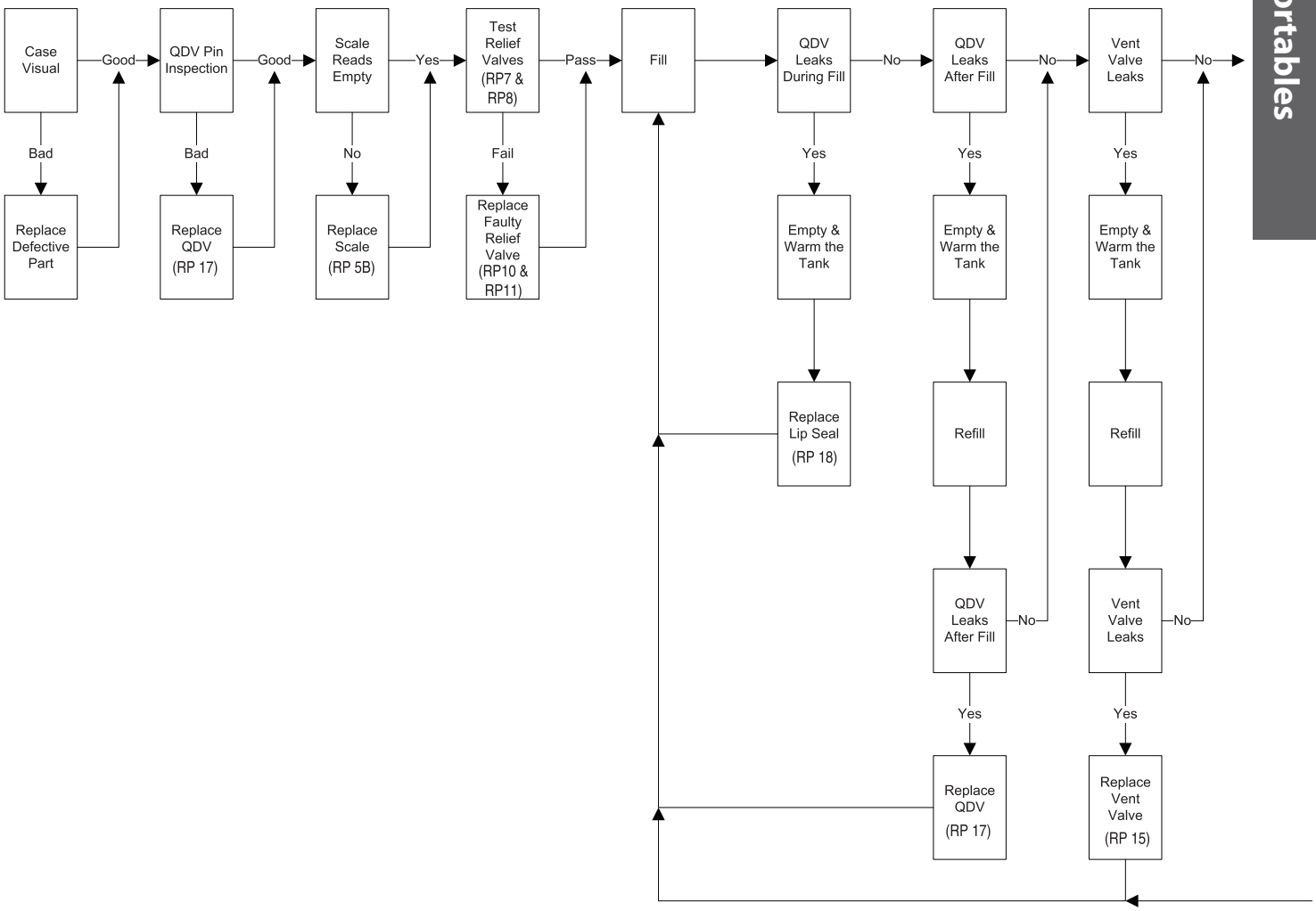
Table 6 (cont.)

Symptom			Probable Cause	Corrective Action
10)	Flow stops suddenly on continuous setting NOTE: For continuous flow to continue a inhalation must be detected periodically. Refer to the Theory of Operation section of this manual for more information.	a)	Cannula is disconnected	Ensure the nasal cannula is firmly attached to the barb(s). Must be using a dual lumen cannula connected to both ports.
		b)	Cannula is blocked or kinked	Inspect the cannula for kinks, bends, or water droplets. Replace the cannula if necessary.
		c)	Cannula tips not positioned properly in the nose	Ensure the cannula remains in the nostrils and do not slide to one side.
		d)	Patient is breathing with their mouth open.	Patient must inhale through their nose to initiate continuous flow.
		e)	Saturation pressure is out of specification	Reference symptom 14. Inspect the saturation pressure of the reservoir used for filling. Allow at least 30 minutes at no flow for the portable to saturate properly.
		f)	Faulty FCV	Test the FCV (RP19) and replace (RP20) if necessary.
11)	Unit flows continuously on demand settings	a)	Saturation Pressure is too high	Inspect the saturation pressure of the reservoir used for filling. Allow at least 30 minutes at no flow for the portable to saturate properly.
		b)	Faulty FCV	Test the FCV (RP19) and replace (RP20) if necessary.
12)	Increased NER	a)	Saturation Pressure is too high	Inspect the saturation pressure of the reservoir used for filling. Allow at least 30 minutes at no flow for the portable to saturate properly.
		b)	Leak in the system	Perform a leak check on the plumbing (RP2). Repair leaks as necessary.
		c)	Relief valve open	Ensure that there is no venting from the relief valves. If there is refer to the corrective actions for “Excessive venting from relief valves (hissing sound)”
		d)	Partial or complete loss of vacuum	Conduct the NER test (RP22) and return the unit to CAIRE, Inc. if necessary.
13)	Excessive Frost NOTE: Minimal frost on the case and on the plumbing is normal. This symptom applies to frost that is much greater than what is normally observed.	a)	Frost is acceptable	Some frost on the outer case and on the plumbing is acceptable, especially at high flow rates during continuous use. This is due to the evaporation of LOX to gas and the temperature difference between the LOX and room temperature.
		b)	High humidity level	High humidity levels can increase frost accumulation.
		c)	Saturation pressure is too high	Inspect the saturation pressure of the reservoir used for filling. Allow at least 30 minutes at no flow for the portable to saturate properly.
		d)	Leak in the system	Preform a leak check on the plumbing (RP2). Repair leaks as necessary.
		e)	Relief valve open	Ensure that there is no venting from the relief valves. If there is refer to the corrective actions for “Excessive venting from relief valves (hissing sound)”
		f)	Partial or complete loss of vacuum	Conduct the NER test (RP22) and return the unit to CAIRE, Inc. if necessary.

Table 6 (cont.)

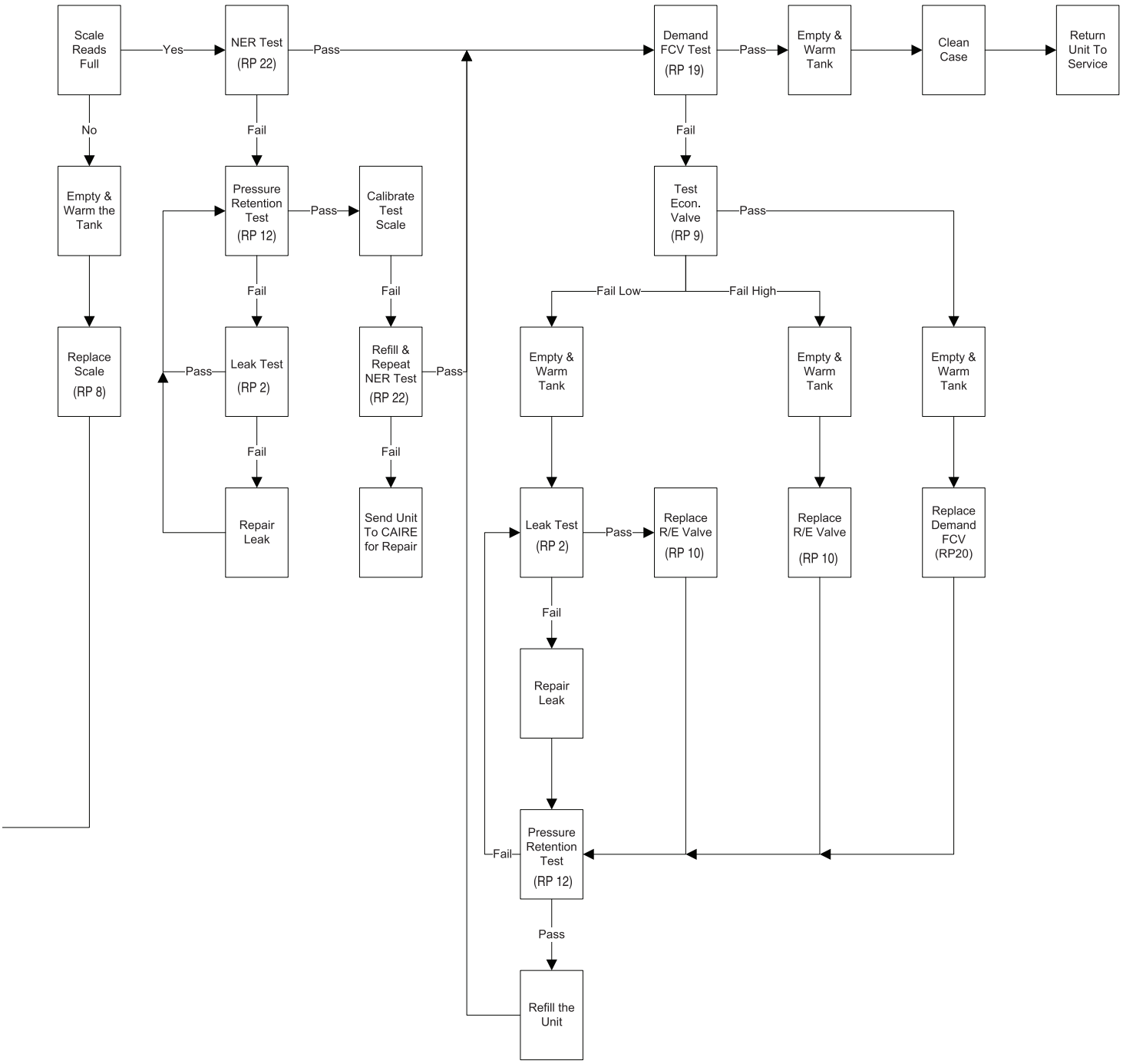
Symptom		Probable Cause		Corrective Action
14)	Unit will not maintain acceptable pressure when in use	a)	Saturation pressure is out of specification	Inspect the saturation pressure of the reservoir used for filling. Allow at least 30 minutes at no flow for the portable to saturate properly.
		b)	Leak in the system	Preform a leak check on the plumbing (RP2). Repair leaks as necessary.
		c)	Economizer valve faulty	Test the economizer (RP9) and replace (RP10) if necessary.
15)	Unit will not maintain acceptable pressure in standby mode	a)	Saturation pressure is out of specification	Inspect the saturation pressure of the reservoir used for filling. Allow at least 30 minutes at no flow for the portable to saturate properly.
		b)	Leak in the system	Preform a leak check on the plumbing (RP2). Repair leaks as necessary.
		c)	PRV faulty	Test the PRV (RP7) and replace (RP10) if necessary.

