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<b>Liquid Oxygen (LOX) Storage and Safety in Transfilling</b> Formulated: 09/01	<b>Effective:</b> 09/11/01 <b>Revised:</b> 01/31/12

## Liquid Oxygen (LOX) Storage, Safety & Usage

**Purpose** To outline the liquid oxygen storage, delivery and responsibilities of LOX oxygen containers and adjunctive transport equipment and requirements for the bulk LOX oxygen system.

**Scope** Guidelines for the storage, delivery and usage of the bulk LOX oxygen system and transporters.

**Audience** Respiratory Care Services employees, hospital employees who provide oxygen therapy during patient transit.

### Procedure

Step	Action
1	<p><b>Bulk LOX 180 Liter Storage</b></p> <ul style="list-style-type: none"> <li>• The Pulmonary Care Services bulk LOX storage is located in the Medical Gas cage above ground and out of doors.</li> <li>• The locations are such that containers and associated equipment are not exposed near electrical power lines, flammable or combustible liquid lines or flammable gas lines.</li> <li>• The units are located so that automobiles and other vehicles cannot damage them.</li> <li>• The units are not located over sewers, open drains, gas lines or underneath electrical lines.</li> </ul>
2	<p><b>In-House LOX Storage of 40 Liter Containers</b></p> <ul style="list-style-type: none"> <li>• A LOX storage room will have a one-hour fire resistance rating.</li> <li>• It will be vented to the outside of the building.</li> <li>• The room will not open directly into locations where combustible anesthesia gases are used or stored.</li> <li>• Combustible materials and petroleum based materials such as oil, alcohol, paint, ether, ethylene or cyclopropane will not be stored in the same room with LOX.</li> </ul>
3	<p>Liquid Oxygen transfill supplies (paper towels, ear plugs) are permitted.</p> <ul style="list-style-type: none"> <li>• Smoking and all other sources of ignition are prohibited in the area.</li> <li>• LOX containers will not be stored near sources of heat such as boilers, furnaces, steam pipes or radiators.</li> </ul>

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Step	Action
4	<p><b>Handling LOX Containers</b></p> <ul style="list-style-type: none"> <li>• LOX Stationary unit valves will be kept closed even when the container is considered empty.</li> <li>• When LOX containers are used within the hospital; securely station them in the appropriate liquid oxygen truck</li> </ul>
5	<p><b>Transfilling of Liquid Oxygen Stationary Units</b></p> <ul style="list-style-type: none"> <li>• Be sure that your hands or gloves are clean and free of oil or grease before you touch any oxygen apparatus.</li> </ul>
6	<p><b>LOX 40 Liter Controls, Indicators &amp; Connectors, Vent Valve</b></p> <p>The vent valve is a quarter turn ball valve that is accessible with a vent key through the top cover. This valve is opened to vent the inner container during the Stationary unit filling process. The valve is closed upon terminating the filling process.</p> <p><b>Fill Connector(s).</b></p> <p>The Nellcor Puritan Bennett (NPB) fill connector used on the <i>Companion</i> Stationary unit is a quick connect coupling used to transfer liquid oxygen to and from the Stationary unit. The side-fill connector used on the Dual- Fill models, serves the same purpose, but allows the transfer of liquid oxygen through an alternate source.</p> <p><b>Release Button</b></p> <p>Pressing the release button on the <i>Companion</i> Stationary unit activates the fill connector release lever mechanism for the Nellcor Puritan Bennett fill connector. This disengages either a portable oxygen unit or a transfer line from the Stationary unit.</p> <p><b>Filling Instructions</b></p> <p>If a <i>Companion</i> Stationary fails a part of this procedure that is vital to the function of the unit, make the necessary repairs before placing the unit in service.</p> <p><b>OXYGEN REQUIREMENTS</b></p> <p>Use only U.S.P. Medical Oxygen to fill a <i>Companion</i> Stationary unit. The oxygen used for filling should have no moisture content. This requirement is the responsibility of the supplier.</p>

