CRYOGEN SAFETY

NIST S 7101.52
Document Approval Date: 06/22/2023
Effective Date[1]: 06/30/2023

1. PURPOSE

The purpose of this suborder is to establish requirements, associated roles and responsibilities, and guidance to enable employees to work safely with or around cryogens.

2. BACKGROUND

None.

3. APPLICABILITY

a. This suborder is limited to the use of liquid helium, liquid nitrogen, liquid neon, and liquid argon and the liquid-to-vapor transition. Since oxygen has the potential to condense, accumulate, and drip from transfer lines when liquid cryogens with normal boiling points lower than that of oxygen are being transferred, and thereby pose a risk of explosion or fire, its properties are included in this document for reference. Other cryogens such as liquid hydrogen, liquid ammonia, and numerous other refrigerants may pose hazards that require significantly different controls from those described in this Cryogen Safety suborder. The use of cryogens other than helium, nitrogen, neon and argon should be brought to the attention of line management for additional review.

b. The requirements related to bulk cryogen storage tanks (BCST) apply to NIST sites for which NIST has jurisdiction, custody, and control. If NIST work at sites for which NIST does not have jurisdiction, custody, and control requires the installation of a BCST, the OU responsible shall work with the authorities at that site to ensure the appropriate safety requirements indicated in Section 6.c(7) are met or equivalent protection is provided.

[1] [1] For revision history, see Appendix A.

4. REFERENCES

a. ASME Boiler and Pressure Vessel Code Section VIII, Division 1.

b. ANSI/ASME B31.1, Power Piping.

c. ANSI/ASME B31.3, Process Piping.

d. CGA P-12, Safe Handling of Cryogenic Liquids.

e. NFPA 45, Fire Protection for Laboratories Using Chemicals.

f. NFPA 55, Standard for the Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks.

5. APPLICABLE NIST DIRECTIVES

a. NIST S 7101.20: *Work and Worker Authorization Based on Hazard Reviews*;

b. NIST S 7101.21: *Personal Protective Equipment (PPE)*;

c. NIST S 7101.22: *Hazard Signage*;

d. NIST S 7101.23: *Safety Education and Training*;

e. NIST S 7101.59: *Chemical Hazard Communication*;

f. NIST S 7101.60: *Chemical Management*; and

g. NIST S 7101.61: *Compressed Gas Safety*.

6. REQUIREMENTS

a. General

(1) The OUs shall manage cryogenic hazards in accordance with NIST S 7101.20: *Work and Worker Authorization Based on Hazard Reviews*, their OU implementations thereof, and the requirements of this suborder.

b. Hazard Analysis

(1) The hazard analysis process shall encompass cryogenic hazards in all areas where cryogens are used and stored.

(2) Oxygen-deficiency/oxygen-enrichment hazard assessments must be done as part of the hazard review before beginning any cryogenic experiments.

(a) The OU shall ensure calculations to determine the need for an oxygen monitor are performed.[2]

i. The OU may perform the calculations themselves or they may request the assistance of another person with the appropriate knowledge to do so (*e.g.*, another cryogen user or the Cryogen Safety Program Manager).

ii. The OU shall ensure the calculations are verified by a second person with the appropriate knowledge to do so, unless the Cryogen Safety Program Manager performs the first set of calculations for them.

Should the calculations performed by the OU indicate the need for an oxygen monitor, the Cryogen Safety Program Manager shall verify the calculations to ensure a possible oxygen-deficiency/oxygen-enrichment hazard, unless the Cryogen Safety Program Manager performed the first set of calculations.

c. Hazard Control

(1) Appropriate control measures shall be selected, documented, and implemented.

(2) Cryogen handling is not permitted in laboratories without adequate ventilation, or, if ventilation is inadequate or non-existent, without additional applied controls that reduce the risk of exposure of personnel to an ODH to an acceptable level.

(3) Hazard signage that is in accordance with NIST S 7101.22: *Hazard Signage* shall be posted at every entrance to every space that may have an ODH hazard. Example signs

[2] There are several acceptable methods of determining the risk of oxygen-deficiency hazards (ODH) available through the Cryogen Safety Program webpage on the NIST safety website. Appendix B of this suborder lists physical characteristics of the most common cryogens, including expansion ratios, which are critical in calculating oxygen-deficiency hazards. Where characteristics are affected by atmospheric pressure, different values are listed for Boulder, CO, and Gaithersburg, MD.

are presented in Appendix C of this suborder. The hazard review shall identify the level of hazard, so that the appropriate signal word can be selected for the sign(s). See Section 7: Definitions of this suborder for a description of the various signal words. In most cases, the signal word will either be "DANGER" or "WARNING".