Troubleshooting & Repair Procedures



To Use Troubleshooting Chart:

1) Start at the upper left corner
2) The top line shows the steps of routine maintenance
3) Unless otherwise noted by the arrows, the flow is to the right or down.


Scale Reads Full
Yes
NER Test (RP 22)
Pass
Demand FCV Test (RP 19)
Pass
Empty & Warm Tank
Clean Case
Return Unit To Service
No
Fail
Fail
Empty & Warm the Tank
Pressure Retention Test (RP 12)
Pass
Calibrate Test Scale
Test Econ. Valve (RP 9)
Pass
Fail
Fail
Fail Low
Fail High
Replace Scale (RP 8)
Pass
Leak Test (RP 2)
Refill & Repeat NER Test (RP 22)
Pass
Empty & Warm Tank
Empty & Warm Tank
Empty & Warm Tank
Fail
Fail
Repair Leak
Send Unit To CAIRE for Repair
Leak Test (RP 2)
Pass
Replace R/E Valve (RP 10)
Replace R/E Valve (RP 10)
Replace Demand FCV (RP20)
Fail
Repair Leak
Fail
Pressure Retention Test (RP 12)
Pass
Refill the Unit

Troubleshooting & Repair Procedures

RP1 – General

The following procedures have been carefully prepared to allow proper removal and replacement of defective components and should be used in conjunction with the Troubleshooting Chart and the tests in this section.

WARNING: Parts that are welded in place must not be replaced in the field. Should these parts fail, return complete assembly or sub-assembly to factory for repair. DO NOT use solder or silver solder to repair broken welds.

WARNING: The manufacturer of Fluorolubricant warns users not to allow Fluorolubricant to contaminate tobacco products. Wash Fluorolubricant from hands before smoking.

WARNING: Do not use glue type thread locking compounds or unapproved sealants on any repairs.

CAUTION: When replacing components, make sure the new part is oriented exactly the same as the original part prior to installation.

CAUTION: Some components require a specific amount of torque when assembling. Follow torque requirements where specified.

NOTE: All replacement parts must be factory approved, cleaned for oxygen service, and stored in sealed plastic bags. The repair area must be clean and separate from other areas. Room air should be filtered, and free from dust, soot, and other contaminants.

NOTE: When replacing components with pipe threads, use PTFE tape thread sealant. Apply two rounds of PTFE tape to threads near end of component, avoiding first thread.

NOTE: When assembling new compression fittings, tighten 1/8", 1/4" and 1/2" nuts eight flats past finger tight and 3/16" nuts five flats past finger tight. When reassembling previously used compression fittings, tighten nuts one to two flats past finger tight.

RP2 – Liquid Leak Detector Test

1. Remove the covers (RP4).

2. Place the cryogenic container assembly on a portable test fixture (B-778202-00). Stand the front cover, with the tubing still connected, next to the bottle assembly as shown in Figure 19.

NOTE: For newer units manufactured without the CPC Connector, the CPC Connector Kit will need to be installed, please refer to RP27.

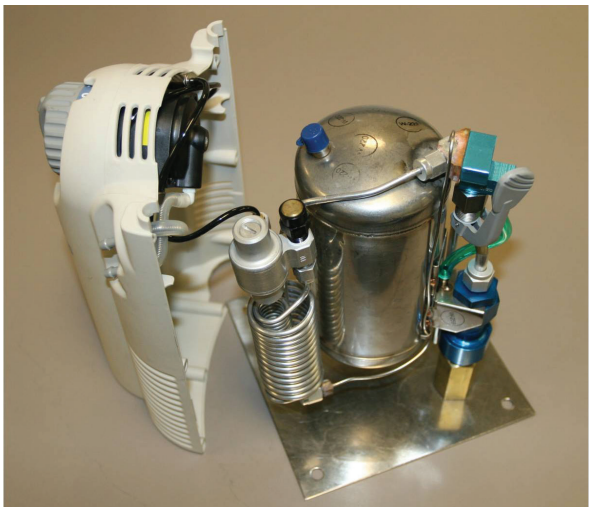


Figure 19: Portable Test Fixture

3. Attach a test pressure gauge (B-701732-00) to the top (delivery) cannula barb of the unit.

4. Turn the flow control knob to a continuous flow setting (0.75 on the H300, C6 on the H850)

5. Attach the DISS nut and tailpiece of a HELiOS oxygen supply line (B-701656-SV) to a 0-6.89 bar (0-100psi) gaseous oxygen source as shown in Figure 20.

NOTE: If an adjustable 0-6.89 bar (0-100 psi) gaseous oxygen source is not available, the H300 or H850 may be pressurized from a HELiOS reservoir that is at operating pressure.

6. Insert the opposite end of the HELiOS oxygen supply line into the quick connect on the front cover of the H300 or H850 as shown in Figure 20.

Figure 20: Pressurizing the HELiOS Portable

7. Increase the gaseous oxygen source pressure until the test pressure gauge reads 1.52 to 1.59 bar (22-23 psi).

CAUTION: Do not apply leak detector to the vent port near the bottom of the demand flow control valve. Valve malfunction will occur.

8. Use a liquid leak detector to test all fittings, connections, and joints.

9. Repair or replace any fittings, connections, or components found to be leaky.

NOTE: Continually monitor the test pressure gauge while leak checking the unit to verify that the pressure in the system remains above 1.52 bar (22 psi).

10. Wet a finger with leak detector and lightly place it against the open end of the vent tube near the bottom of the unit as shown in Figure 21. If bubbling occurs, verify that the vent valve closes completely. If bubbling continues, replace the vent valve (RP15).

Figure 21: Vent Outlet Leak Testing

11. Disconnect the HELiOS oxygen supply line from the quick connect on the front cover.

NOTE: Steps 11-13 are not required for newer units manufactured without the CPC Fitting.

12. Insert an open-ended HELiOS oxygen supply line coupling (B-701686-00) into the quick connect on the front cover.

13. Wet a finger with leak detector and lightly place it against the open end of the coupling as shown in Figure 22. If bubbling occurs, replace the inline check valve (RP24).

NOTE: This is not required for newer units manufactured without the CPC Fitting.

Figure 22: Inline Check Valve Leak Test

NOTE: A large leak in the check valve may bleed down the pressure before you can insert the coupling for the bubble test. You will typically hear gas escape from the quick connect when there is a large check valve leak. Verify that 22psi still reads on the pressure gauge.

14. Disconnect the test pressure gauge and the HELiOS oxygen supply line.

NOTE: If unit was equipped without CPC fittung, remove kit and install tube in reverse order of RP27.

15. Reinstall the case (RP4).

RP3A – Emptying the Unit (H300)

1. Set the flow control valve to a setting of 4.
2. Remove the DISS barb adaptor from the Jet Venturi Assembly (B-778210-00).
3. Attach that end of the Jet Venturi to the top cannula barb of the H300.
4. Attach the opposite end of the Jet Venturi to the bottom cannula barb of the H300.
5. Open the Jet Venturi needle valve. Ensure that the Jet Venturi outlet and the bleed port remain open.

CAUTION: Damage to the demand flow control valve is possible. Make sure you hook up the tube exactly as shown in Figure 19 and do not block the Jet Venturi outlet or the bleed port.

Figure 23: Jet Venturi installation

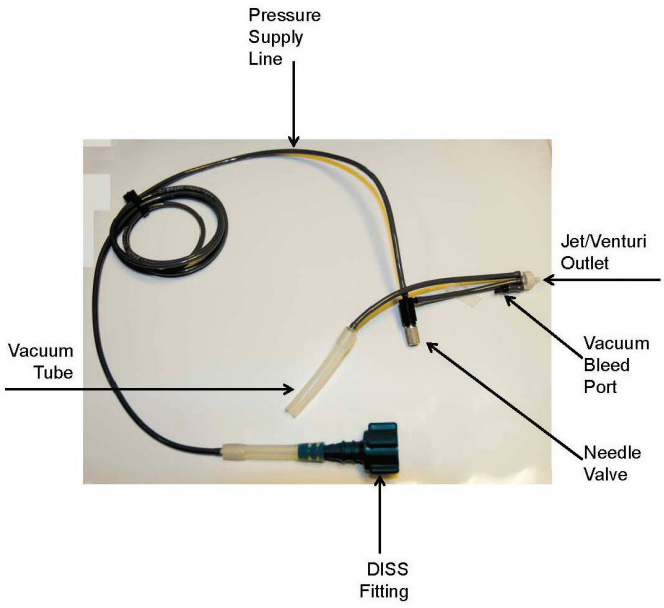


Figure 24: Jet Venturi assembly

6. Squeeze the tube connected to the bottom cannula barb. You should hear and/or feel a continuous flow of oxygen coming from the open connection of the Jet Venturi.
7. Allow the H300 to deliver continuous flow until the unit is empty.
8. Set the flow control to 0 and disconnect the tubing and Jet Venturi.
9. Verify that the unit is empty using the contents indicator scale.
10. Open the vent valve to vent any residual pressure.

