UNIVERSITY OF GEORGIA
Office of Research Safety
Environmental Safety Division

Oxygen Displacing Gases/Liquids

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Oxygen displacing gases/liquids are compressed gases or cryogenic liquids that have the potential to displace a sufficient enough amount of oxygen in the event of a release, that breathing becomes difficult or impossible. This scenario is more likely when the gases or liquids of concern are located in small or poorly ventilated spaces.

Examples of common oxygen displacing gases include nitrogen and noble gases such as argon or helium.

A common cryogen that falls into this category is liquid nitrogen. Cryogens also have the additional hazard of being very cold and can cause serious skin or eye damage if appropriate PPE is not worn.

Personal Protective Equipment & Personnel Monitoring

Lab Coat

Traditional white lab coat.

Gloves

Insulated cryo-gloves are needed when handling cryogenic materials

Eye Protection

ANSI Z87.1-compliant safety glasses or safety goggles.

Labeling & Storage

Store upright in a cool, dry location.

Compressed gas cylinders should be anchored to a stable structure such as a wall with a chain or strap approximately ½ to ¾ of the way up the cylinder.

Cryogen containers should be placed on a level, non-porous surface. During vaporization, cryogens expand significantly (e.g., 1 ft^3 of liquid nitrogen = 700 ft^3 of gaseous nitrogen). This results in a buildup of pressure which could cause an explosion of a sealed container. For this reason, only use containers approved for cryogen storage. When bench top cryogen containers are used, only transfer cryogens from small dewars or secondary containers and never from the primary pressurized tank.

Additionally, all containers should be tagged as either full, in-use, or empty. Untagged cylinders or cryogen containers are assumed to be full. Compressed gas cylinders not in use must have regulators removed and safety caps in place.

Engineering Controls, Equipment, & Material

Fume Hood	Typically a fume hood is not necessary for the handling of these materials. However, cryogens and noble gases can displace oxygen, resulting in rapid suffocation, so having an oxygen monitor may be advisable and is dependent upon the size of the room, ventilation, and the volume of oxygen displacing gases in a room. Additional details are provided later in this SOP. If you have a question about a lab-specific protocol or procedure involving the use of oxygen displacing gases and proper engineering controls, please contact the Office of Research Safety at 706-542-5288.

First Aid & Emergencies

Skin or Eye Contact	Remove contaminated clothing and accessories; flush affected area with water. If symptoms persist, get medical attention.
Inhalation	Move person into fresh air. If symptoms persist, get medical attention.

Oxygen Deficiency Hazard Analysis

Since oxygen deficiency concerns can arise due to the storage of these materials in small, poorly ventilated rooms, certain mitigation strategies should be employed to address these concerns. Normal atmospheric oxygen concentration is approximately 20.9% and effects can start to be felt once the concentration drops below 19.5%.

The Office of Research Safety evaluates areas that contain these oxygen displacing gases/liquids to determine what the minimum oxygen concentration might be in the event of an uncontrolled release. ORS will generally assign risk levels in accordance with the chart below.

Risk Level	**LOW**	**MODERATE**	**HIGH**
Min. O2 Conc.	>15%	10-15%	<10%

Mitigation strategies recommended by ORS may include any of the following:

- Increasing ventilation in a space
- Decreasing the volume of oxygen displacing gases/liquids in a space
- Customizing a standard operating procedure to limit risk
- Training
- Postings
- Installation of an oxygen monitor

Laboratories utilizing liquid nitrogen may choose to conduct a self-evaluation. To assist with this, a quick reference tool for areas containing liquid nitrogen is available in the appendix to this SOP. Laboratories can use this tool to determine which risk level a space may fall into when common dewar sizes of liquid nitrogen are stored there. If a laboratory decides to utilize this tool and lands in the yellow or red portion of the chart, they must contact the Office of Research Safety for a formal evaluation. Please keep in mind that this tool should only be used for liquid nitrogen.

References

Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards, National Research Council, 2011.

Physics Division Cryogenic Safety Manual, Argonne National Laboratory, 2001.

Cryogenic and Oxygen Deficiency Hazard Safety, SLAC National Accelerator Laboratory: Environment, Safety and Health Division, 2020.

Chapter 55: Cryogenic Fluids, 2018 International Fire Code, International Code Council.

Contacts

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Self-Evaluation Tool for Labs Utilizing Liquid Nitrogen

Below is a quick reference tool that laboratories can utilize to quickly determine which strategies may be appropriate for spaces housing **liquid nitrogen**. Please note that this tool only accounts for liquid nitrogen volume and room volume. Ventilation rates and rates of release are not considered. For an in-depth analysis, please contact the Office of Research Safety at 706-542-5288.

In order to use the tool, you will need to know your room volume in cubic meters. To first find the area of your room, you will need to access building floorplans provided through the Facilities Management Division. Once you have logged in, find the floorplan for your building number. Once this value is determined, estimate the height of your ceiling in feet. Multiply the estimated ceiling height by the square footage of the room from the floorplan. Multiply this value by 0.0283 to convert to cubic meters.

Once this value is determined, find it along the x-axis and then go up until it crosses the line corresponding to the volume of your largest dewar. This will give you a general idea of where in the hazard banding the room likely falls in the event of a full tank release.