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<b>Step</b>	<b>Action</b>
7 Continued	<p><b>TRANSFER LINE</b></p> <p>The standard Nellcor Puritan Bennett transfer line is shown in <b>Figure 1-8</b>. A transfer line with both a Nellcor Puritan Bennett and a side fill adapter is also shown in <b>Figure 1-8</b>. The side fill adapter is not available from Nellcor Puritan Bennett. However, a universal adapter kit that attaches most side fill adapters to the transfer line is available.</p> <p><b>FILLING LOSSES</b></p> <p>The filling procedure results in some loss of oxygen for the following reasons:</p> <ol style="list-style-type: none"> <li>1. Vaporization that is inherent in the process of cooling the metal parts of the source vessel, the transfer line and the <i>Companion</i> Stationary unit</li> <li>2. Gaseous oxygen venting during the fill</li> <li>3. Saturation losses</li> </ol> <p><b>PRE-FILL INSPECTION PROCEDURE</b></p> <ol style="list-style-type: none"> <li>1. Ask the user if there are any questions or concerns regarding the equipment since your last visit.</li> <li>2. Visually inspect Stationary for overall product integrity (Cracked or damaged components).</li> <li>3. Verify all labels are present and legible on the unit. (<b>Figure 1-9</b>)</li> <li>4. Verify that there is no frost or heavy condensation on the container below the shroud and no excessive venting from the relief valve. (Some venting from relief valve is normal.)</li> <li>5. Verify the LOX content level is consistent with the delivery schedule and expected patient usage.</li> <li>6. Verify the fill connector/s (Top and/or Side) are not worn, leaking or damaged. Verify the release lever mechanism for the top fill works.</li> <li>7. Verify the vent valve stops are not bent or broken.</li> </ol>
8	Verify the contents indicator or contents base scale is operational and reads full at the end of the filling procedure. (If Applicable)

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Step	Action
8 Continued	<p>Verify the condensate drain spout is functional.</p> <p>Continuously adjust the liquid valve throughout the fill to maintain the needle on the attached pressure gauge between 18-20 psig (124-138 kPa).</p> <p><b>NOTE:</b> It may be necessary to open the liquid withdraw valve completely, and throttle the <i>Companion</i> vent valve back to maintain the proper pressure during the fill.</p> <p><b>NOTE:</b> At this point a vigorous audible venting noise will confirm that the filling process has started.</p> <ol style="list-style-type: none"> <li>Close and reopen the vent valve on the Stationary unit when 45 to 60 seconds have passed. This will minimize the possibility of the vent valve freezing in the open position.</li> </ol> <p><b>NOTE:</b> As the level of liquid oxygen in the unit nears the top of the inner container, the sound and appearance of the escaping vapors will change. The vapor will become denser, and as liquid oxygen reaches the vent valve, a discharge of liquid oxygen will be seen and heard.</p> <p><b>NOTE:</b> The first discharge of liquid oxygen observed usually results from turbulence inside the container and does not necessarily indicate that the unit is full. To insure a complete fill, continue filling until a steady stream of liquid oxygen is observed.</p> <ol style="list-style-type: none"> <li>When a steady stream of liquid oxygen is observed exiting the vent valve, close the vent valve immediately by rotating the vent key 1/4 turn clockwise. Simultaneously, disconnect the transfer line as follows:  Nellcor Puritan Bennett fill connector: Depress the release button and remove the transfer line.</li> </ol>

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Step	Action
8 Continued	<p><b>WARNING</b></p> <p>Extreme cold hazard. Liquid oxygen discharge from fill connector can occur. Never stand directly over, or in front of, fill connector when disconnecting transfer line. Open vent valve to stop release of liquid oxygen.</p> <p><b>NOTE:</b></p> <p>If the vent valve freezes in the open position, terminate filling by disconnecting the fill connector and allowing the vent valve to warm until it closes easily. If the vent valve remains open for a period of time, the liquid oxygen in the unit will desaturate to a pressure lower than required. If this occurs, refer to the vent valve, close the vent valve immediately by rotating the Resaturating Liquid Oxygen.</p> <p>3. Close the source vessel liquid valve and replace the fill connector cover, if applicable, on the Stationary unit.</p> <p><b>NOTE:</b></p> <p>Closing the liquid valve on the source vessel immediately following a fill may trap liquid oxygen in the transfer line. This will cause pressure to build in the transfer line and may cause the relief valve to vent.</p> <p><b>TESTING</b></p> <ul style="list-style-type: none"> <li>• Verify that the Stationary unit pressure is 18.5-25 psig (128-172 kPa).</li> <li>• Connect a test flow meter to the oxygen outlet of the Stationary, and check the patient's prescribed flow setting(s).</li> </ul> <p><b>NOTE:</b></p> <p>If system is at relief valve pressure (20.5-25 psig/144-172 kPa) flows may be slightly high. You may vent the system to bring the pressure down to the operating pressure (18.5-20.5 psig/128-144 kPa) and then test flows.</p>