RP3B – Emptying the Unit (H850)

1. Set the flow control valve to a setting of 6.0 LPM Continuous (C6).

NOTE: The procedure for the H300 can be duplicated on the H850 if continuous flow is not achieved by blowing into the cannula.

2. Blow into the bottom cannula barb to initiate oxygen flow.
3. Allow the H850 to deliver continuous flow until the unit is empty.
4. Turn the FCV knob to 0 and verify that the H850 is empty by picking up the contents indicator strap.
5. Open the vent valve to vent any residual pressure.

RP4 – Cover Removal

1. Empty the unit (RP3).
2. Place the unit on its side with the rear cover facing you.
3. Use a T10 Torx driver to remove the Torx screws (7 in the H300, 10 in the H850) from the rear cover.
4. Pull both legs of the carrying handle away from the covers simultaneously.
5. Separate the rear cover about 3/4 in (2 cm) from the front cover, and then slide it down about 3/4 in (2cm).
6. Rotate the cover counterclockwise until the vent valve lever can be pulled thought the clearance opening in the rear cover.
7. H850 Only: Remove the screw holding the vent valve to the front cover and unsnap the QDV from the front cover.
8. Carefully lift the container assembly up and away from the front cover and place it on the table next to the cover.
9. Re-install the case by reversing steps 1-8.

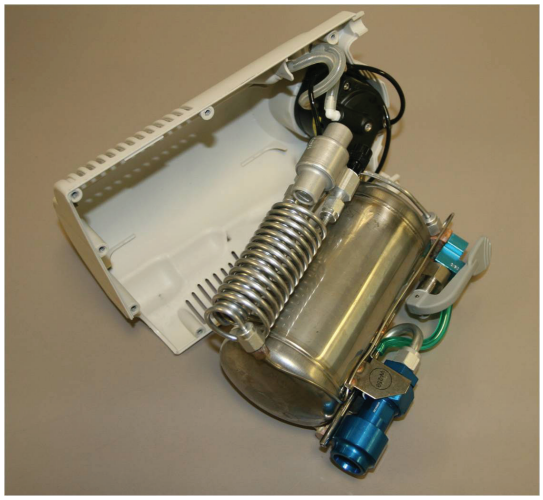


Figure 25: H300 Container Removal

Figure 26: H850 Container Removal

NOTE: Use the two longer cover screws in the top two screw holes. Do not over tighten the screws.

NOTE: Make sure that the two indexing pins on the front of the demand flow control valve engage the corresponding index holes in the front cover. Center the container assembly in the front cover mounting bosses. Ensure that the container liquid withdrawal tube is not pinched between the front cover and the fill connector.

NOTE: Fully seat the carrying handle in the cover handle bosses. The handle should angle toward the front of the unit.

RP5A – Front Cover R/R

1. Remove the cover (RP4)
2. Pull straight back on the flow control knob from the outside of the front cover to remove it.
3. Pull the demand flow control valve back out of its seat inside the front cover.
4. Disconnect the two flexible silicone tubes from the back of the cannula barbs.
5. Disconnect the black urethane tube from the inlet barb of the inline check valve.

NOTE: This is not required for newer units manufactured without the CPC Fitting.

6. Remove the C-Clips that secure the cannula barbs to the front cover using a flat head screwdriver.
7. Remove the cannula barbs from the outside of the front cover.

8. Remove the nut that secures the oxygen supply line quick connect to the front cover using a 5/8 inch open-end wrench.

NOTE: This is not required for units manufactured without the CPC Fitting.

9. Remove the quick connect from the outside of the cover.

NOTE: This is not required for units manufactured without the CPC Fitting.

10. To replace the front cover, reverse steps 1-9.

RP5B – Rear Cover R/R

1. Remove the case (RP4)

2. Disconnect the two contents indicator assembly springs from the spring hooks (shown in Figure 23) molded into the bottom of the rear cover by grasping the hooked ends with needle-nose pliers.

3. Disconnect the two springs from the contents indicator assembly steel pull handle and indicator plate by grasping the hooked ends with needle-nose pliers.

CAUTION: Do not over-stretch the contents indicator spring. This can cause inaccurate readings.

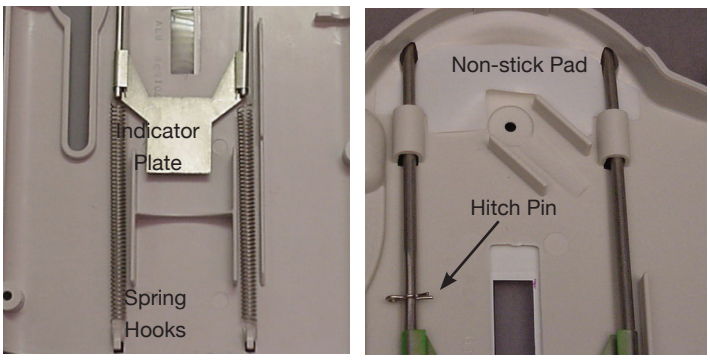


Figure 27: Contents Indicator Spring

4. Slide the indicator plate off the end of the steel pull handle.

5. Remove the hitch pin (if present) from the steel pull handle.

6. Slide the steel pull handle out the top of the rear cover.

7. Remove the non-stick pad located above the two pull handle guides.

8. Remove the carrying strap from the steel pull handle.

9. To replace the rear cover, reverse steps 1-8.

NOTE: Install the steel pull handle so that the arm with two holes is the farthest from the vent lever opening. Insert the straight leg of the hitch pin through the upper hole in the pull handle until the pin snaps into place. The open end of the hitch pin should face the center of the rear cover.

NOTE: When installing the contents indicator springs, make sure that the open ends of the spring hooks face the center of the rear cover. The top spring hooks must fit through the holes in the indicator plate arms and the steel pull handle. The non-stick pad must be in position behind the steel pull handle.

NOTE: When replacing the rear cover, be sure to install a new warning label.

RP6 – Contents Indicator Test

1. Verify that the unit is empty and nothing is attached to it.

2. Place the H300 or H850 on a table and hold it down while gently pulling up on the contents indicator strap. Verify that the indicator operates smoothly and without binding.

3. Suspend the unit in the air by its contents indicator strap only. Verify that the green bar does not appear in the window on the rear case.

4. Completely fill the unit with liquid oxygen.

5. Lift the unit in the air by its contents indicator strap.

6. Push the bottom backside of the unit gently forward so that it stands straight vertically. Verify that the green bar fills the window on the rear case.

7. If the contents indicator reads inaccurately, replace the contents indicator (RP5B).

RP7 – Primary Relief Valve Test

1. Remove the covers (RP4).

2. Set the container assembly on the portable test fixture (B-778202-00).

NOTE: For newer units manufactured without the CPC Connector, the CPC Connector Kit will need to be installed, please refer to RP27.

3. Stand the front cover, with tubing still connected, next to the container assembly as shown in Figure 19.

4. Set the flow control knob in the off position (0).

5. Attach the DISS nut end of a HELiOS oxygen supply line (B-701656-SV) to an 0-6.90 bar (0-100 psi) source of gaseous oxygen.

6. Insert the opposite end of the HELiOS oxygen supply line into the quick connect.

7. Disconnect the flexible vent tube from the barbed fitting at the vent valve outlet.

8. Connect the test pressure gauge tube to the vent valve barbed fitting and secure it with a tie wrap as shown in figure 28.

Figure 28: Test Pressure Gauge Set-Up

9. Use a 3/16 inch tubing nut (B-775067-00) or 2 inch (5.08 cm) spacer to prop the vent valve lever in the open position.

10. Place one drop of leak detector on the R/E valve bronze vent port silencer disk shown in Figure 29.

Figure 29: PRV Liquid Leak Testing

11. Slowly increase the gaseous oxygen source pressure until tiny, foam-like bubbles just begin to form on the surface of the silencer disk to indicate that the PRV has opened. You can also listen for an audible hissing sound.

12. Verify that the PRV opens at ≤1.90 bar (≤27.5 psi) on the H300, or 1.79-2.07 bar (26-30 psi) on the H850.

13. If the opening pressure is not within the acceptable range, repeat the PRV test. If the PRV fails to open in the acceptable range a second time, replace the R/E valve (RP10).

14. Slowly reduce the gaseous oxygen source pressure until the stream of bubbles begins to diminish.

15. Verify that the PRV closes (bubble begin to diminish) at a pressure greater than 1.59 bar (23psi) for the H300, or 1.72 bar (25 psi) for the H850.

16. If the closing pressure does not meet the acceptable range, repeat the test. If the PRV fails to re-seat in the acceptable range a second time, replace the R/E valve (RP10).

17. Remove the test pressure gauge and nut/spacer from the vent valve.

18. Reconnect the flexible vent tube to the vent valve barbed fitting.

NOTE: If unit was equipped without CPC fitting, remove kit and reinstall tube in reverse order of RP27.

19. Re-install the case (RP4).

RP8 – Secondary Relief Valve Test

1. Remove the covers (RP4).

2. Set the container assembly on the portable test fixture.

3. Place the front cover, with tubing still connected, next to the container assembly as shown in Figure 19.

NOTE: Note: For newer units manufactured without the CPC Connector, the CPC Connector Kit will need to be installed, please refer to RP27.

CAUTION: Disconnect and clamp off the demand flow control valve oxygen inlet tube before performing the secondary relief valve test. High test pressure can damage the FCV.

4. Disconnect the 1/16 in (0.15 cm) diameter urethane tube from the demand flow control valve inlet barbed fitting (toward the front of the valve). Clamp the inlet tube with a tubing clamp or hemostat.

