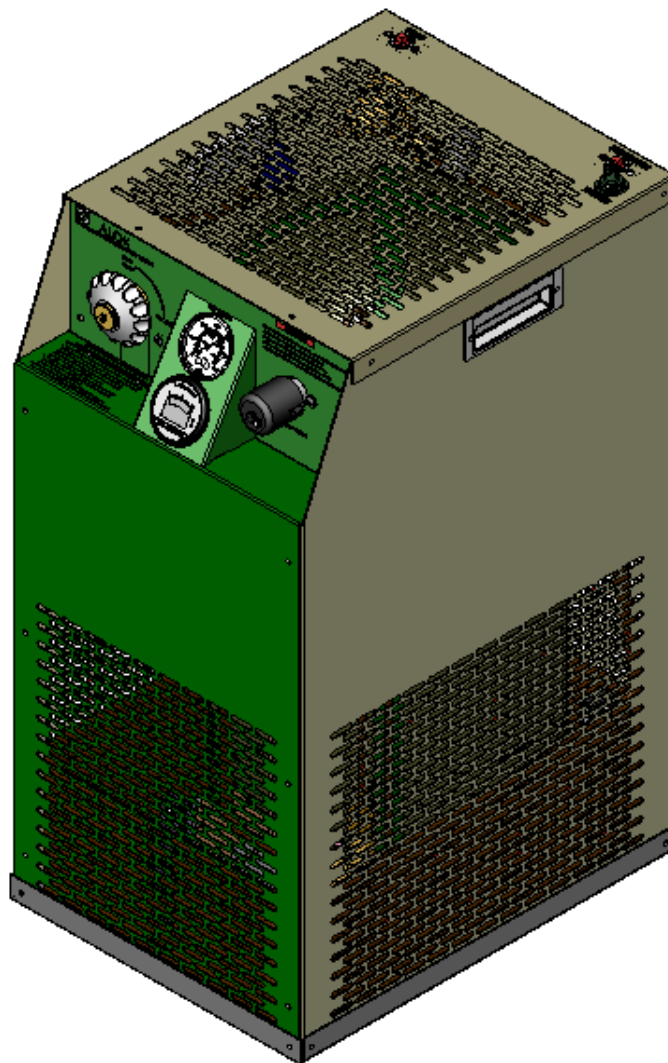


# Ambulance Liquid Oxygen (ALOX) System Installation and Operation Manual 8.5-Liter and 25-Liter Systems

## Part Numbers

10C-0040-2 (8.5 Liter)

10C-0043-2 (25 Liter)



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## 1.0 INTRODUCTION

### 1.1 Purpose

The Ambulance Liquid Oxygen (ALOX) System when filled with liquid oxygen (LOX) will provide an uninterrupted supply of therapeutic oxygen.

### 1.2 Scope

The technical documentation associated with the ALOX System consists of an installation and operation manual. The installation and operation manual includes arrangement drawings, operating instructions and servicing procedures. An installation and operation manual will be provided with each delivered ALOX System.

### 1.3 Safety Precautions

**Read these instructions first.** Throughout this manual there will be three kinds of information with emphasis in the text. Carefully read and understand these notices. Each is important and related to the text following each notice.

#### WARNING

Warnings identify conditions that concern your personal safety and/or the safety of others. They include actions required to prevent injury or death.

#### CAUTION

Cautions identify conditions that may cause possible damage to the equipment or other property; or situations that may cause reduced, or loss of, oxygen flow.

#### Note:

Indicates points of particular interest or emphasis for more efficient and convenient operation.

#### 1.3.1 Warnings

#### WARNING

- **Smoking** – Do not allow smoking or other sources of ignition within 50 feet of the ALOX System.
- **Absorbent Material** – Keep oxygen away from absorbent materials, loose clothing, or rags. These materials can trap gaseous oxygen and can later be easily ignited.
- **Hydrocarbons** – Keep the ALOX System, the surrounding work area, tools, associated equipment, and clothing as clean as possible and free from oil, grease, gasoline, kerosene, asphalt, and other hydrocarbons. Spontaneous ignition upon contact of oxygen with these substances may result.