(4) When a laboratory cannot reduce the risk of exposure of personnel to an ODH to an acceptable level (normally ≥ 19.5% oxygen), the hazard review shall ensure that an oxygen monitor is used. A fixed oxygen monitor shall have an audible alarm, warning light, and a digital readout. Personal monitors may also be used or required depending on the risk.

(a) Oxygen monitors shall be installed, used, maintained, and calibrated according to manufacturers' recommendations.

(b) Calibration and maintenance records shall be kept with or near the monitor.

(c) The hazard review should consider the need to tie the alarm to a central fire alarm system. This may be appropriate in cases where the potential ODH may affect spaces beyond a single laboratory or single room.

i. The NIST Authority Having Jurisdiction (AHJ) shall be notified if there is a request to tie the oxygen monitor into the NIST fire alarm system such that the NIST AHJ can approve or disapprove the tie in. If approved, the NIST AHJ shall witness its installation.

(5) Cryogen containers that are appropriate for the experiment design, facility, and research activity shall be selected during the hazard review.

(a) Glass dewars and cryostats can be used only after they have been specifically addressed in the applicable hazard review.

(b) Appropriate styrofoam containers are permitted for the temporary storage of small amounts of LN2 if allowed by the hazard review.

(c) Regular thermos bottles are not permitted for storing liquid cryogens even for short periods of time.

(d) Non-pressurized storage dewars shall not be pressurized or modified to be pressurized as these containers are not designed to withstand pressure.

(e) Hazard reviews shall be conducted before any dewar is modified and subsequently used. All potentially impacted personnel, including storeroom personnel who fill the dewar, shall be included in the hazard review process and/or informed of its results.

(f) Changes to dewars shall be accomplished by the addition of plumbing or hardware where practical and technically appropriate, rather than the removal of existing hardware and substituting new.

(g) Adequate pressure-relief devices must be provided throughout the cryogen system to prevent high-pressure gas build-up as the liquid evaporates. For example, a cryostat should have redundant fill tubes or, if not, a burst disk on the vacuum space. Basically, there should always be at least two relief paths for a liquid-containing vessel. This issue needs to be dealt with on a case-by-case basis as part of the hazard review.

(h) Cryogenic systems that are designed, fabricated, or modified in-house shall be designed to withstand pressures of at least 150% of the maximum pressure relief on the system.

(i) Calculations of the proper relief valve size and pressure drop shall be included in the hazard review for any cryogen system that is to be designed, fabricated, or modified in-house.

(j) If feasible, existing equipment, systems, and operations shall be brought into compliance with current standards. The safety aspects related to any exceptions to current standards shall be reviewed in detail and documented, and further operation shall be contingent on OU Director's approval.

(k) Maintenance and inspection requirements for dewars, cryostats, and cryogenic systems shall be developed during the hazard review process and included in the Standard Operating Procedures (SOPs). At a minimum, an initial inspection of the equipment by a trained cryogen user should be conducted before equipment is put into operation.

(l) A plan for testing pressure relief devices on cryogenic systems, in accordance with the manufacturer's or installer's recommendations, shall be included in the hazard review for the system.

(6) Transport

(a) To transport a dewar between floors, use an elevator. Small amounts of cryogen in non-pressurized containers may be carried on stairs with extreme caution and shall be assessed in the OU on a case-by-case basis. Due to the risk of an Oxygen Deficiency Hazard, no one may accompany a dewar in an elevator. Depending on the elevator this may require two people (one at the sending floor and one at the receiving floor), and signage prohibiting anyone from riding the elevator with the dewar. An example sign is included in Appendix C of this suborder. If an elevator allows manual operation using a key, transport may be accomplished without a person at the receiving floor as the elevator will remain in the manual mode (preventing use by other people) until the operator with the key arrives to remove the dewar and switch it out of manual mode. Signage prohibiting anyone from entering the elevator is recommended in the manual mode.

(b) Transporting cryogens in vehicles shall only be done by personnel who work in the storeroom, shipping and receiving, a laboratory, or by a contract supplier, and the personnel shall be specifically trained in the proper transport of cryogens. All transports of cryogens must occur in open vehicles, such as pickups or flatbed trucks, and the dewars being transported must be secured. Wheel brakes, if present on the dewar, must be locked.

