



## Liquid Oxygen (LOX) Frequently Ask Questions (FAQ)



### **What exactly is LOX?**

LOX stands for Liquid Oxygen. LOX is a pale blue, nonviscous, water like fluid that boils at -297°F. At atmospheric pressure, it is 1.14 times heavier than water and weighs 2.5123 pounds per liter.

LOX, when converted to gaseous oxygen, at 70°F, expands to approximately 860 times its original volume. So one liter of LOX expands to about 860 liters of gas. Liquid to gas expansion at atmospheric pressure is shown below.

<b>L i q u i d O x y g e n a t - 2 9 7 ° F ( - 1 8 3 ° C )</b>	<b>G a s e o u s O x y g e n a t 7 0 ° F ( 2 1 ° C )</b>
1 l i t e r	8 6 0 l i t e r s
5 l i t e r s	4 , 3 0 0 l i t e r s
1 0 l i t e r s	8 , 6 0 0 l i t e r s
1 5 l i t e r s	1 2 , 9 0 0 l i t e r s
2 5 l i t e r s	2 1 , 5 0 0 l i t e r s
5 0 l i t e r s	4 3 , 0 0 0 l i t e r s
7 5 l i t e r s	6 4 , 5 0 0 l i t e r s

### **Where would I get LOX?**

Almost every hospital in the United States stores their oxygen in liquid form. For this reason, companies such as Airgas, Air Liquide, Praxair, BOC and others manufacture LOX all over the United States. All local gas suppliers, be it for medical, home health care, industrial, welding, etc., also store their oxygen in liquid form and then convert it to gas for filling high pressure cylinders.

By contacting either a major manufacturer of LOX or local supplier of gases, a source of LOX can be found. Almost all suppliers will either deliver a LOX storage tank to your site (which you would fill the Essex LOX system from) or will bring a LOX truck to your location and fill your systems as needed. We will be happy to help in locating a suitable LOX source for your location.

### **What does LOX cost as compared to High Pressure gas?**

Because all oxygen is first created in liquid form, LOX is invariably cheaper than high-pressure oxygen gas. In order to get high-pressure oxygen gas, the LOX has to be converted to gas and then pressurized to fill the high-pressure cylinders. For these reasons, LOX will provide more gaseous oxygen at a lower price for the user if the LOX is supplied and then converted to gas on demand.

As mentioned in "where would I get LOX", all local gas suppliers store their oxygen in liquid form. Therefore, a source of LOX can easily be found.

A word of caution, because gas suppliers make considerable \$ by renting and/or refilling high-pressure cylinders, they may show reluctance to want to supply LOX. However, armed with the knowledge in the FAQ, it should be relatively easy to convince them to be your LOX supplier, or you may just get it from someone else.



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### **What are the advantages of LOX?**

The main advantage of LOX is that for every liter of LOX, you have 860 gaseous liters of oxygen gas. Therefore, it is possible to store large quantities of gas in a small package, when stored as LOX, as compared to the high-pressure alternative.

Another advantage for the Essex ground ambulance system is that it is mounted and filled in the ambulance. This prevents the need to remove heavy high-pressure cylinders, thus reducing Workman's Compensation claims due to injuries from handling heavy cylinders.

The Essex LOX systems are low pressure (300 psi max) as compared to high-pressure cylinders. Low-pressure systems are invariably safer than high-pressure, especially where oxygen is involved.

The compact size of LOX systems, as compared to equivalent high-pressure volume, allows for less space requirements in ambulances or other vehicles, where storage space is usually at a premium.

The weight of a LOX system is much less than the high-pressure cylinders required to hold the equivalent amount of gaseous oxygen.

With Essex LOX systems, almost all of the LOX can be used. As long as there is pressure in the LOX system, oxygen gas will be supplied. This is not the case with high-pressure cylinders, since they are removed from service once they reach a minimum pressure. The user then does not get to use all that he paid for, and then pays for it again when the cylinder gets re-filled.

### **What are the disadvantages of LOX?**

There is only one disadvantage of LOX as compared to high-pressure gas alternatives. Because LOX is a cryogen and has to remain at  $-297^{\circ}\text{F}$  in order to stay a liquid, the LOX in any storage vessel (or dewar) will slowly boil off and have to be released through a vent line. This is normally referred to as the Normal Evaporation Rate or NER. Essex designs and builds some of the most rugged and lowest NER dewars in the market.

However, if the system is used on a daily basis, or very near to a daily basis, the loss of oxygen, due to boil off, would be minimal, since the oxygen is being used for patient breathing.

Based on the weekly use of oxygen, a relatively easy calculation could be performed to help determine if the overall cost of using LOX would be cheaper than the high-pressure alternative. In almost all cases, the cost for LOX is less expensive.

### **How rugged are Essex LOX systems?**

Essex prides itself on building the most rugged LOX systems for the ground ambulance and commercial industry. Essex has been building military LOX systems since 1963, and had taken the knowledge of what it takes to survive in adverse environments, and applies this to the design of our ground ambulance and mass incident response LOX systems.

Our ground ambulance systems exceed the KKK-A-1822E specification for ground ambulances. In addition, the Essex LOX systems have been tested for vibration, shock, acceleration, and crash loads.



## **Liquid Oxygen (LOX) Frequently Ask Questions (FAQ)**



### **Are there any special training requirements?**

Because the Essex LOX systems automatically convert the LOX to a gas, on demand, the administration of oxygen does not change for the user. The source of all oxygen gas in a hospital is from a liquid source, thus hospitals recognize LOX as the standard for medical oxygen.