## WARNING

- **Ventilation** – Operate and maintain the ALOX System only in a well-ventilated location.
- **Freezing risk** – Avoid skin contact with LOX. The extreme low temperature of the liquid will immediately freeze any skin that it contacts and severe frostbite may result.
- Never allow the system vent tube to be obstructed. The vent tube must remain open at all times. Never confine liquid oxygen in any piping or container without adequate safety devices. The pressure build up when the liquid expands to gas will rupture most piping, tubing or containers.
- Protective clothing and safety devices should be worn by personnel handling liquid oxygen during servicing of the ALOX System.
- Only personnel fully trained and qualified in handling and servicing liquid oxygen are authorized to service the ALOX System.
- Stay clear of the liquid oxygen fill valve and vent tube during servicing.
- Stand to one side when disconnecting the servicing transfer nozzle and/or hose to avoid possible liquid oxygen contact.
- To prevent excessive pressure buildup in the servicing hose and possible injury to personnel, ensure that the oxygen tank servicing hose is fully depressurized. Open the servicing line pressure relief valve if the oxygen tank is so equipped.
- **Ambulance** – Position the ALOX System so that it does not inhibit emergency resuscitative care in the ambulance, i.e., Advanced Cardiac Life Support (ACLS) initiatives, or impede access to emergency equipment, supplies, or systems in rear-loading ambulances.
- **Purging** – Only gaseous nitrogen conforming to Federal Specification A-A-59503, Type I, Grades A or B, Class 1 will be used as a source for purging.
- **Storage/Shipment** – Unit must be purged of LOX prior to storage/shipment within shipping container.

### 1.4 Capabilities

The ALOX System has the capacity to store either eight and one half liters or twenty-five liters of LOX and convert it to a gaseous state, depending on the model purchased. It also has the capability to be filled by current LOX storage/filling systems commercially available.

## 1.5 Performance Characteristics

Capacity	25 Liters of LOX – PN 10C-0043-2 8.5 Liters of LOX – PN 10C-0040-2
Service Delivery Rate	Up to 100 LPM at 50 PSIG ± 5 PSIG
Temperature:	
Operating	32°F to 120°F (0°C to 49°C)
Non-Operating (Storage)	-40°F to 158°F (-40°C to 70°C)
Humidity:	
Operating	Up to 95%
Storage (in shipping container)	Up to 100%
Altitude	Sea level to 15,000 feet
Relief Valve Settings:	
System	285 PSIG
Safety	400 PSIG
Rupture Disc Burst Pressure	750 PSIG at 72°F (22°C)
Optimal Time To Performance After Filling With 100 PSI LOX	Immediately

## 1.6 Description

Nomenclature	25 Liter ALOX System	8.5 Liter ALOX System
Overall Dimensions (nominal):		
Height	28 Inches	14 Inches
Width	14 Inches	14 Inches
Depth	18 Inches	18 Inches
Weight (Empty)	65 Lbs	40 Lbs
Weight (Full)	128 Lbs	62 Lbs

## 1.7 Power Information

LOX Container and the remote gauge require 10 to 24 VDC, less than 100 milliamp (1.2 Watts).

## 1.8 Properties of Liquid Oxygen

- Liquid oxygen is a pale blue, nonviscous, water like fluid. Liquid oxygen boils at -297°F (-183°C). At atmospheric pressure it is 1.14 times heavier than water and weighs 2.512 pounds per liter.
- Oxygen is a very reactive material, combining with most of the chemical elements. The union of oxygen with another substance is known as oxidation. Extremely rapid or spontaneous oxidation is known as combustion. While oxygen is non-combustible, it strongly supports and rapidly accelerates the combustion of all flammable materials, some to an explosive degree.
- Liquid oxygen, when converted to gaseous oxygen, expands to about 860 times its original volume. One cubic foot of liquid oxygen (at sea level pressure) expands to about 860 cubic feet of gas at 70°F (21°C) and sea level pressure.

## 1.9 Support Equipment

A list of support equipment recommended for use with the ALOX system is contained in Table 1.1.