(7) Bulk Cryogen Storage Tanks (BCST)

(a) OSHE shall maintain an inventory of all bulk cryogen storage tanks (BCSTs) located on NIST sites for which NIST has jurisdiction, custody, and control.

i. This inventory shall be reviewed annually by the Program Manager for Cryogen Safety.

(b) The OU responsible for each BCST shall assign an individual to act as the OU Point of Contact (PoC) for the BCST.

i. The OU PoC shall facilitate communications between the NIST Contracting Officer Representative (COR), the cryogen supply contractor, the OU, and all cryogen users served by the BCST.

(c) All new BCSTs shall be designed and constructed in accordance with all applicable standards and state-of-the-art industry practices.

i. The Fire & Facilities Safety Group, OSHE, shall review all technical plans for the proposed installation of a BCST.

ii. Prior to BCST installation, the contractor shall provide a job-specific safety and health plan for the installation. This plan shall be approved by OFPM and the OSHE prior to beginning the execution of the project.

(d) Physical security for BCSTs

i. Each BCST shall be provided with physical security to protect the tank from vehicular traffic and other sources of physical impact or damage, to include but not be limited to the use of:

(i) Bollards designed for this purpose;
(ii) Curbs;
(iii) Jersey barriers; and/or
(iv) Other traffic control devices.

ii. For BCSTs located on an unsecured site, the physical security shall also prevent access to the tank and its associated systems by unauthorized personnel through means such as:

(i) Fences;
(ii) Locked gates; and
(iii) Other equivalent features.

(e) Signage for BCST

i. Each BCST shall have a Point-of-Contact sign indicating the OU point of contact (PoC) for the tank, including, but not limited to:

(i) NIST staff member name(s) and on-campus telephone number(s);
(ii) OU, division, group name;
(iii) After hours contact(s) name and contact telephone number(s); and
(iv) NIST Emergency telephone number corresponding to the campus.

ii. Each BCST shall have a hazard sign (please see Appendix C):

(i) Compliant with NIST S 7101.20: *Hazard Signage*;

(ii) In accordance with Compressed Gas Association standards CGA C-7; and
(iii) Using the signal word "Warning" with an orange background.

iii. Each BCST shall have an NFPA "diamond" hazard identification system diagram.

(i) In accordance with Compressed Gas Association standards CGA P-19, liquid nitrogen, liquid argon, and liquid carbon dioxide shall have hazard ratings of 3-0-0-SA.

iv. Each BCST on the Gaithersburg campus shall have an emergency "Notice" sign with the phone number for the Gaithersburg Fire Protection Group (please see Appendix C).

v. All signs shall be:

(i) Large enough to be read at a safe distance from the BCST;
(ii) Weatherproof; and
(iii) Secured to the supporting surface so that they cannot be removed or disturbed by the elements or other physical forces.

(f) Routine In-service Inspections

i. The OU PoC shall perform a visual inspection of each BCST at least monthly. The inspection form found in Appendix D, or the equivalent, may be used to document this effort.

ii. The inspection shall include a visual inspection of the tank's:

(i) Exterior surfaces;
(ii) Physical security measures; and
(iii) Signage.

iii. Evidence of the following shall be documented and reported to the OU's Safety Program Coordinator or appropriate Group Leader and the COR for the bulk cryogen delivery contract:

(i) Leaks;
(ii) Shell distortions;

(iii) Signs of settlement, i.e, any visible sign that the tank has shifted to a lower position than in the past;
(iv) Corrosion;
(v) Poor condition of the foundation, paint coatings, insulation systems, and appurtenances; and
(vi) Other potential damage.

iv. All conditions requiring corrective actions shall be reported to the inspector's Supervisor and shall be addressed by the OU responsible for the tank. The bulk cryogen contractor shall be notified of the required corrective action(s) in cases where they are responsible for maintenance of the tank.

v. Each inspection shall be recorded and retained for at least five years by the OU PoC.

(g) Contractor-Provided Services
The contractor hired to provide bulk cryogens shall provide the following safety-related services as part of their contract.

i. The contractor shall provide a job-specific safety and health plan that has been approved by the COR and OSHE prior to beginning the execution of the contract.

ii. Annual Inspections

(i) The contractor shall conduct an annual inspection of all tanks covered by the contract, NIST-owned and contractor-owned.
(ii) The contractor shall inspect the tanks using American Petroleum Institute (API) Standard 653, *Tank Inspection, Repair, Alteration, and Reconstruction*.
(iii) Each inspection record shall be retained for at least five years by the OU PoC.

iii. The contractor shall replace all pressure relief safeties at least once every five years.