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Step	Action
8 Continued	<p><b>Determining Saturation Pressure</b></p> <p>Perform the procedure listed below to determine the saturation point of liquid oxygen in a <i>Companion</i> Stationary unit. The saturation point cannot be determined by simply taking a pressure reading on the unit.</p> <p><b>Determining Saturation Pressure</b></p> <p>Perform the procedure listed below to determine the saturation point of liquid oxygen in a <i>Companion</i> Stationary unit. The saturation point cannot be determined by simply taking a pressure reading on the unit.</p> <p><b>PROCEDURE</b></p> <ol style="list-style-type: none"> <li>1. Connect either the pressurizing fixture (Figure 1-13) to the fill connector or a pressure gauge to the humidifier adapter on the <i>Companion</i> Stationary unit.</li> <li>2. Momentarily open the Stationary vent valve and observe the needle of the gauge drop.</li> <li>3. Note where the needle of the gauge hovers, and shut the vent valve. This is the approximate saturation pressure of the Stationary unit. Readings between 18.5-25.0 psig (128-172 kPa) are in the acceptable operating range of the unit. Readings below 18.5 psig (128 kPa) are not usually considered normal, but may be acceptable if there is no immediate patient flow required on the unit.</li> <li>4. Perform the Resaturating Liquid Oxygen procedure on an as needed basis according to the information provided.</li> </ol> <p><b>NOTE:</b></p> <p>Readings above 25.0 psig are not considered normal. This is usually a result of the liquid being over saturated. Open the vent valve until the needle of the pressure gauge reads between 18.5-25.0 psig (128- 172 kPa) and then close the vent valve</p>

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Step	Action
9	<p><b>Resaturating Liquid Oxygen</b></p> <p>If the <i>Companion</i> Stationary unit loses its saturation pressure and the cause of this condition is corrected without emptying the liquid contents, the saturation may be restored by any of the three following methods. The simplest way to restore saturation (Method 1) is to simply allow the unit to stand in normal room conditions for a specified amount of time. The entire volume of liquid will usually regain proper saturation within 48 hours. If however this is not a reasonable option, the liquid may be resaturated by either of the following methods.</p> <p><b>Resaturating Liquid (Method 2)</b></p> <ol style="list-style-type: none"> <li>1. Attach the source adapter of the transfer line assembly to either the gas withdrawal or vent valve on the source vessel.</li> <li>2. Attach the pressure gauge (Figure 1-10) to the humidifier adapter and set the flow control valve to the highest setting.</li> <li>3. Engage the transfer line fill adapter to the Stationary fill connector by aligning the fill adapter over the fill connector and applying approximately 20 lbs. of downward force.</li> <li>4. Partially open the vent or gas withdraw valve on the source vessel, and slowly adjust the valve open as far as possible without blowing open the Stationary primary relief valve. Be sure to leave the Stationary vent valve closed.</li> </ol> <p><b>NOTE:</b></p> <p>If there is immediate noticeable audible venting of the Stationary primary relief valve, start to close the vent or gas withdraw valve until the relief valve on the Stationary closes.</p> <ol style="list-style-type: none"> <li>5. When the attached pressure gauge reads 18.5-20.5 psig (128-141 kPa) and relief valve venting is heard, shut off the gaseous oxygen supply to the unit.</li> <li>6. Recheck the saturation pressure as described on the previous page. Repeat the resaturation procedure until the liquid is saturated.</li> </ol>

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Step	Action
9 Continued	<p><b>Resaturating Liquid -(Method 3- Use Only U.S.P. Oxygen)</b></p> <p><b>NOTE:</b></p> <p>Check regulations for oxygen traceability requirements when using this method.</p> <ol style="list-style-type: none"> <li>1. Attach the pressurizing fixture to the Stationary unit by means of the hold-down strap. Attach an adjustable 0-50 psig (0-345 kPa) source of gaseous U.S.P. oxygen to the DISS (Diameter Index Safety System) oxygen inlet connection on the fixture.</li> <li>2. Partially open the gaseous oxygen source tank valve, and slowly adjust the pressure regulator to as high a pressure possible without blowing open the Stationary primary relief valve. Be sure to leave the Stationary vent valve closed.</li> </ol> <p><b>NOTE:</b></p> <p>If there is immediate noticeable audible venting of the primary relief valve, reduce the regulator pressure on the gaseous oxygen supply until the relief valve closes.</p> <ol style="list-style-type: none"> <li>3. When the gauge on the pressurizing fixture reads 18.5-20.5 psig (128-141 kPa) and relief valve venting is heard, shut off the gaseous oxygen supply to the unit.</li> <li>4. Recheck the saturation pressure as described above. Repeat the resaturation procedure until the liquid is saturated.</li> </ol> <p><b>ROUTINE MAINTENANCE</b></p> <p>Routine Maintenance for the <i>Companion</i> Stationary is built into the filling procedure. When all steps of the filling procedure are performed properly there is no additional routine maintenance required. It is however important to remember that if a <i>Companion</i> Stationary fails a part of the filling procedure that is vital to the function of the unit, make the necessary repairs before placing the unit in service.</p>