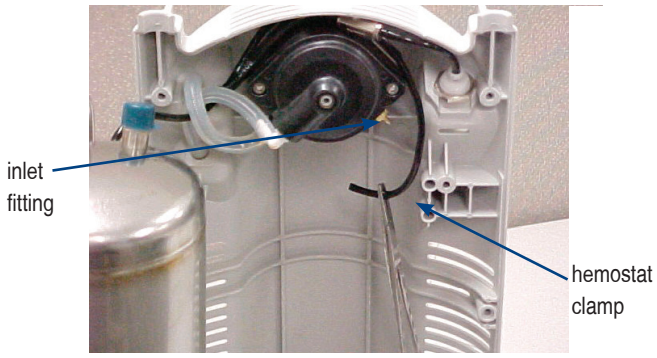


Figure 30: Disconnecting the FCV Inlet Tube

5. Set the flow control knob in the off position (0).

6. Attach the DISS end of a HELiOS oxygen supply line (B-701656-SV) to a 0-6.90 bar (0-100 psi) source of gaseous oxygen.

7. Insert the opposite end of the HELiOS oxygen supply line into the quick connect on the front cover.

8. Disconnect the flexible vent tube from the barbed fitting at the vent valve outlet.

9. Connect the test pressure gauge tube to the vent valve barbed fitting as shown in Figure 28 and secure it with a tie wrap.

10. Use a 3/16 in (0.48 cm) tubing nut (B-775067-00) or 2 in (5.08 cm) spacer to prop the vent valve lever in the open position.

11. Obtain a 6 in (15.24 cm) micro clamp bar and size 00 rubber stopper. Trim the rubber stopper so that it is about 0.5 in (1.27 cm) long. Place the smaller end of the rubber stopper over the R/E valve vent port. Position the bar clamp stationary arm on the larger end of the stopper and the moveable arm on the R/E valve body. Tighten the clamp to seal the vent port.

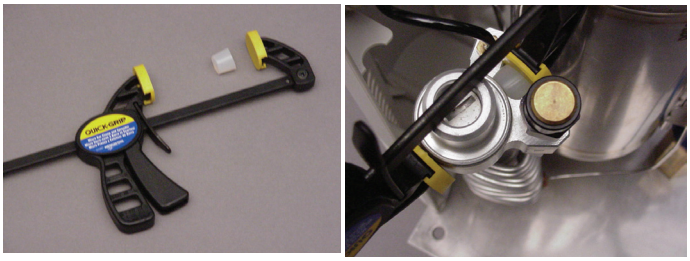


Figure 31: Bar Clamp Sealing the R/E Port

12. Slowly pressurize the H300 or H850 by adjusting the gaseous oxygen source regulator.

13. Verify that the secondary relief valve opens (audible hiss) at 5.24-5.79 bar (76-84 psi).

NOTE: If the SRV opens at a pressure slightly higher than the SRV setting, reduce the oxygen source pressure to 3.45 bar (50 psi). Release the tubing clamp or hemostat until the pressure in the H300 or H850 drops to 3.45 bar (50 psi). Re-clamp the inlet tube and repeat the test a second time. If the SRV fails the test again, replace the SRV (RP11).

14. Slowly reduce the pressure of the gaseous oxygen source until the audible hissing noise is no longer heard.

15. Verify that the SRV closes (audible hiss no longer heard) at a pressure greater than 4.41 bar (64 psi).

NOTE: If the SRV does not close within this range the first time, repeat the SRV test. If it fails to close within an acceptable range the second time, replace the SRV (RP11).

16. Reduce the oxygen source pressure to 0 bar/psi and disconnect the HELiOS oxygen supply line from the quick connect on the front cover.

17. Disconnect the test pressure gauge from the vent valve and vent the pressure in the unit through the open vent valve.

18. Connect the flexible vent tube to the vent valve barbed fitting and remove the nut or spacer propping the vent lever open.

19. Remove the bar clamp and the tubing clamp/hemostat.

20. Connect the urethane tube to the FCV.

NOTE: If unit was equipped without CPC fitting, remove kit and reinstall tube in reverse order of RP27.

21. Re-Install the covers (RP4).

RP9A – Economizer Test (H300)

1. Make sure the unit has been leak tested (RP2).
2. Fill the H300 from a properly saturated source of liquid oxygen.
3. Remove the case (RP4).
4. Set the unit on the portable test fixture.
5. Stand the front cover, with tubing connected, next to the bottle assembly as shown in Figure 19.
6. Allow the unit to sit undisturbed for 30 minutes to stabilize at its primary relief valve setting.
7. Disconnect the flexible vent tube from the barbed fitting on the vent valve.
8. Connect a test pressure gauge to the vent valve barbed fitting and secure it with a tie wrap.
9. Prop the vent valve lever in the open position using a 3/16 in (0.48 cm) tubing spacer nut. Verify that the test pressure gauge reads 1.65-2.07 bar (24-30 psi) and that the primary relief valve is venting.
10. Set the flow control knob to a setting of 2.

NOTE: The H300 must deliver continuous flow to perform the Economizer Test. The following steps use the Jet Venturi assembly to ensure that the H-300 provides continuous flow for the economizer test.

11. Connect the jet/venturi assembly to the sense cannula barb on the H300 front cover.
12. Connect the DISS tubing adapter on the long tube of the jet/venturi assembly to an adjustable 0-6.90 bar (0–100 psi) source of gaseous oxygen.

CAUTION: Damage to the demand FCV is possible. Make sure you hook up the Jet Venturi exactly as described. Do not block the outlet port on the Jet Venturi assembly.

13. Increase the adjustable gaseous oxygen source pressure until you feel a continuous oxygen flow from the top cannula barb of the H300.
14. Check the reading on the test pressure gauge every 5 minutes until the pressure stabilizes. Stabilization occurs when 2 consecutive pressure readings are within 0.069 bar (1 psi) of each other.
15. If the economizer pressure is not within 1.41-1.59 bar (20.5-23.0 psi), replace the R/E valve (RP10).
16. Reassemble the unit by reversing steps 1-12.

RP9B – Economizer Test (H850)

1. Make sure the unit has been leak tested (RP2).
2. Fill the H850 from a properly saturated source of liquid oxygen.
3. Remove the case (RP4).
4. Set the unit on the portable test fixture.
5. Stand the front cover, with tubing connected, next to the bottle assembly as shown in Figure 19.
6. Allow the unit to sit undisturbed for 30 minutes to stabilize at its primary relief valve setting.
7. Disconnect the flexible vent tube from the barbed fitting on the vent valve.
8. Connect a test pressure gauge to the vent valve barbed fitting and secure it with a tie wrap.
9. Prop the vent valve lever in the open position using a 3/16 in (0.48 cm) tubing spacer nut. Verify that the test pressure gauge reads 1.79-2.07 bar (26-30 psi) and that the primary relief valve is venting.
10. Set the flow control knob to a setting of C6.

NOTE: The H850 must deliver continuous flow to test the economizer valve.

11. Check the reading on the test pressure gauge every 5 minutes until the pressure stabilizes. Stabilization occurs when two consecutive pressure readings are within 0.069 bar (1 psi) of each other.
12. If the economizer pressure is not within 1.53-1.71 bar (22.25-24.75 psi), replace the R/E valve (RP10).
13. Reassemble the unit by reversing steps 1-9.

RP10 – R/E Valve R/R

1. Remove the covers (RP4).
2. Remove the flexible urethane tube from the barbed fitting on the R/E valve outlet arm. Use a 1/4 inch open-end wrench to remove the barbed fitting.
3. Use an adjustable wrench to hold the R/E valve inlet arm stationary. Use a 7/16 inch open-end wrench to remove the gas withdrawal warming coil compression nut from the inlet arm fitting.
4. Pull the gas withdrawal warming coil tube out of the fitting.

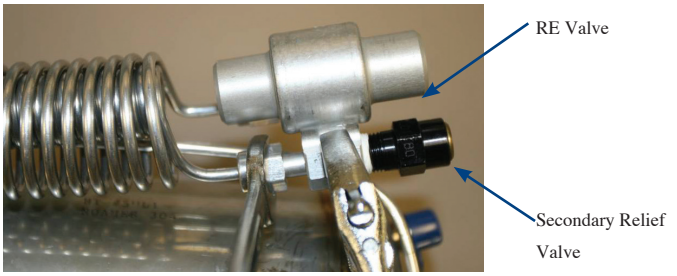


Figure 32: Gas Withdrawal Coil Removal

5. Use an adjustable wrench to hold the R/E valve outlet arm stationary. Use a 1/2 inch open-end wrench to remove the liquid withdrawal warming coil compression nut from the outlet arm fitting.
6. Pull the liquid withdrawal warming coil tube out of the fitting.
7. Use an adjustable wrench to hold the R/E valve inlet arm stationary. Use a 1/2 inch open-end wrench to remove the secondary relief valve.
8. Apply Teflon tape sealant to the threads of the SRV if needed.
9. Install the SRV in the inlet arm port of the new R/E valve and tighten it until snug.
10. Insert the gas withdrawal warming coil (smaller diameter coil) tube in the R/E valve inlet arm fitting and finger tighten the compression nut.
11. Insert the liquid withdrawal warming coil (larger diameter coil) in the R/E valve outlet arm port and finger tighten the compression nut.
12. Tighten both compression nuts using a 7/16 inch open-end wrench on the nuts and an adjustable wrench on the R/E valve arms.
13. Install the barbed fitting in the R/E valve outlet arm.
14. Install the flexible urethane tube on the barbed fitting.

NOTE: The R/E valve arms should face the container.

15. Replace the case (RP4).

RP11 – SRV R/R

1. Remove the covers (RP4).
2. Use an adjustable wrench to hold the R/E valve inlet arm stationary.
3. Use a 1/2 inch open-end wrench to remove the SRV.
4. Apply Teflon tape to the threads of the new SRV.
5. Install the new SRV in the R/E valve inlet arm port.
6. Use an adjustable wrench to hold the R/E valve stationary.
7. Use a 1/2 inch open-end wrench to tighten the SRV until snug.