(h) All modifications and repairs of existing tanks shall be designed and constructed in accordance with all applicable standards and state-of-the-art industry practices.

i. Prior to tank modification or repair, the contractor shall provide a job-specific safety and health plan for the work to be performed. This plan shall be approved by OFPM and the OSHE prior to beginning the execution of the project.

ii. Each modification or repair shall be documented and retained for the life of the tank by the OU PoC.

(8) The hazard review or associated SOPs shall describe the required controls to minimize the risks, in accordance with the requirements of NIST S 7101.60: *Chemical Management*.

(a) Safe work practices to minimize the risk of cryogen contact, based on how the cryogen is being used, shall be listed in SOPs. An OU or Division may choose to adopt a set list of safe work practices, such as the cryogen tool titled *Short List of Proper Cryogen Handling Practices*, in order to avoid repetition in multiple hazard reviews and/or SOPs.

(9) Personal protection equipment (PPE) assessments for the use of cryogens shall be completed as part of the hazard review and in accordance with the NIST S 7101.21: *Personal Protective Equipment*. Some well-defined and controlled tasks may require less PPE, and some operations may need to balance the need for dexterity with PPE requirements. To accommodate these needs, the PPE requirements may be reduced when the reason is documented as part of an approved SOP and hazard review.

(a) When pouring cryogens from hand-held dewars or transferring liquid cryogens from low-pressure pressurized storage dewars, the following shall be required:

i. Eye protection that provides at least as much protection as safety glasses with side shields;

ii. Closed toe shoes;

iii. Gloves whenever there is risk of exposure to liquid cryogen, cold gas, or cold surfaces, except when the loss of dexterity would present a greater risk. Either approved cryogenic gloves or oil-free leather gloves must be used, and they should be loose enough to allow for rapid removal;

iv. Protective clothing when there is risk of exposure to the liquid cryogen, such as when transferring from a storage dewar into a smaller cryostat. Either a

cryogenic apron or a lab coat with no pockets (to prevent trapping the liquid) should be worn. Clothing should be reviewed for its potential to trap the cryogen before transfer is made; and

v. Protective clothing when there is a risk of exposure to cold gas during cryogen transfer and when wearing the protective clothing would not present a greater hazard. Simple coverage is often sufficient.

(b) When transferring cryogens from high-pressure pressurized storage dewars, the PPE required must be specified in the hazard review for each specific experiment.

(10) Avoid ingestion or inhalation of cryogenic liquid or gas. Under no circumstances should liquid cryogen be put in the mouth as a demonstration, even in small quantities.

(11) Chemical Inventory and Hazard Communication

(a) Cryogen containers shall be inventoried in accordance with the requirements of NIST S 7101.59: *Chemical Hazard Communication*:

i. Each large (e.g., 100 – 240 liter) pressurized cryogen storage container must be entered into NIST's hazardous chemical inventory database; and

ii. Chemical labeling shall be in accordance with the requirements of NIST S 7101.59, and specifically, must be placed on the container without obscuring any other label information.

(b) Hazards associated with cryogens shall be communicated in accordance with the requirements of the NIST S 7101.59: *Chemical Hazard Communication*.

i. Door signage shall comply with the requirements of NIST S 7101.22: *Hazard Signage* (Appendix C contains sample hazard signage for ODH); and

ii. The hazardous chemical inventory that lists chemicals by their product identifiers that appear on the associated container labels and Safety Data Sheets (SDSs) for each work area shall be updated as necessary.

(12) Training

(a) Training developed by the OSHE Cryogen Safety Program Manager and the OUs shall be in accordance with the requirements of the NIST S 7101.23: *Safety Education*

and Training and made available for use by employees. The training should include topics such as the following, as appropriate:

i. Properties of cryogens in their liquid and gas states;

ii. Safe operation of equipment being used with cryogens (*i.e.*, location and function of valves, pressure reading devices, safety devices, inspections, *etc.*);

iii. Equipment hazards/failure modes;

iv. Oxygen deficiency risk assessments where cryogens are being used;

v. Materials compatible with cryogens (if relevant to the task);

vi. Location and use of personal protective equipment (PPE);

vii. Emergency response; and

viii. Situations that cause cryo-pumping and formation of an ice blockage; ice blockage identification; and ice blockage removal techniques or resources.