**Table 1.1 Special Tools and Test Equipment List**

Tool/Equipment No.	Figure No.	Nomenclature	Use and Application
50C-0068-1	1.1	Purge Kit, Converter System, Liquid Oxygen	See Para. 4.6.2
50C-0059-10	N/A	Fill Kit, 10 Foot Hose	
50C-0059-15	N/A	Fill Kit, 15 Foot Hose	



**Figure 1.1. Purge Kit**

## 2.0 INSTALLATION AND PREPARATION FOR USE

### 2.1 Condition On Receipt

The ALOX System is shipped in a disposable shipping carton from the manufacturer. The system includes the fittings necessary for making connections in your ambulance. The ALOX system has been vented to atmospheric pressure and plugged prior to shipment.

### 2.2 External Surfaces

Upon receipt, remove the ALOX system from the shipping carton and thoroughly inspect the system for possible damage or contamination that may have occurred during shipment.

### 2.3 Inspection

Visually inspect the ALOX system for loose or damaged parts. Inspect the tank pressure gauge to ascertain that the ALOX system is empty. Verify that the supply and overboard vents are plugged.

## 2.4 Installation

Installing the ALOX system into the ambulance compartment.

- a. Only a trained professional should install the ALOX system.
- b. Any supply lines used with pressurized cylinder systems will work with the ALOX system. If a supply line or vent is not already installed in the ambulance, install them before installing the ALOX system. It is recommended that a shut off valve be installed between the supply outlet of the ALOX System and the supply line inside of the ambulance.

### **WARNING**

Ensure that all parts have been cleaned for oxygen service prior to connecting to the ALOX System.

- c. The pressure from the ALOX system is 50 psig  $\pm$  5 PSIG, the same as from cylinder pressure regulators. It requires no external pressure regulators for the supply line. Remove any existing pressure regulators from the supply line.
- d. Flow control devices required for patient care equipment can be used with the ALOX system with no special adjustments.
- e. Place the template on the floor of the compartment where the ALOX system is to be installed. The ALOX system requires ¼" clearance on all sides and 4" clearance on top to prevent damage to vent, supply and electrical connections.
- f. Mark the drill points. Remove template and drill (4) 9/32" diameter holes through the floor of the compartment.
- g. Slide lock washer onto ¼-20 x 2.00" bolt. Then place fender washer onto bolt. Slide mounting bolt with washers up through mounting hole in compartment floor. If the bolt is too short, replace it with a ¼-20 stainless steel bolt of the appropriate length.
- h. Place the ALOX system on the floor of the compartment and align the (4) holes in the bottom of the ALOX system with the (4) mounting holes in the compartment floor. Tighten the (4) bolts with washers into the ALOX system.

## 2.5 External Connections

Overboard vent tube, supply tube and electrical connections for the ALOX system.

- a. Remove the plug from the "OVERBOARD VENT" port on the top of the ALOX system. Wrap Teflon around the pipe threads of the male tube connector. Install and tighten the male connector into the "OVERBOARD VENT" port.
- b. Connect the vent tube to the male connector and tighten the nut on male connector to crimp ferrule onto the tube.

- c. Remove the plug from the “SUPPLY” port on the top of the ALOX system. Wrap Teflon around the pipe threads of the male DISS adapter fitting. Install and tighten the male DISS adapter fitting into the “SUPPLY” port.
- d. Connect the supply tube to the DISS fitting.
- e. After the LOX Container is mounted, connect the round plug (MS3116F8-4S from wire harness 10C-0040-0104) to the Electrical Receptacle on top. See figure 2.1.
- f. After Quantity Gauge is panel mounted, connect the square white plug (from wire harness) to the gauge. See figure 2.2.



**Figure 2.1**



**Figure 2.2**

- g. Connect the white wires together from the LOX Container wire harness to the Quantity Gauge wire harness.
- h. Connect the black wires from the two wire harnesses to -VDC.
- i. Connect the red wires from the LOX Container and the Gauge to a +12VDC, fuse protected circuit (limits; 1/4 to 5Amp).
- j. If additional wire lengths are needed, use like color and SAE J1128-GXL rated 20 AWG wire.

## **2.6 Leak Testing**

You will need a source of regulated high pressure medical grade gaseous oxygen, a fill kit and a bottle of leak detector for this procedure.

- a. Read fill kit instructions prior to performing this procedure.
- b. Connect the fill kit and a source of medical grade gaseous oxygen to the fill valve of the ALOX system.
- c. Apply leak detector on the fittings and tube connections of the “SUPPLY” port.