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Step	Action
10	<p><b>CALIBRATION OF TEST EQUIPMENT</b></p> <p>Perform periodic calibration checks of test equipment (pressure gauges, weight scales, flow meters etc.) to ensure the reliable operation of your <i>Companion</i> Stationary unit. Perform these checks at intervals based on your previous experience calibrating that particular piece of test equipment. If the piece of test equipment is new you may use a default of every 6 months. However, if the test equipment sees an unusually high usage rate, you may want to consider checking it once a month. Once you have begun using the piece of test equipment you may adjust the calibration schedule. If for example you start out calibrating your filling pressure gauge every 6 months and it is repeatedly out of calibration when you check it, you may want to adjust the schedule to every 3 months. You should reach an interval where your equipment is in calibration every time it is checked. Always perform a calibration check on a piece of test equipment that has been dropped or mishandled before using it on a <i>Companion</i> Stationary unit.</p> <p><b>FILLING INSTRUCTIONS FOR THE COMPANION T:</b></p> <ol style="list-style-type: none"> <li>1. Remove moisture cup by rotating thumbnut 1/4 turn counter-clockwise. Wring out moisture pad held with velcro.</li> <li>2. Using a clean, dry, lint-free cloth or paper towel, dry male and female fill connectors</li> <li>3. Check Companion stationary unit contents indicator to verify that there is an ample supply of liquid for filling.</li> <li>4. Place Companion T into recess of stationary unit taking care to align fill connectors. Depress Companion T approximately 3/8" downward after initial engagement.</li> <li>5. Hold unit down and open vent valve.</li> </ol> <p><b>IMPORTANT:</b></p> <p>After 30-40 seconds close and reopen vent valve to break up any ice that may have begun to form around valve stem.</p> <ol style="list-style-type: none"> <li>6. When there is a noticeable change in the sound of venting gas, followed by the emission of a dense, white vapor, close vent valve.</li> </ol>

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<b>Step</b>	<b>Action</b>																														
10 Continued	<p><b>NOTE:</b> Should vent valve fail to close, remove unit and allow it to sit until vent valve closes and seals properly (10-15 minutes). A period of 2-3 hours at no flow may be required to allow it to restore adequate pressure for accurate flow rates.</p> <p>7. Disengage Companion T by lifting shoulder strap and depressing release button. If units have become frozen together, it may be necessary to use a rather sharp downward force on release button.</p> <p><b>NOTE:</b> Should liquid oxygen leakage occur when transport is disengaged, proceed to re-engage and disengage the unit. This will help dislodge any ice or other obstruction.</p> <p>8. Check Companion T contents gauge by lifting strap nearest gauge.</p> <p>9. Attach moisture cup by inserting fastener and rotating thumbnut clockwise until it snaps into position at the desired rate.</p> <p>10. Place oxygen tube on the "adaptor" and turn flow controller</p>																														
11	<p>Before delivering an oxygen cylinders to a patient's room, calculate the duration of gas available with the following guide:</p> <p><b>LIQUID OXYGEN</b></p> <p>Length of time (hours) At a given flow rate</p> <table border="1"> <thead> <tr> <th><b>Flow Rate</b></th> <th><b>Time (Hours)</b></th> <th><b>Flow Rate</b></th> <th><b>Time (Hours)</b></th> <th><b>Flow Rate</b></th> <th><b>Time (Hours)</b></th> </tr> </thead> <tbody> <tr> <td>0.50</td> <td>27.0</td> <td>1.0</td> <td>15.5</td> <td>1.5</td> <td>11.4</td> </tr> <tr> <td>2.0</td> <td>8.5</td> <td>3.0</td> <td>5.8</td> <td>4.0</td> <td>4.3</td> </tr> <tr> <td>5.0</td> <td>3.4</td> <td>6.0</td> <td>2.6</td> <td>8.0</td> <td>2.1</td> </tr> <tr> <td>10.0</td> <td>1.7</td> <td>15.0</td> <td>1.1</td> <td></td> <td></td> </tr> </tbody> </table>	<b>Flow Rate</b>	<b>Time (Hours)</b>	<b>Flow Rate</b>	<b>Time (Hours)</b>	<b>Flow Rate</b>	<b>Time (Hours)</b>	0.50	27.0	1.0	15.5	1.5	11.4	2.0	8.5	3.0	5.8	4.0	4.3	5.0	3.4	6.0	2.6	8.0	2.1	10.0	1.7	15.0	1.1		
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**Corresponding Policies** UTMB Institutional Handbook of Operating Procedures: Sentinel Events Policy # 9.13.16, <http://www.utmb.edu/policy/ihop/search/09-13-16.pdf>

JCAHO: Management of the Environment of Care; EC.1.7, Medical Gas Management <http://www.utmb.edu/JCAHO/>

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**References** Reference ISO 1012-1 (Quality Assurance Requirements for Measuring Equipment)

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