CAUTION: High pressure hazard. Over tightening the SRV can cause it to operate improperly. Do not over tighten the valve. Always perform the SRV test (RP8) after installation.

8. Replace the outer case (RP4).

RP12 – Pressure Hold Test

1. Attach a test pressure gauge (B-701732-00) to the top cannula barb on the front cover of the H300 or H850.

NOTE: For newer units manufactured without the CPC Connector, the CPC Connector Kit will need to be installed first, refer to RP27, then reinstall the front case.

2. Set the flow control knob to a continuous flow setting (0.75 on the H300, C6 on the H850).

3. Attach the DISS nut and tailpiece of a HELiOS oxygen supply line (B-701656-SV) to a 0-6.90 bar (0-100 psi) source of gaseous oxygen.

4. Insert the opposite end of the HELiOS oxygen supply line in the quick connect.

5. Increase the gaseous oxygen source pressure until the test pressure gauge reads 1.52 bar (22 psi) for the H300, or 1.65 bar (24 psi) for the H850.

NOTE: If you do not get a reading on the pressure gauge, reset the demand valve as follows. Connect one tube of a dual-lumen cannula to the bottom cannula barb and breathe in once or twice.

6. Disconnect the HELiOS oxygen supply line from the quick connect.

7. Allow the unit to sit undisturbed for 10 minutes.

8. Verify that the portable maintains a minimum pressure of 1.03 bar (15 psi) for the H300, or 1.24 bar (18 psi) for the H850 at the end of the evaluation period.

9. If the pressure drops below this level, locate the leak by performing the liquid leak detector test (RP2).

10. Disconnect the test pressure gauge.

NOTE: If unit was equipped without CPC fitting, remove kit and reinstall tube in reverse order of RP27, then reinstall front case.

RP13A – Liquid Withdrawal Warming Coil R/R (H300)

1. Remove the covers (RP4).

2. Use an adjustable wrench to hold the R/E valve outlet arm (with barbed fitting) stationary. Use a 7/16 inch open-end wrench to remove the liquid withdrawal warming coil compression nut from the R/E valve fitting.

3. Use a 5/16 inch open-end wrench to hold the fitting on the stainless steel container tube stationary. Use a 7/16 inch open-end wrench to remove the remaining liquid withdrawal coil compression nut from the fitting.

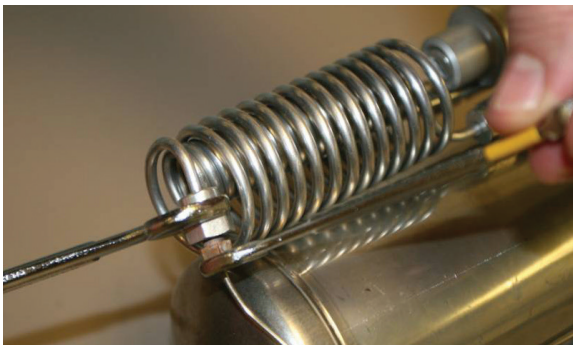


Figure 33: Compression Nut Removal

4. Pull the ends of the warming coil from their fittings and remove the coil.

NOTE: Make sure to route the flexible urethane vent tube through the inside of the warming coil positioned directly below the vent valve.

5. To reinstall the warming coil, reverse steps 1-4.

RP13B – Liquid Withdrawal Warming Coil R/R (H850)

1. Remove the covers (RP4).
2. Remove the flexible urethane tube from the barbed fitting on the R/E outlet arm.
3. Remove the flexible urethane tube from the barbed fitting on the side of the vent valve.
4. Cut and remove the two zip ties (if present) that secure the liquid withdrawal coil to the gas withdrawal coil at the top of the cryogenic container.
5. Use a 3/8 inch open-end wrench to hold the R/E valve outlet arm (with barbed fitting) stationary. Use a 1/2 inch open-end wrench to remove the liquid withdrawal coil compression nut from the R/E valve fitting.
6. Use a 3/8 inch open-end wrench to hold the fitting on the stainless steel container tube stationary. Use a 1/2 inch open-end wrench to remove the liquid withdrawal compression nut from the fitting.
7. Pull the ends of the warming coil from their fittings.
8. Remove the warming coil.
9. Remove the two plastic insulator wraps from the warming coil (if present) and save them for use on the replacement coil.

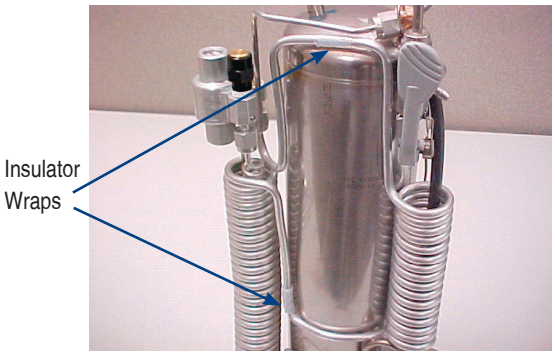


Figure 34: Insulator Wrap Locations

10. Replace the liquid withdrawal coil by reversing steps 1-9.

NOTE: Make sure to route the 1/8 in flexible urethane vent tube through the inside of the warming coil positioned directly below the vent valve.

NOTE: Install the two plastic insulator wraps on the new warming coil at the locations shown in Figure 46.

RP14A – Gas Withdrawal Warming Coil R/R (H300)

1. Remove the covers (RP4).
2. Use an adjustable wrench to hold the R/E valve inlet arm (with the SRV) stationary. Use a 7/16 inch open-end wrench to remove the gas withdrawal warming coil compression nut from the R/E valve fitting.

CAUTION: Be careful not to dent the top of the container when performing the following step.

3. Use an adjustable wrench to hold the vent valve mounting block on the top of the container stationary. Use a 7/16 inch open-end wrench to remove the remaining gas withdrawal coil compression nut from the mounting block fitting.
4. Pull the ends of the gas withdrawal coil from their fittings and remove the coil.
5. Replace the gas withdrawal coil by reversing steps 1-4.

RP14B – Gas Withdrawal Warming Coil R/R (H850)

1. Remove the covers (RP4).
2. Remove the flexible urethane tube from the barbed fitting on the R/E valve outlet arm.
3. Cut and remove the two zip ties that secure the liquid withdrawal coil to the gas withdrawal coil at the top of the cryogenic container.
4. Use an adjustable wrench to hold the R/E valve inlet arm (with the SRV) stationary. Use a 7/16 inch open-end wrench to remove the gas withdrawal warming coil compression nut from the R/E valve fitting.

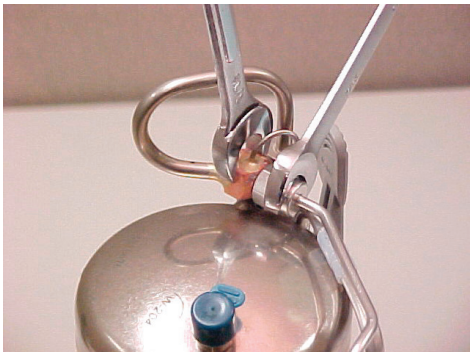


Figure 35: Removing the Compression Nut

5. Use a 7/16 inch open-end wrench to hold the manifold block on the top of the container stationary. Use a 7/16 inch open-end wrench to remove the remaining gas withdrawal coil compression nut from the manifold block.
6. Remove the ends of the warming coil from their fittings.
7. Remove the gas withdrawal coil by pulling it up and out of the liquid withdrawal warming coil.
8. Replace the gas withdrawal coil by reversing steps 1-7.

RP15A – Vent Valve Assembly R/R (H300)

1. Remove the covers (RP4).
2. Disconnect the flexible vent tube from the barbed fitting at the vent valve outlet.
3. Hold the vent valve large hex nut stationary using a 5/8 inch open-end wrench and loosen the jam nut that holds the vent valve to the mounting bracket using a 11/16 inch open-end wrench.

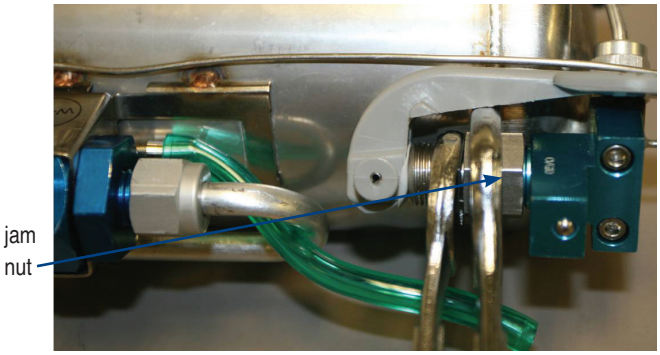


Figure 36: H300 Vent Valve Removal

4. Remove the two vent valve screws and lock washers using a 7/64 in hex wrench.
5. Slide the vent valve out of its mounting bracket.
6. Replace the vent valve assembly by reversing steps 1-5.

RP15B – Vent Valve Assembly R/R (H850)

1. Remove the covers (RP4).
2. Disconnect the flexible vent tube from the barbed fitting on the side of the vent valve.
3. Pull the vent lever down and place a 1/2 inch open-end wrench on the vent valve body just above the hex nut.
4. Loosen the tubing compression nut at the top of the valve using a 1/2 inch open-end wrench.
5. Remove the vent valve mounting screw using a T10 torx driver.
6. Lift the container assembly and the vent valve from the front cover.
7. Continue to loosen and then remove the tubing compression nut from the vent valve completely.
8. Remove the valve from the tube.
9. Replace the vent valve assembly by reversing step 1-8. Make sure that the valve is aligned properly in the back case as shown below.