(b) Training shall be provided by the OU to all cryogen users and transporters during their initial assignment and it shall include hands-on training.

i. Refresher training shall be provided by the OU when it is apparent the cryogen user or transport would benefit from such training.

(13) Emergency Procedures

(a) The hazard review shall include emergency procedures for the laboratories.

(b) Situations warranting consideration as appropriate include:

i. Response to alarms;

ii. Asphyxiation;

iii. Frostbite;

iv. Ice plug;

v. Tipped container;

vi. Damaged container;

vii. Spill;

viii. Over-pressurization and/or explosion;

ix. Implosion; and

x. Embrittlement of materials.

d. Recordkeeping

(1) Training shall be provided, documented, and recorded in accordance with the requirements of the NIST S 7101.23: *Safety Education and Training*.

(2) Oxygen monitor calibration and maintenance records shall be kept:

(a) For a minimum of two years; and

(b) In accordance with OU/Division policies and procedures.

7. DEFINITIONS

a. Bulk Cryogen Storage Tank (BCST) – A liquid cryogen container, normally with a capacity greater than 300 gallons (1,136 L) designed primarily for stationary installations not intended for loading, unloading, or attachment to a transport vehicle as part of its normal operation in the process of use.

b. Cryogen – A liquid with a normal boiling point below -150 degrees C; applies to either the cryogenic liquid or its gas at or near its boiling point.

c. Cryostat – A cryogenic vessel configured for low-temperature experiments (as opposed to a dewar which is for storing cryogens).

d. Dewar – Vacuum-jacketed vessel designed to store cryogens. May be of two types:

(1) Non-pressurized Storage Dewar – Non-pressurized, vacuum-jacketed vessel with a loose-fitting dust cap over the outlet of the neck tubes, which reduces the chance of

atmospheric moisture plugging the neck and allows gas produced from the vaporizing liquid to escape. Depending on the size, liquid is removed by pouring or using a transfer tube. Tubing must be vented to maintain atmospheric pressure and prevent pressurization.

(2) Pressurized Storage Dewar – Double-walled vacuum vessel with multilayer insulation in the annular space and equipped with safety-relief valves and rupture discs to protect the vessels from pressure build-up. These containers are categorized as either low-pressure (which can operate at pressures up to about 25 psig) or high-pressure (which can operate at pressures up to 350 psig) liquid containers, with varying capacities. Product may be withdrawn as a gas by passing liquid through the internal vaporizer or as a liquid under its own vapor pressure or an external pressure source.

e. Emergency – A highly dangerous condition that needs to be addressed immediately, which may be caused by an unplanned or unanticipated occurrence such as equipment failure, a container rupture, or an uncontrolled release of a hazardous chemical into the workplace.

f. Engineering Controls – Include designing or modifying laboratories, equipment, ventilation systems, and processes to reduce or eliminate the exposure to hazardous sources or conditions. Engineering controls are used to remove a hazard or place a barrier between the worker and the hazard.

g. OU Responsible – The OU with the primary user(s) of the bulk cryogen storage tank.

h. Oxygen Deficiency – <19.5% oxygen in air, as defined by OSHA.

i. Oxygen Enrichment – >23.0% oxygen in air, as defined by OSHA.

j. Signal Word – A word that designates a degree or level of hazard seriousness.

(1) "Danger" – Indicates an imminently hazardous situation that, if not avoided, ***will*** result in death or serious injury.

(2) "Warning" – Indicates a hazardous situation that, if not avoided, ***could*** result in death or serious injury.

(3) "Caution" – Indicates a potentially hazardous situation that, if not avoided, ***may*** result in minor or moderate injury.

(4) "Notice" – The preferred word to address situations not related to personal injury.

8. ACRONYMS

a. ACGIH – American Conference of Governmental Industrial Hygienists

b. ANSI – American National Standards Institute

c. ASME – American Society of Mechanical Engineers

d. ASTM – American Society of Testing and Materials

e. CGA – Compressed Gas Association

f. COR – Contracting Officer Representative

g. IDLH – Immediately Dangerous to Life and Health

h. NFPA – National Fire Protection Association

i. NIST – National Institute of Standards and Technology

j. ODH – Oxygen Deficiency Hazard

k. OSHA – Occupational Safety and Health Administration at the U.S. Department of Labor or state level

l. PPE – Personal Protective Equipment

m. SOP – Standard Operating Procedure

9. RESPONSIBILITIES

The OUs are responsible for ensuring that the requirements in Section 6 are met.

a. CORs shall be responsible for including the appropriate language in contracts regarding contractor-provided services.