When converting an ambulance from high-pressure to LOX, no interior tubing changes are required. Existing flow meters and wall outlets are used.

Filling the LOX system from a LOX storage dewar is simple. It could be compared to fueling a vehicle. Fill times are usually minimal. A short training session is usually all that is required to become proficient on filling a LOX system.

### **Are there any special maintenance or safety requirements for LOX?**

With the Essex LOX systems, no periodic hydrostatic re-certification is required. Our systems are virtually maintenance free and no scheduled maintenance is necessary. Essex has technical service personnel available to answer any questions that arise when the systems are being used in the field. A resolution to any question is usually easily found, and if not, either a technician will visit or we will arrange for the unit to be returned to Essex for evaluation and a loaner would be available to prevent the ambulance from being out of service. Most users also normally have at least one or two systems available for backup on site.

The Essex LOX systems have redundant safety devices which prevents the system from having any catastrophic failures if the system develops a higher than normal NER.

The only safety equipment needed for the Essex LOX system is during the filling of the unit. Because the filling process requires the transfer of LOX from the storage dewar into the LOX system, cryogenic gloves and eye protection is required. Also long pants and sleeves (or full length cryogenic gloves) are also required, in case of a LOX spill. Further information and training can be provided to potential users either on-site or at the Essex headquarters.

### **How do I justify the purchase of a LOX system?**

Besides the long-term benefit of reduced costs associated with oxygen gas as well as all the other benefits, Essex LOX systems support several of the Department of Homeland Security Target Capabilities in the Target Capabilities List (TCL). Specific TCL's supported are Triage and Pre-hospital Treatment, Medical Surge, and Mass Care. In addition, the Essex LOX systems also fall under the section on Medical Supplies and Pharmaceuticals under the Oxygen Administration Equipment and supplies category of the Federal Authorized Equipment List..

### **Do I need to buy anything special or additional equipment if we order an MODS-75 device?**

The only additional equipment required is a fill harness assembly that is needed for attachment to the fill source for the MODS-75. Both 10-foot and 15-foot versions are available.

### **Will there be any specialized training for operating and/or maintaining the system?**

Even though the manual supplied with the MODS is self explanatory, upon customer request, we usually provide either on-site or at Essex training for new users.



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### **Can I use a liquid system to drive my vent, Thumper or suction devices?**

Yes, the Patient Distribution Kits provides 50-psi gas up to 150 LPM flow and will provide adequate gas pressure for ventilators, thumpers and other devices.

### **How will I get the system repaired or serviced if there is a problem?**

Some troubleshooting can be accomplished on the ambulance and Essex customer service technicians are available for consultation. If the problem cannot be solved remotely, we can arrange for either the unit to be sent to Essex for evaluation and repair. Most users have a spare system available to replace the unit sent in for repair. Our service technicians are also available to travel to the customer site.

### **Is there a way to contact a current user for feedback on their experience?**

Yes, Essex would be more than happy to provide references for contacting current users of our systems.

### **Will the MODS-75 system require regular DOT or hydrostatic testing like the gas cylinders do now?**

Because the MODS-75 is a low-pressure system, periodic hydrostatic testing is not required.

### **What temperature is the oxygen gas being administered to the patient?**

The temperature of the gas at the outlet of the ALOX is within 20 deg of ambient temperature, which is already safe for breathing. Once the gas travels through the lines in the ambulance, or additional hose assemblies, the temperature of the gas is most likely at the ambient temperature within the ambulance.

### **How long will the MODS last in operation?**

Every user may have a different scenario of number of patients and amount of flow. The MODS holds 64,000 gaseous liters and with the additional capability of attaching commercial dewars, such as VGL's, the duration of the MODS can be extended indefinitely. The following charts may help in a better understanding of duration versus various patient scenarios.



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**MODS-75 Longevity Matrices (no additional VGL)**

Scenario One			
50 patients breathing 5 LPM			
# Patients	LPM	Total Flow (LPM)	Duration (Hours) of MODS without VGLs
50	5	250	4.27

Scenario Two			
60 patients at various flow levels			
# Patients	LPM	Total Flow (LPM)	Duration (Hours) of MODS without VGLs
10	15		
25	5		
15	2		
		305	3.50

Scenario Three			
50 patients at various flow levels			
# Patients	LPM	Total Flow (LPM)	Duration (Hours) of MODS without VGLs
10	15		
30	7		
10	2		
		380	2.81

Scenario Four			
75 patients at various flow levels			
# Patients	LPM	Total Flow (LPM)	Duration (Hours) of MODS without VGLs
15	15		
30	5		
30	2		
		435	2.45



Liquid Oxygen (LOX) Frequently Ask Questions (FAQ)



**MODS-75 Longevity Matrices with 2 Additional VGLs**

Scenario One				Scenario Two			
<b>50 patients breathing 5 LPM</b>				<b>60 patients at various flow levels</b>			
# Patients	LPM	Total Flow (LPM)	Duration (Hours) of MODS with 2 VGLs	# Patients	LPM	Total Flow (LPM)	Duration (Hours) of MODS with 2 VGLs
50	5	250	26.00	10	15		
				25	5		
				15	2		
						305	21.31
Scenario Three				Scenario Four			
<b>50 patients at various flow levels</b>				<b>75 patients at various flow levels</b>			
# Patients	LPM	Total Flow (LPM)	Duration (Hours) of MODS with 2 VGLs	# Patients	LPM	Total Flow (LPM)	Duration (Hours) of MODS with 2 VGLs
10	15			15	15		
30	7			30	5		
10	2			30	2		
		380	17.11			435	14.94