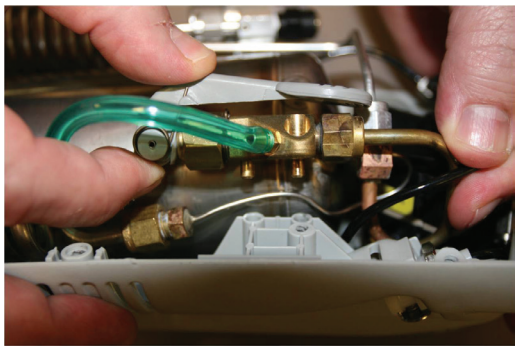


Figure 37: H850 Vent Valve Installation

RP16– Vent Valve Disassembly & Repair

1. Remove the vent valve assembly (RP15)
2. Pry the short, straight end of the torsion spring off of its anchor point on the vent valve lever using a small flat-blade screwdriver.
3. Push the long, hooked end of the torsion spring off of the valve body using a small flat-blade screwdriver.
4. Remove the torsion spring.
5. Remove the vent tube barbed fitting using a 1/4 inch open-end wrench.
6. Push out the lever pin using a 1/16 inch hex key, pin punch, or ball driver.

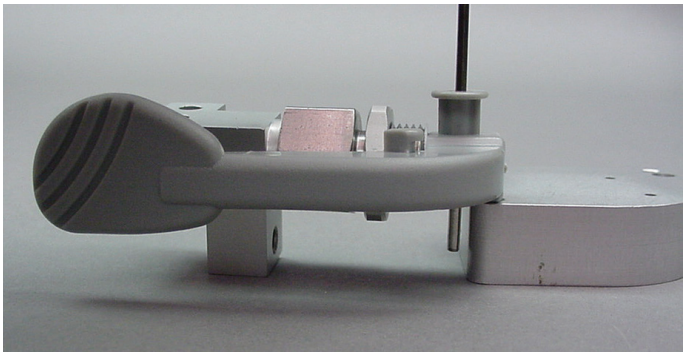


Figure 38: Pin Removal

7. Remove the lever and the Teflon washer.

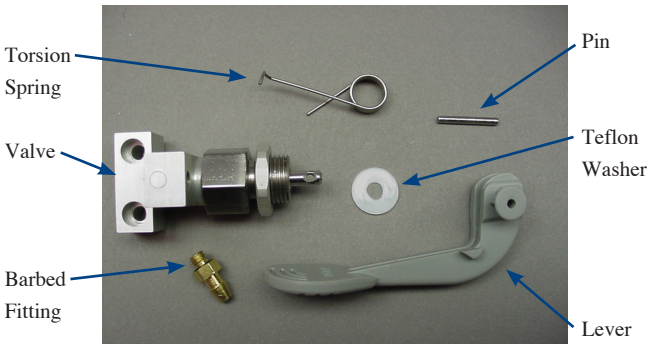


Figure 39: Vent Valve Disassembly

8. Replace vent valve parts and re-assemble it by reversing steps 1-7.

RP17A – QDV Assembly R/R (H300)

1. Remove the case (RP4).

2. Use an adjustable wrench to hold the fill connector mounting bracket stationary. Use a second 9/16 inch open-end wrench to remove the fill on the machined flats of the fill connector body to loosen and remove the compression nut of the fill tube from the top of the fill connector.

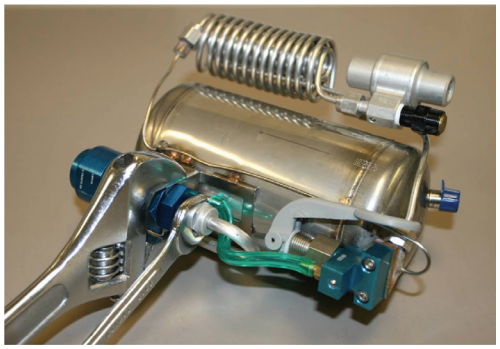


Figure 40: H300 QDV Removal

3. Use a 7/16 inch open-end wrench to hold the fill tube container fitting stationary. Use a 9/16 inch open-end wrench to remove the fill tube lower compression nut from the cryogenic container.

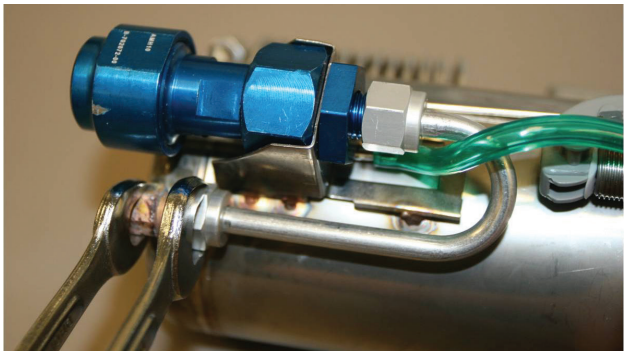


Figure 41: H300 Fill Tube Removal

4. Remove the fill tube.

5. Use an adjustable wrench to hold the fill connector mounting bracket stationary. Use a 7/8 inch open-end wrench to remove the jam nut from the fill connector assembly.

6. Remove the QDV from the mounting bracket.

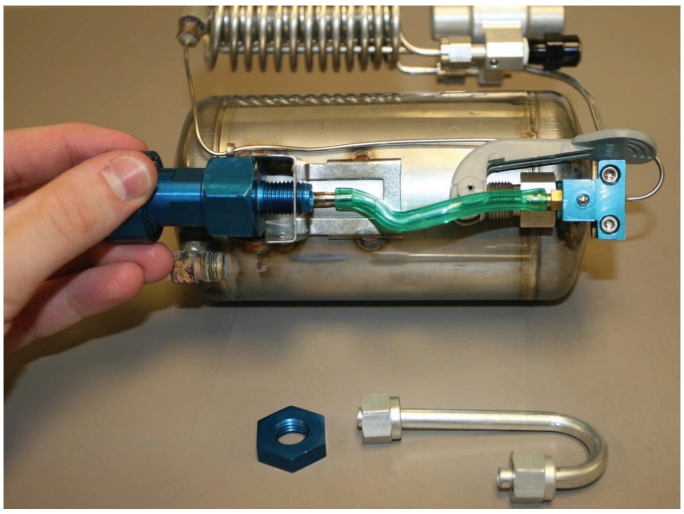


Figure 42: H300 QDV Assembly Removal

7. To replace, reverse steps 1-6.

NOTE: Use a torque wrench to tighten the fill connector to a torque of 35 lb/ft (511 n/m) and the jam nut to a torque of 20 lb/ft (292N-m).

NOTE: The internal threads in the fill connector jam nut do not run completely through the nut. Install the fill connector jam nut with the unthreaded end toward the mounting bracket.

NOTE: Position the fill tube so that the ferrules on each end are seated in their fittings on the fill connector and the container. Alternately hand tighten the fill tube nuts to seat the ferrules evenly. Use two wrenches to tighten the nuts securely.

RP17B – QDV Assembly R/R (H850)

1. Remove the covers (RP4).

2. Use an adjustable wrench to hold the fill connector adaptor stationary. Use a second adjustable wrench on the machined flats of the fill connector body to loosen and remove the fill connector.

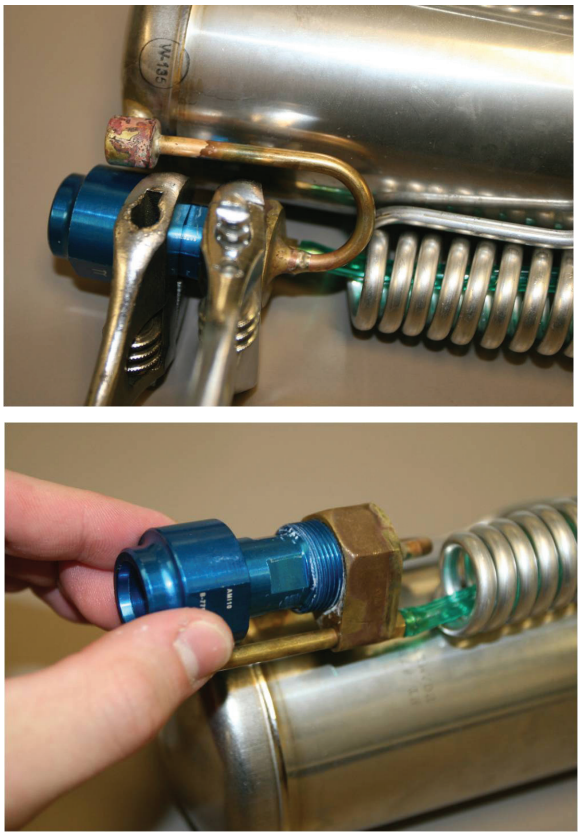


Figure 43: H850 QDV Removal

3. To replace the QDV assembly, reverse steps 1-2.

RP18 – QDV Lip Seal R/R

1. Remove the QDV (RP17).

2. Hold the QDV body with an adjustable wrench placed on the machined flats. Use a second adjustable wrench to remove the lip seal retainer sleeve.

3. Pull the lip seal out of the fill connector body.

Figure 44: Lip Seal Removal

4. Insert the stepped (spring) end of the new lip seal into the corresponding recess in the large end of the QDV body. Make sure that it is squarely seated.

Figure 45: Lip Seal Replacement

5. Thread the lip seal retainer onto the large end of the fill connector body and tighten to a torque of 35 lb/ft (511 n/m).

6. Replace the QDV assembly (RP17).

RP19 – Demand Flow Control Valve Test

1. Make sure the unit has been leak tested (RP2).
2. Fill the H300 or H850 from a properly saturated source of liquid oxygen.
3. Allow the unit to sit undisturbed for approximately 30 minutes to allow it to stabilize at its primary relief valve pressure.
4. Attach a calibrated flow meter to the top cannula barb on the H300 or H850 using a length of 3/16 in (0.48 cm) diameter tubing (B-778214-00) if necessary.
5. Set the flow control valve to its lowest demand setting (1 on the H300, D1.5 on the H850).
6. Verify that there is no oxygen flow from the unit and the flow meter reads "0".
7. Disconnect the calibrated flow meter.
8. Connect the Jet Venturi assembly (B-778210-00) to the bottom cannula barb on the front of the H300 or H850.
9. Connect the DISS nut and tailpiece of the Jet Venturi assembly to a 0-6.90 bar (0-100 psi) source of gaseous oxygen.