- d. Pressurize the ALOX system to 235 psig.
- e. If bubbles form on the fittings or tubes, repair or replace the fitting or connection. See table 2.1 for troubleshooting assistance.

**Table 2.1 Troubleshooting Leaks**

<b>Trouble</b>	<b>Probable Cause</b>	<b>Remedy</b>
Fitting does not seat properly.	There is debris in the threads.	Remove the debris from the threads and reseal the fitting while maintaining a minimum positive pressure in the ALOX System.
Fitting leaks during the pressure test.	The fitting is not tight enough.	Tighten the fitting and repeat the pressure test.
	The Teflon tape is not sealing the fitting properly.	Replace the Teflon tape and repeat the pressure test while maintaining a minimum positive pressure in the ALOX System.
	The fitting is cross-threaded.	Contact Essex for assistance and repairs.

- f. Repeat the test until no leaks are detected.
- g. The ALOX system can be filled with liquid oxygen. See paragraph 4.4, Filling Procedure.

### **3.0 PRINCIPLES OF OPERATION**

The system has the capacity to store liquid oxygen (LOX) and convert the LOX to a gaseous state. The gaseous oxygen is then delivered at a flow rate up to 100 LPM.

- a. The ALOX system is configured to be filled by externally accepting the female filler valve from the available fill kit. It is capable of storing up to either eight and one half liters or twenty-five liters of oxygen in the liquid state, depending on the model purchased.
- b. The LOX is converted to a gaseous form and the outlet pressure is maintained at approximately 50 PSIG. Heat exchangers are provided to elevate the gas temperature. To prevent a potentially hazardous situation from gas pressure buildup, two venting relief valves, set at 285 PSIG and 400 PSIG, and a nominal 750 PSIG burst disc are incorporated into the ALOX system.
- c. The pressure regulator lowers the gas pressure to a nominal 50 PSIG before it reaches the supply outlet located in the left rear corner of the top surface of the Container Assembly.
- d. The pressure gauge on the ALOX system continuously registers the liquid oxygen storage tank pressure. The contained LOX volume can be verified by the incorporated contents gauging system.

## 4.0 OPERATING INSTRUCTIONS

### 4.1 General

The instructions in this section are for information and guidance of the personnel responsible for operation of the ALOX System. The operator shall be completely familiar with, as well as know, the location and purpose of all operating controls and indicating instruments. All persons who operate the ALOX system shall be thoroughly familiar with the hazards of oxygen and the necessary safety precautions for the work assigned.

#### WARNING

- **Smoking** – Do not allow smoking or other sources of ignition within 50 feet of the ALOX system.
- **Absorbent Material** – Keep oxygen away from absorbent materials, loose clothing, or rags. These materials can trap gaseous oxygen and can later be easily ignited.
- **Hydrocarbons** – Keep the ALOX system, the surrounding work area, tools, associated equipment, and clothing as clean as possible and free from oil, grease, gasoline, kerosene, asphalt, and other hydrocarbons. Spontaneous ignition upon contact of oxygen with these substances may result.

### 4.2 Illustrations and Explanations

#### 4.2.1 ALOX System Components

The ALOX system combines the following items into a single unit: a liquid oxygen storage tank, heat exchangers, relief valves, pressure regulating valves, storage tank pressure gauge, LOX/gaseous oxygen quantity indicator, miscellaneous tubing and fittings, overboard vent port and supply port.

- a. Since this unit contains a vacuum insulated container, the following notice is applicable:

#### CAUTION

High Vacuum Container.  
Handle With Care

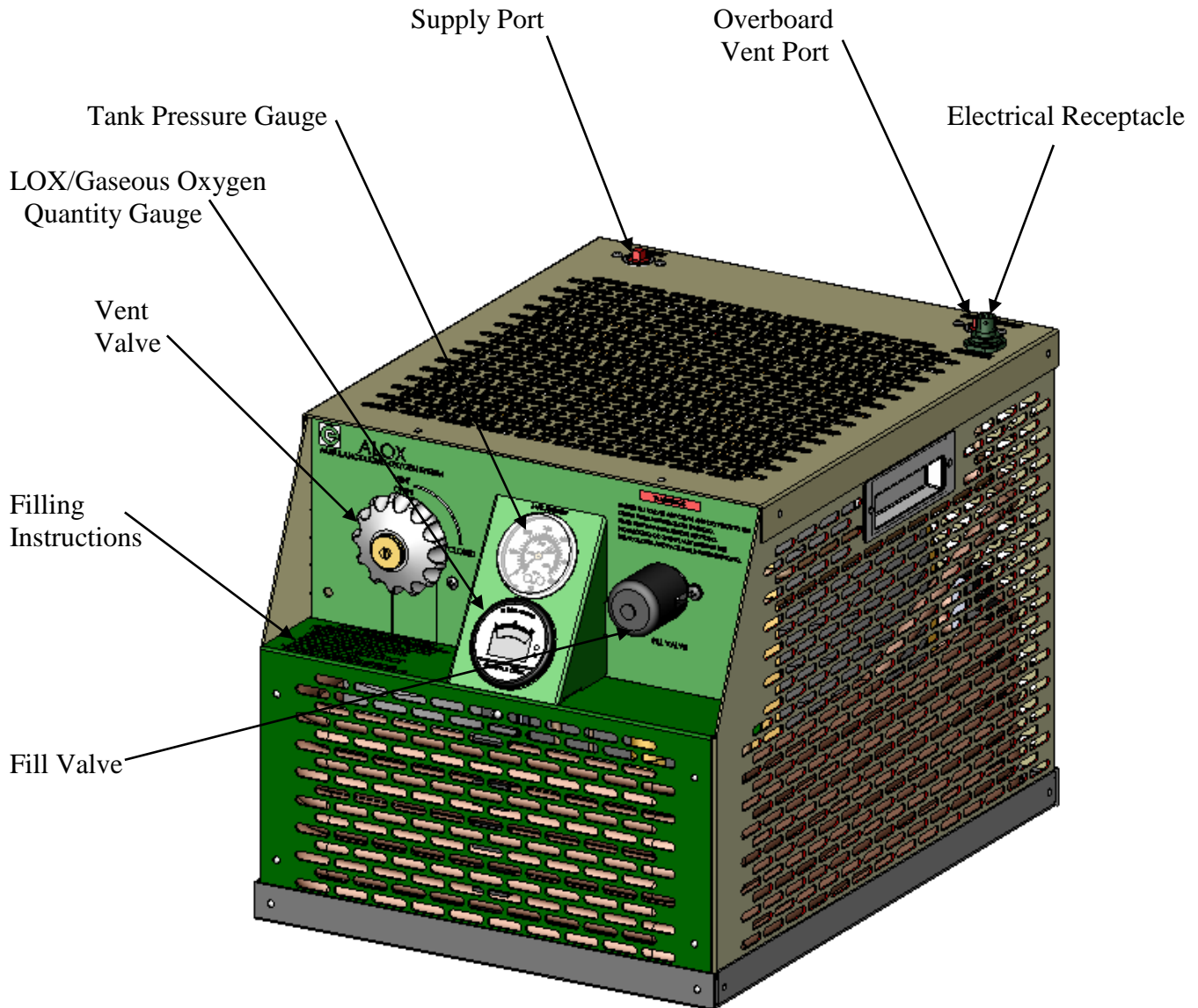
#### WARNING

Stand clear of the Overboard Vent Tube during filling.

- b. The liquid oxygen filling procedure is as outlined in paragraph 4.4. Observe the warning of "Overboard Vent" located above the fill valve on the front panel of the ALOX system.
- c. Install the ALOX system in accordance with the installation instruction provided in paragraph 2.5.

**CAUTION**

Keep the ALOX system fill valve capped at all times when the ALOX system is not being filled to prevent contamination entry.



**Figure 4.1. System Components (8.5 Liter Model)**

- d. Fill Valve – The fill valve connects the LOX storage tank to the fill source during the filling operation. The male half of the valve is installed in the ALOX system. The female half of the valve is included in the fill kit.
- e. Vent Valve – The vent valve is used to open and close the overboard vent during fill operations. Do not lubricate the vent valve. The valve should be a little stiff to operate.