10. AUTHORITIES

There are no authorities specific to this suborder alone.

11. DIRECTIVE OWNER

Chief Safety Officer

12. APPENDICES

a. Appendix A. Revision History

b. Appendix B. Cryogen Properties

c. Appendix C. Hazard Signage

d. Appendic D. Example of BCST Monthly Visual Inspection Form

596 **Appendix A. Revision History**

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Version No.	Approval Date	Effective Date	Brief Description of Change; Rationale
1	04/30/13	04/01/14	None – Initial document
2	06/06/19	06/30/23	• Requirement added for cryogenic systems that are designed, fabricated, or modified in-house to be designed to withstand pressures of at least 150% of maximum pressure relief on system • Requirement added to include calculations of the proper relief valve size and pressure drop in the hazard review for any cryogen system that is to be designed, fabricated, or modified in-house • Requirement added to include plan as part of hazard review for testing pressure relief devices on cryogenic systems, in accordance with the manufacturer's or installer's recommendations • Requirement added related to chemical inventorying of cryogens. • Added appendix for revision history • Minor edits updating the document • NOTE: Effective date was originally TBD due to COVID-19 pandemic. Updated on 4/17/23.
3	6/22/23		• Added Section 3.b to address addition of BCST requirements. • Modification to Section 6.b(2) to clearly indicate requirements for oxygen-deficiency/oxygen-enrichment hazard assessments • Modification to Section 6.b(4)(c) to clearly indicate requirements for tying an O2 monitor into the NIST central fire alarm system. • Added Section 6.b(7) to clearly indicate requirements for BCSTs. • Added definitions for "BCST" and "OU Responsible" in Section 7. • Added COR responsibility in Section 9. • Added two signs to Appendix C. • Added Appendix D.

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Appendix B. Cryogen Properties

Table 1 reflects a partial list of properties for the cryogens included in this suborder, namely, helium, nitrogen, neon, and argon. In addition, since oxygen has the potential to condense on surfaces cooled by cryogens with normal boiling points lower than that of oxygen, thereby posing a risk of explosion or fire, its properties are included here for reference.

Table 1: Properties of common cryogens

		Helium		Neon		Nitrogen		Argon		Oxygen	
Boiling Point (K)	@Sea level, 101.325 kPa (1atm)	4.2		27.1		77.3		87.3		90.2	
Liquid Density (g/L)	@Sea level, 101.325 kPa (1atm)	125		1207		806		1395		1141	
	Location	273K	293K	273K	293K	273K	293K	273K	293K	273K	293K
Gas Density (g/L)	Boulder	0.15	0.14	0.77	0.72	1.07	1.00	1.53	1.43	1.23	1.14
	Gaithersburg	0.18	0.17	0.90	0.84	1.25	1.17	1.78	1.66	1.43	1.33
Gas/liquid Expansion Ratio (from liquid to gas, local atm)	Boulder	813	873	1561	1676	751	806	911	978	930	998
	Gaithersburg	698	750	1341	1439	644	692	782	839	798	857

610 **Appendix C. Hazard Signage**

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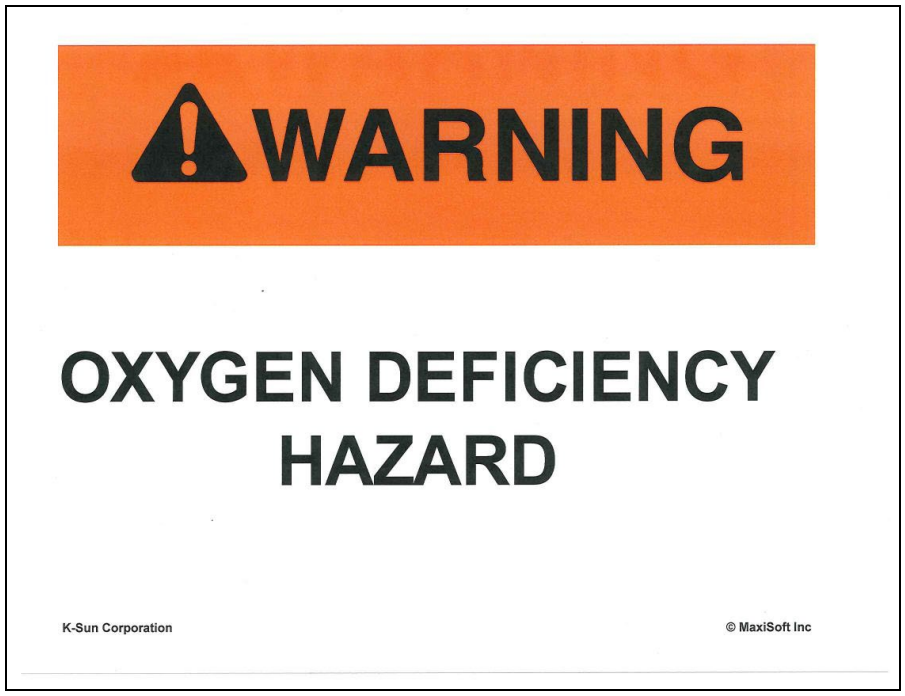
612 (1) Oxygen deficiency hazard