Figure 46: Jet Venturi Assembly Attachment

NOTE: Do not block the open "bleeds" on the Jet Venturi assembly. This can cause damage to the flow control valve.

10. Slowly increase the pressure of the gaseous oxygen source until a continuous flow comes from the top cannula barb.
11. Reconnect a calibrated flow meter as described in step 4.
12. Check the demand inspiration tailflow at each demand flow setting. Verify that they are within the ranges listed in Table 7 (H300) or Table 8 (H850).
13. Disconnect the Jet Venturi assembly from the unit.
14. Set the flow control knob to the lowest continuous flow setting (0.12 for the H300, C1 for the H850)
15. Check the continuous flow at each flow setting. Verify that they are within the ranges listed in Table 6 (H300) or Table 7 (H850).
16. Disconnect the test flow meter.
17. Attached a dual lumen cannula to the H300 or H850.
18. Adjust the cannula to your face and breathe normally.
19. At all demand flow settings, verify that oxygen flow cycles on and off in response to your inhalation and exhalation. Verify that you sense a brief "puff" of oxygen at the beginning of each inhalation.
20. Disconnect the cannula.

NOTE: If continuous flow does not occur at these flow settings, reset the demand valve by blowing across (not into) the bottom cannula barb or by attaching a dual lumen cannula to the bottom cannula barb and breathing in once or twice.

Table 7: H300 Flow Tolerance

Flow Setting	Measured Flow	Specification (LPM)	Acceptable Range (LPM)
0	None	0.00	0.00
0.12	Continuous	0.12	0.02 - 0.22
0.25	Continuous	0.25	0.10 - 0.40
0.5	Continuous	0.50	0.35 - 0.65
0.75	Continuous	0.75	0.60 - 0.90
1	Tail Flow	0.50	0.35 - 0.65
1.5	Tail Flow	0.65	0.50 - 0.80
2	Tail Flow	0.75	0.60 - 0.90
2.5	Tail Flow	1.00	0.85 - 1.15
3	Tail Flow	1.50	1.30 - 1.70
3.5	Tail Flow	1.75	1.40 - 1.90
4	Tail Flow	2.00	1.70 - 2.30

Table 8: H850 Flow Tolerance

Flow Setting	Measured Flow	Specification (LPM)	Acceptable Range (LPM)
D1.5	Tail Flow	0.65	0.5 - 0.8
D2	Tail Flow	0.75	0.6 - 0.9
D2.5	Tail Flow	1.00	0.85 - 1.15
D3	Tail Flow	1.50	1.3 - 1.7
D4	Tail Flow	2.00	1.7 - 2.3
0	None	0.00	0.00
C1	Continuous	1.00	0.85 - 1.15
C2	Continuous	2.00	1.7 - 2.3
C3	Continuous	3.00	2.6 - 3.4
C4	Continuous	4.00	3.5 - 4.5
C5	Continuous	5.00	4.4 - 5.7
C6	Continuous	6.00	5.3 - 6.8

NOTE: The values in Tables 7 & 8 are based on ambient conditions of 70oF (21oC) and 29.4 in Hg (74 mm Hg) and an operating pressure range of 1.54 to 1.71 bar (22.3 psi to 24.8 psi). Any deviations from these conditions can affect flow results.

NOTE: If the flow measurements are out of specification, check the pressure in the unit. A combination of high or low pressure and the tolerance of the particular flow meter can result in inaccurate readings.

RP20 – Demand FCV R/R

1. Remove the covers (RP4).
2. Remove the flow control knob by pulling it straight back from the front cover.
3. Pull the demand flow control valve backwards out of its seat inside the front cover.
4. Use a small flat head screwdriver to carefully pry the polyurethane tube off of the demand flow control valve inlet barbed fitting.
5. Use a small flat head screwdriver to carefully pry the silicone tubes off of the cannula barb fittings.
6. Install the new flow control valve by reversing steps 1-5.

NOTE: The demand flow control valve is not field serviceable. Only the barbs and inlet filter screen may be replaces as needed.

CAUTION: The demand flow control valve is manufactured to exacting tolerances and uses a number of small orifices. Ensure that hands, tools, and work table are clean when working with the valve. Do not allow liquids to enter the vent port located directly across from the vent valve inlet fitting.

RP21 – Demand FCV Filter Screen Replacement

1. Remove the demand FCV (RP20).
2. Remove the inlet barbed fitting by unscrewing it from the FCV.
3. Hold the valve so that the inlet port faces downward.
4. Use a dental pick or other similar tool to carefully remove the inlet filter screen.

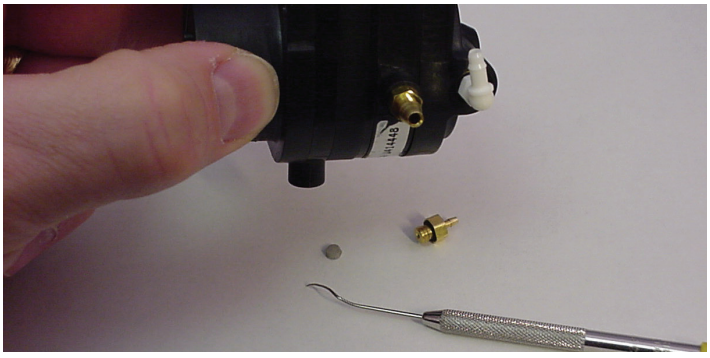


Figure 47: Inlet Filter Screen Removal

5. Push the replacement filter screen into the inlet port until it is seated on the internal support ledge.

NOTE: Do not install two filter screens. This may cause a flow restriction.

6. Re-install the inlet barbed fitting.

NOTE: When installing the brass barbed fitting, verify the presence and condition of the seal gasket on the threaded end of the fitting.

7. Replace the FCV (RP20).

RP22 – Normal Evaporation Rate (NER) Test

1) Ensure the unit has been leak tested (RP2).

2) Fill the H300 or H850 from a properly saturated source of liquid oxygen.

3) Allow the unit to sit undisturbed for 1-2 hours to allow it to stabilize at its PRV pressure.

4) Record the initial weight (w1) of the unit and the time this weight was measured.

5) Allow the unit to sit undisturbed for 5-6 hours.

6) Record the final weight (w2) of the unit and the time this weight was measured.

7) Calculate the NER (the weight of contents that evaporates per day) using the formula below:

$$\frac{w_2 - w_1}{\left(\frac{\#\ \text{hours}}{24}\right)} = \text{NER}$$

8) Verify that the NER is within the specifications listed in Table 4.

RP23 – Oxygen Supply Line Quick Connect R/R

1. Remove the case (RP4).

2. Use a small flat head screwdriver to carefully pry the urethane tube from the inlet barbed fitting of the inline check valve.

3. Use a 5/8 inch open end wrench to remove the nut that secures the quick connect to the front cover.

4. Pull the quick connect down and out of its mounting hole.

5. Remove the urethane tube from the barb on the quick connect.

6. Install the new quick connect by reversing steps 1-5.

RP24 – Inline Check Valve R/R

1. Remove the case (RP4).

2. Use a small flat head screwdriver to carefully pry the urethane tube from the inlet barbed fitting of the inline check valve.

3. Use a small flat head screwdriver to carefully pry the urethane tube from the outlet barbed fitting on the inline check valve.

4. Install the new inline check valve by reversing steps 1-3.

RP25 – Compression Fitting (Nut & Ferrule) Replacement

1. Inspect the tube end. Make sure that it is cut square and that the outside surface is free of scratches or other marks at least 1 in (25 mm) back from the tube end.

2. Lightly buff the tube end with a Scotch-Brite pad or fine emery paper to remove any surface marks.

3. Make sure the tube end is bottomed against the tube stop in the fitting body. This is necessary to prevent movement of the tube while the nut forces the ferrule to grip the tube and create a seal.

4. Hold the fitting body stationary with an open-end wrench while tightening the tube nut with a second wrench.

NOTE: Never permit the fitting body to rotate during this procedure. Always use two wrenches.

5. Tighten the tube finger-tight.

6. Using an open-end wrench, tighten the nut beyond finger-tight.

   a. For 1/4 in (0.64 cm) diameter tubing, tighten the nut and additional 1 & ¼ turns.

   b. For 1/8 in (0.32 cm) or 3/16 in (0.48 cm) diameter tubing, tighten the nut an additional ¾ turn.