- f. LOX Quantity Gauge - The LOX quantity indicator displays both a bar graph for 0% - 100% remaining and a numeric conversion of the liquid volume to gaseous liters of oxygen.
- g. Tank Pressure Gauge - The tank pressure gauge registers from 0 to 600 PSIG. This gauge displays the pressure of the LOX inside the storage tank. This gauge will continuously monitor the storage tank pressure.
- h. Supply Port – The supply port is connected to the ambulance supply line through the DISS adapter fitting supplied with the ALOX system.
- i. Overboard Vent Port – The overboard vent port is connected to the ambulance vent tube through the male connector fitting supplied with the ALOX system.
- j. Electrical Receptacle – The electrical receptacle is the interface to bring power into the ALOX system to power the LOX quantity sender assembly and the LOX quantity gauge. In addition it is also the interface to send the LOX quantity signal from the LOX quantity sender assembly to the quantity gauge mounted remotely in the ambulance.
- k. LOX Storage Tank (not shown) – The LOX storage tank stores the liquid oxygen. The quantity sender assembly connects to a probe in the storage tank to determine the liquid quantity level.

### 4.3 Scheduled Maintenance

The following procedures should be performed every four months or sooner if necessary.

#### 4.3.1 Warnings and Notes

- a. Those persons not directly involved in maintenance operations shall stay outside a 25-foot radius of the liquid oxygen servicing area. Servicing personnel will ensure that their hands, feet, clothing, etc., are clean and free of petroleum-based products.
- b. When transferring LOX, personnel authorized and/or trained to fill the converter with LOX should wear the following personal protective equipment:
  1. Protective face shield or goggles
  2. Leather work gloves or welders gauntlets with cotton or wool inserts
  3. Cuff-less trousers
  4. Long sleeve shirt or jacket
  5. Shoes which fit closely around the top, with rubber soles and heels.
  6. All items shall be clean and free of grease, oil, and fuel.

#### **WARNING**

- LOX will freeze and seriously damage human skin tissue upon contact.
- Do not allow LOX to contact petroleum products as fire or explosion may result.
- Personnel handling liquid oxygen must wear all required protective clothing and devices.

### **WARNING**

- Only personnel fully trained and qualified in handling and servicing liquid oxygen are authorized to service the ALOX System.
- No smoking or operation of any internal combustion engine, electrical motor, ground heater or open flame is permitted within 50 feet of the container assembly being serviced with oxygen.
- Stay clear of the liquid oxygen vents and/or openings during servicing.
- Stand to one side when disconnecting the liquid oxygen servicing transfer nozzle and/or hose to avoid possible liquid oxygen contact.

#### **4.3.2 Maintenance Instructions**

- a. Visual Inspection - Inspect the ALOX system for worn, loose or damaged parts.
- b. Purging – The ALOX system should be purged with hot, dry nitrogen. This is done to clear moisture from the system. See paragraph 4.6.2.

#### **4.4 Filling Procedure**

- a. Read the following special precautions and warnings on handling oxygen.

### **WARNING**

- Only personnel fully trained and qualified in the operation of the ALOX System are authorized to use this equipment.
- All safety precautions contained in pertinent directives will be observed at all times when using this equipment.
- Keep away from exposure to oil and grease. Do not handle oxygen with greasy hands or clothing. Do not let fittings, hoses, or any oxygen equipment come in contact with oil, grease, hydraulic fluid, asphalt, or dirt.
- Never allow the unit vent port to be obstructed. The vent port must remain open at all times.
- When oxygen equipment is in use, keep in a well-ventilated area away from all gasoline, kerosene, oil, grease, asphalt, and other hydrocarbons. These substances are not compatible with liquid or gaseous oxygen.
- Keep oxygen away from open flame. A small flame in the presence of oxygen can quickly flare up and become uncontrolled.
- Do not place the ALOX System where it may come in contact with petroleum products as fire and/or explosion may result.
- Do not fill unit or vent LOX on asphalt surface.

**Note:**

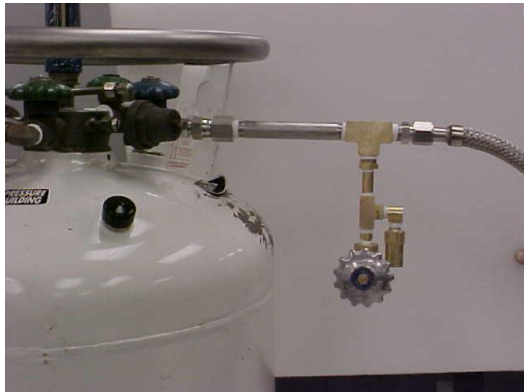
A hissing sound is normal when the Container Assembly is venting and should be no cause for concern.