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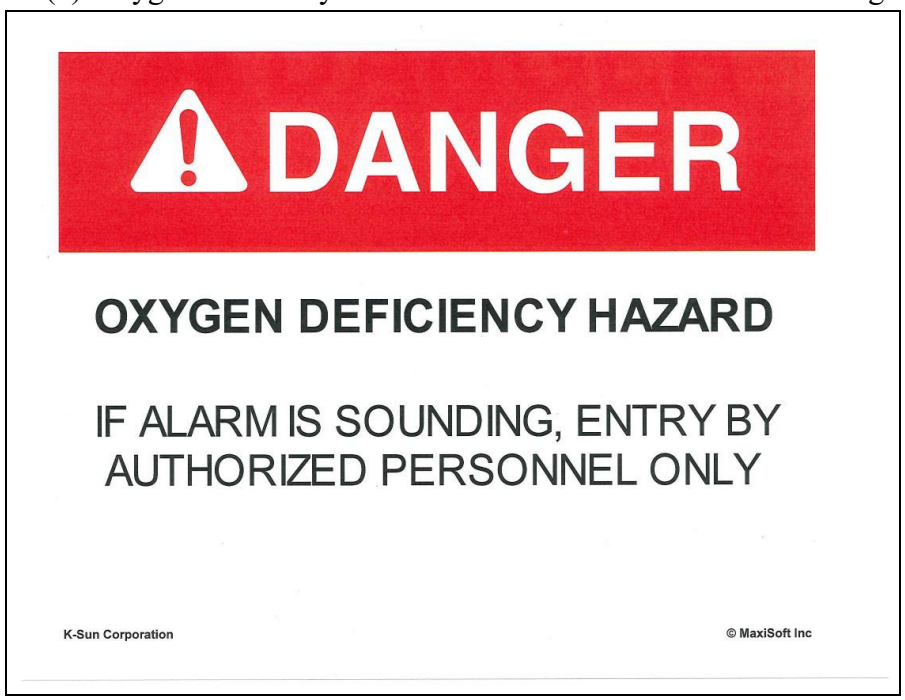
616 (2) Oxygen deficiency hazard – Do not enter if alarm is sounding



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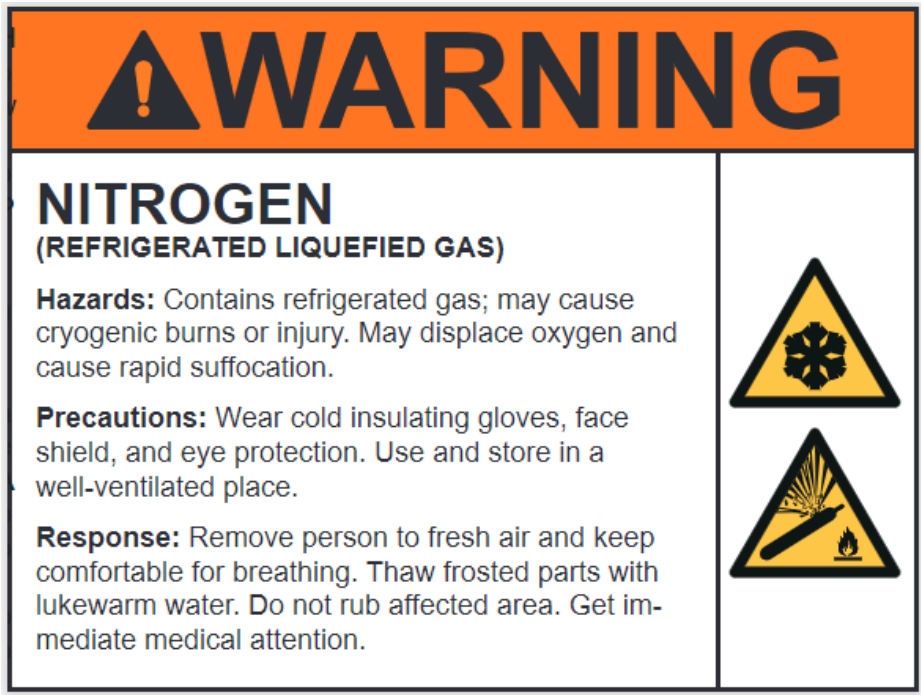
(3) Do Not Enter Elevator