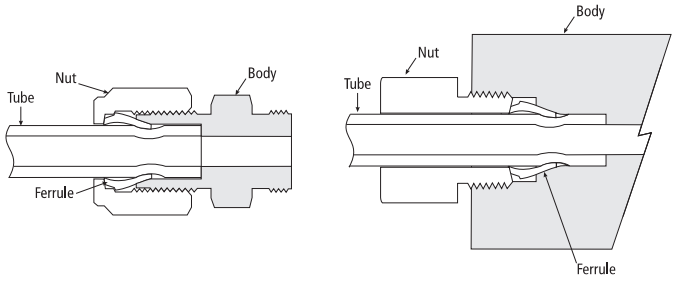


Figure 48: Compression Fitting

RP26 – Flexible Tubing Replacement

1. Use a small flat-blade screwdriver to carefully back the brass collar (when used) off of the barbed fitting.

2. Work the screwdriver between the end of the tube and the fitting body.

3. Simultaneously pull on the tube and pry the end of the tube back from the barb.

4. Inspect the end of the new tube. Be sure that the end is cut square and that it is free of cuts and tears.

5. Install a brass collar on the tube (if used) so that the large end of the collar is toward the barbed fitting.

6. Push the tube squarely onto the barb as far as possible.

7. Push the brass collar (if used) onto the tube end connected to the barbed fitting.

RP27 - CPC Connector Kit Installation (For Testing units without CPC Connector Installed)

1. Remove tubing from barbed fittings of Conserver and R/E Valve.

2. Connect CPC Connector Kit's (PN: 20748595) 7.5" tubing end to inlet barb of Conserver and 3" tubing end to R/E Valve barbed fitting. Refer to Figure 49 for unit without CPC Connector Kit converted to unit with CPC Connector Kit

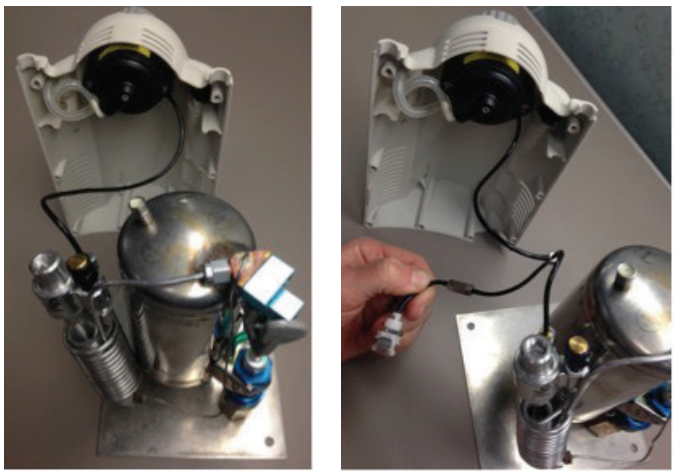


Figure 49: Newer Unit Manufactured without CPC Connector and Fittings (Left). CPC Connector Kit Installed for Testing Purposes (Right).

XII Parts Price List

Contact Customer Service or visit www.cairemedical.com
to obtain your parts list.

XIII Ordering Information

Ordering Information

The following steps should be used when ordering a new HLEiOS or replacement parts for an existing unit:

1. **Compile a list of all equipment and replacement parts to be ordered.**

   Use the following part numbers to order a complete generic English unit:

   HELiOS Plus H300 #B-701604-00

   HELiOS Marathon H850 #H850

   For European part numbers, please call +44(0) 1189 367080. For Asia part numbers, please call +61 297 494333

2. **Fill out a purchase order containing the following information:**

   a. Purchase order number.
   b. Name and address of billing location.
   c. Name and address of shipping location.
   d. Quantity, part number, description, and unit cost for each item ordered.

3. **Telephone or fax CAIRE Inc. at one of the numbers listed below to begin immediate processing of the order:**

   USA

Toll Free Phone:	800 48 CAIRE
	(800 482 2473)
Toll Free Fax:	888 WE CAIRE
(To place an order):	(888 932 2473)
Phone:	770 257 1299
Fax:	770 257 1300

   Asia, Australia, Pacific Rim

Phone:	+61 297 494333
Fax:	888 932 2473

   Europe

Phone:	+44(0) 1344 403100
Fax:	+44 118 9799245

4. **E-Mail or fax the completed purchase order for confirmation to:**

   North and South America/Asia/Pac Rim email to:

   customerservice.usa@chartindustries.com

   Africa/Europe/Middle East email to:

   customerservice.europe@chartindustries.com

   North and South America fax to: 888-932-2473

   Asia/Pac Rim fax to: 770-721-7758

   Africa/Europe/Middle East fax to: +44 118 9799245

All new equipment will be shipped either "prepaid",, F.O.B. from the factory, or collect via your specified carrier. All replacement parts will be sent by UPS "prepaid", and the shipping charges for equipment and parts will be added to the final invoice. Payment for replacement parts are located on CAIRE, Inc.'s, invoice with payment date indicated. All shipments will originate from the factory. If a particular carrier or method of shipment is desired, specify when placing order.

For additional ordering and contact information, visit www.cairemedical.com.

XIV Return & Restocking Policy

When a CAIRE unit is received, it should be inspected immediately, as outlined in Section VIII, Unpacking and Setup Instructions.

If a problem with the unit should be encountered, reference should be made to the Troubleshooting Chart in Section XI. If these procedures do not provide a solution for the problem, the following steps should be taken:

1. Call CAIRE, Inc. Customer Service.

North and South America/Asia/Pac Rim:

Phone (US Only)	800-482-2473
Phone	770-721-7759

Africa/Europe/Middle East:

Phone	+44 (0) 1344 403100

2. State the problem with the unit.
3. If it is determined that the problem cannot be solved by the distributor, a Return Material Authorization (RMA) number will be assigned to the unit or part(s).
4. If a Purchase Order Number is to be referenced, please give this number to the Customer Service Representative at that time.
5. Carefully package the parts, or repack the unit in its original shipping container, precisely as shipped.
6. Write the Return Authorization Number on the top of the shipping container.
7. Customer Service will provide the correct shipping location once the RMA is provided.

Restocking Policy

If it becomes necessary to cancel an order with CAIRE Inc. after the shipment has been received, use the following "Restock Policy" procedure:

1. Call CAIRE, Inc. Customer Service.
2. When contacting Customer Service personnel, it will be necessary to relay the following information:

a. State the quantity and description of equipment to be returned.

b. Give the Serial Number of each unit to be returned.

c. State the equipment purchase date.

3. An RMA number will be issued in the name of the distributor by CAIRE, Inc. for the equipment to be returned.
4. When the equipment is shipped to the factory, the RMA number must appear on the packing slip and shipping boxes.
5. Customer Service will provide the correct shipping location once the RMA is provided
6. Finally, a "Credit Memo", minus a 15% restocking fee, will be issued to the distributor when all equipment has been received, inspected, and restocked by CAIRE, Inc

Return of Unused Non-Defective Merchandise

CAIRE Inc., at its discretion, charges a 15% restocking fee for unused non-defective merchandise that is returned. An RMA number must be obtained from CAIRE Inc. Customer Service prior to return of any goods. Merchandise cannot be returned for credit after sixty (60) days. Customer to pay all freight charges. Tracking capability and insurance on all returned goods is advised. CAIRE Inc. will not be responsible for misdirected shipments.

Service Tools/Equipment/Supplies

Table #9

Required Tools
Adjustable Wrench – 10 inch
Adjustable Wrench – 8 inch
Clamp or Hemostat
Dental Pick
Flat Head Screwdriver
Hex (Allen) Wrenches - Various Sizes
Jewler's Screwdriver
Micro Bar Clamp
Needle Nose Pliers
Open Ended Wrench – 1/2 inch
Open Ended Wrench – 1/4 inch
Open Ended Wrench – 5/8 inch
Open Ended Wrench – 7/16 inch
Open Ended Wrench – 9/16 inch
Phillips Head Screwdriver
Side Cutters
T10 Torx Driver
Tie Wraps

Table #10

Required Fixtures/Equipment
Calibrated Flow Meter
Calibrated Weight Scale
Jet Venturi Assembly
Liquid Oxygen Source
Portable Test Fixture
Test Pressure Gauge w/ Tubing
Gaseous Oxygen Source 0-6.89 bar (0-100 psi)
Oxygen Compatible Tubing – 3/16 inch (0.48 cm) diameter
Tee Connector – 3/16 inch (0.48 cm)

Table #11

Required Supplies
Household Glass Cleaner
Krytox Lubricant
Lint-Free Cloth
Snoop Liquid Leak Detector
TEFLON Tape
Scotch Brite Adhesive Pad

For a complete list of accessories, see the accessories catalog on www.cairemedical.com.

XV Service Tools/Equipment/Supplies

Tools and Accessories available from CAIRE

Description	Item Number
Backpack H850	069209
Belt Pack H300	B-701654-00
Belt Pack H300 Large Waist Extension	14951835
CPC Quick Connect Kit	20748595
DISS Adaptor	B-776945-00
Dual Lumen Cannula – 5 ft (1.5 m) Delivery Both Nostrils (Concentric)	10035468
Dual Lumen Cannula – 7 ft (2.1 m) Delivery Both Nostrils (Concentric)	10035467
Dual Lumen Cannula – 5 ft (1.5 m) Delivery Both Nostrils (Split)	6-778058-00
Dual Lumen Cannula – 7 ft (2.1 m) Delivery Both Nostrils (Split)	6-778057-00
Dual Lumen Cannula – 4 ft (0.9 m) Delivery One Nostril	B-701931-00
Dual Lumen Cannula – 7 ft (2.1 m) Delivery One Nostril	B-701930-00
Erie Liter Meter (0-8 LPM)	97200076
Erie Liter Meter (6-15 LPM)	10995620
Fluoro-Lubricant (2 oz tube)	CA200071
HELiOS Oxygen Supply Line – 50 ft (15.24 m)	B-701656-SV
HELiOS Oxygen Supply Line Coupler	B-701686-00
Jet Venturi Assembly	B-778210-00
Jewler's Screw Driver	97403016
Krytox Lubricant (2oz Tube)	B-775239-00
Oxygen Compatible Tubing – 3/16 inch (0.48 cm)	B-778214-00
Portable Test Fixture	B-778202-00
Pressure Gauge (0-100 PSI)	B-776004-00
Pressure Gauge (0-60 PSI)	97403577
Shipping Carton H300	B-701688-00
Shipping Carton H850	069270
Shipping Insert H300	B-701688-00
Shipping Insert H850	10000172
Snoop Liquid Leak Detector (8 oz bottle)	B-775272-00
Tee Connector 3/16 in (0.48 cm)	B-778211-00
TEFLON Tape	B-775036-00
Test Pressure Gauge w/ Tubing	B-701732-00
Zip Ties	B-775091-00

CAIRE®

A Chart Industries Company

Chart Industries, Inc.
CAIRE Inc., BioMedical Group
2200 Airport Industrial Dr., Ste. 500
Ball Ground, GA 30107
Ph 770-721-7700 • Toll Free 1-800-482-2473
Fax 770-721-7701

Chart Biomedical Ltd.
Unit 6, Ashville Way
Wokingham
Berks RG41 2PL, United Kingdom
Ph +44 (0) 1189 367080 • Fax +44 (0) 1189 799245

CHART™

www.cairemedical.com