- b. Remove the fill valve cap. Inspect the servicing and ALOX fill valves for contamination or moisture. Clean with a lint-free cloth, if necessary.

**Note:**

LOX source pressure should be 100-125 PSI.

The ALOX is filled with a standard LS-160 (capacity = 160 liquid liters) liquid cylinder available from most gas suppliers.



**Figure 4.2**



**Figure 4.3**

- c. Attach fill kit to liquid withdrawal line on the LS-160. Insure fill line drain valve is closed. Hook female filler valve to the ALOX fill valve by turning clockwise one-quarter turn.
- d. Open liquid withdrawal valve on the LS-160 and the vent valve on the ALOX System. If pressurized, vent ALOX tank to 20-30 psi less than the source filling pressure. Adjust vent valve to keep ALOX tank pressure 20 to 30 psi less than the source pressure while filling the ALOX System. Lines will frost before filling occurs.
- e. Fill the ALOX System until the quantity gauge indicates full. Close the ALOX vent valve and allow pressure to build until it equals the LOX source. Close liquid withdrawal valve on the LS-160.
- f. Disconnect the female filler valve from the ALOX System and recap the ALOX fill valve. **RELIEVE PRESSURE IN THE LOX SUPPLY LINE!**

#### **4.5 Liquid Oxygen Draining**

Bleed oxygen from the supply line until pressure and liquid are depleted.

## 4.6 Purging

### 4.6.1 Conditions of Purging

Purge shall be performed when any of the following conditions occur:

- a. Prior to storage.
- b. When the unit has become empty and has warmed to ambient temperature.
- c. Every four months per maintenance schedule.

### 4.6.2 Purging Instructions

To purge the Container Assembly proceed as follows:

#### **WARNING**

Only gaseous nitrogen conforming to federal specification A-A-59503, Type I, Grades A or B, Class 1 will be used as a source for purging.

#### **WARNING**

While operating purging unit, protective gloves must be worn by the operator. Discharge fittings can reach temperature that will cause severe burns if grasped with bare hands.

- a. Ascertain the Container Assembly has been drained as described in paragraph 4.5 or has been completely emptied of LOX during use.
- b. Purge Kit, Essex P/N 50C-0068-1. Figure 4.3 shows a typical setup for the purge kit.



**Figure 4.3 Purge Kit Setup**

- c. With the Container Assembly and a purge heater positioned on a clean work area, connect the approved nitrogen source product, equipped with a shutoff valve and regulator capable of controlling the source pressure from 50 to 100 PSIG, to the inlet of the purge heater.
- d. Using the female filler adapter provided with the purge kit, connect the outlet of the purge heater to the fill valve of the ALOX system. Plug the power cable from the purge heater into an electrical outlet providing a source of 115 volts AC.
- e. Open the gaseous nitrogen source shutoff valve and adjust the source inlet pressure to approximately 55 PSIG. Open the vent valve on the front of the ALOX system. Turn the purge heater power switch on. Purging gas should begin to exhaust from the overboard vent of the ambulance.

**Note:**

Place your hand within the exhaust stream coming from the vent port to determine whether the exhaust temperature is slightly above the surrounding air temperature.

- f. Continue to hot purge for a minimum of 45 minutes until the exhaust temperature is slightly above ambient temperature.
- g. Turn the purge heater off and cold purge for at least 15 minutes.
- h. Ascertain that the exhaust temperature at the vent port is equal to or slightly below ambient temperature. If not, additional cold purging will be required.
- i. Close the vent valve on the front of the ALOX System.
- j. Disconnect the purge heater filler adapter from the ALOX System fill port, trapping pressure inside the system.
- k. Turn the purging source off, then disconnect and properly store all purging appliances.
- l. Make sure the dust cap has been put on the Fill Valve of the ALOX System.
- m. If the ALOX System is being placed in storage, plug the supply and overboard vent ports to prevent contamination of ALOX System.