(4) Suffocation (Asphyxiation) Warning Symbol

(5) Cold Warning Symbol

(6) Warning for liquified nitrogen gas



635 (7) Notice signs for BCSTs on the NIST-Gaithersburg campus
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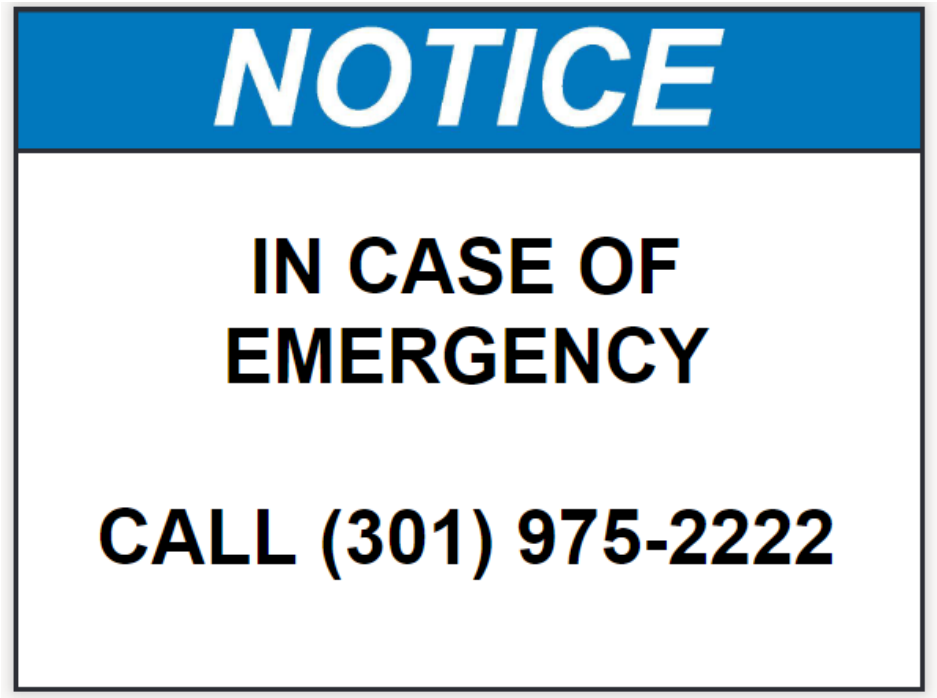

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639 **Appendix D: Example of BCST Monthly Visual Inspection Form**
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NIST NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY U.S. DEPARTMENT OF COMMERCE

BULK CRYOGEN STORAGE TANK (BCST) MONTHLY VISUAL INSPECTION FORM

Routine in-service visual inspection of tank exterior and surroundings

Tank Location: _____ Contents: _____

Inspector: _____ Date: _____

Signage present:	Observations:	Corrective actions required:
Occupant sign	Yes / No	
Hazard sign	Yes / No	
NFPA diamond	Yes / No	
Gaithersburg phone #	Yes / No	
Excessive ice buildup	Yes / No	
Trash accumulation, etc.	Yes / No	
Unusual visible/audible release	Yes / No	
Tank pressure		
Evidence of:		
Leaks	Yes / No	
Shell distortion	Yes / No	
Signs of settlement	Yes / No	
Corrosion	Yes / No	
Condition of:		
Foundation	Good / Poor / Changed	
Paint coating	Good / Poor / Changed	
Insulation systems	Good / Poor / Changed	
Appurtenances	Good / Poor / Changed	
Physical Security	Good / Poor / Changed	
Date(s) required corrective action(s) reported to Supervisor/OU/Contractor:		

Date/Comments: _____

_____

The OU must retain this inspection record for at least five years.

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