## 5.0 TROUBLESHOOTING

The following table is a listing of possible troubles that may be encountered during operation, the possible cause, and the recommended remedies that must be taken to isolate and correct the trouble.

**Table 5.1 ALOX System Troubleshooting Procedures**

<b>Trouble</b>	<b>Probable Cause</b>	<b>Remedy</b>
The vent or fill valve will not open/close.	Moisture may have frozen in a valve.	Disconnect the service line from the ALOX system and allow the valves to warm up for 5 to 10 minutes. If this fails to resolve problem contact Essex for assistance and repairs.
Unit will not fill.	Filling pressure is too low.	Increase pressure 30 psig once at service line source. If this fails to resolve problem contact Essex for assistance and repairs.
	Restricted internal line.	Contact Essex for assistance and repairs.
Oxygen supply is consumed too quickly or there is low operating pressure.	Tank not completely filled during filling procedure.	Refill the unit. If this fails to resolve problem contact Essex for assistance and repairs.
	There is a leak in the system that allowed the contents to escape.	Contact Essex for assistance and repairs.
The remote quantity gauge is not accurate.	A worn wire caused a malfunction in the gauge reading.	Contact Essex for assistance and repairs.
	The gauge or probe has malfunctioned.	
Decrease in oxygen flow.	A leak or constriction in the oxygen supply line.	Contact Essex for assistance and repairs.
	Liquid oxygen not at 70 psig or higher.	
Frost collects on the outside of the ALOX system.	A leak on the inside of the ALOX system.	Contact Essex for assistance and repairs.
Service line cannot be disconnected from the fill valve.	Service line is frozen to the fill valve.	Close supply tank service valve and allow the fill valve and service line to warm up.
Undesirable odors or moisture.	The main tank is contaminated.	Drain System and purge with warm nitrogen. Refill the ALOX system.

## 6.0 PARTS LIST

## 6.1 Parts List

<b>Tool/Equipment No.</b>	<b>Nomenclature</b>
LS-160	Liquid Oxygen Cylinder with 100-125 psig relief valve
50C-0059-10	Fill Kit with 10 Foot Hose
50C-0059-15	Fill Kit with 15 Foot Hose
50C-0058-3	Fill Manifold (included in fill kit)
20C-0070-2	Female Fill Valve (included in fill kit)
50C-0084-10	Fill Hose, 10 Foot (included in fill kit)
50C-0084-15	Fill Hose, 15 Foot (included in fill kit)
50C-0068-1	Purge Kit

## 7.0 LIMITED WARRANTY

Essex Industries (hereinafter referred to as Seller) warrants the Ambulance LOX System (ALOX) System will be free from defects in workmanship and materials for a period of one (1) year on parts, labor and vacuum integrity from the date of acceptance by the Ambulance Operator.

Buyer's exclusive remedy for breach of this warranty shall be the repair or replacement at Seller's option and expense, of any product or component part thereof that is proven to be other than as herein warranted.

Surface transportation charges covering any defective product or component, shall be at Seller's expense; however, transportation charges covering any product or component part returned and redelivered which proves not to be defective shall be at Buyer's expense.

This warranty does not extend to any Seller product or component part thereof which has been subjected to misuse, accident, or improper installation, maintenance, or application; or to any product part thereof which has been repaired or altered outside of Seller's facilities unless authorized in writing by Seller, or unless such installation, repair or alteration is performed by Seller, or repair facility authorized by Seller. Any repaired or replacement product or component part thereof provided by Seller under this warranty shall, upon delivery to the Buyer, be warranted for a period of ninety (90) days on parts and labor and one (1) year on vacuum integrity from return of item.

**THIS WARRANTY IS IN LIEU OF AND EXCLUDES ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, ARISING BY OPERATION OF LAW OR OTHERWISE AND WHETHER RELATED TO MERCHANTABILITY, FITNESS FOR PARTICULAR OR INTENDED PURPOSE OR OTHERWISE AND IN NO EVENT SHALL SELLER BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.**

**Limits of Liability:**

*Seller shall not under any circumstances be liable for any damages greater than the cost of the articles sold hereunder, including general, special, incidental, or consequential damages, whether arising from Seller's breach of contract, breach of expressed or implied warranty, or law giving rise to strict liability, or any other cause.*



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