



Goddard Procedural Requirements (GPR)

DIRECTIVE NO.	<u>GPR 8710.7</u>	APPROVED BY Signature:	<u>Original signed by</u>
EFFECTIVE DATE:	<u>March 4, 2008</u>	NAME:	<u>Edward J. Weiler</u>
EXPIRATION DATE:	<u>March 4, 2013</u>	TITLE:	<u>Director</u>

COMPLIANCE IS MANDATORY

Responsible Office: Code 250/Safety and Environmental Division

Title: Cryogenic Safety

PREFACE

P.1 PURPOSE

This directive establishes requirements for minimizing cryogenic hazards to personnel, hardware, and facilities at the Goddard Space Flight Center (GSFC). It also describes the controls and measures implemented by GSFC to assess and mitigate the hazards associated with cryogenic systems, such as over-pressurization, frostbite, and potential oxygen-deficient areas.

P.2 APPLICABILITY

This directive shall apply to all GSFC personnel, facilities, and activities at all permanent and temporary sites. This directive shall also apply to all GSFC tenant organizations, contractors, grantees, clubs, and other persons operating on GSFC property as required by law and as directed by contractual, grant, and agreement documents.

P.3 AUTHORITY

- a. National Aeronautics and Space Act, 42 U.S.C. §§ 2451-et seq.
- b. [NPD 8710.2](#), NASA Safety and Health Program Policy

P.4 REFERENCES

- a. [NPD 8710.5](#), NASA Safety Policy for Pressure Vessels and Pressurized Systems
- b. [NPR 8715.3](#), NASA Safety Manual
- c. [GPR 3410.2](#), Employee Competence and Quality Management System Training
- d. [GPR 8621.1](#), Reporting of Mishaps and Close Calls
- e. [GPR 8710.3](#), Certification and Recertification of Ground-Based Pressure Vessels and Pressurized Systems
- f. [GPR-8730.1](#), Calibration and Metrology
- g. NASA-STD-8719.17, NASA Requirements for Ground-Based Pressure Vessels and Pressurized Systems (PV/S)
- h. ANSI Z78.1: Occupational Eye and Face Protection
- i. ASTM G63-99: Standard Guide for Evaluating Nonmetallic Materials for Oxygen Service
- j. ASTM G88-05: Standard Guide for Designing Systems for Oxygen Service

CHECK THE GSFC DIRECTIVES MANAGEMENT SYSTEM AT
<http://gdms.gsfc.nasa.gov> TO VERIFY THAT THIS IS THE CORRECT VERSION PRIOR TO USE.

DIRECTIVE NO.	GPR 8710.7
EFFECTIVE DATE:	March 4, 2008
EXPIRATION DATE:	March 4, 2013

- k. ASTM G93-88: Standard Practices for Cleaning Methods for Materials and Equipment Used in Oxygen Enriched Environments
- l. ASTM G94-05, Standard Guide for Evaluating Metals for Oxygen Service
- m. ASTM MNL 36, Guidelines for Oxygen System Design, Material Selection, Operations, Storage, and Transportation
- n. CGA Pamphlet G-4.1, Cleaning Equipment for Oxygen Service
- o. CGA Pamphlet P-1, Safe handling of Compressed Gases in Containers
- p. NFPA 50 Standard for Bulk Oxygen Systems at Consumer Sites
- q. NFPA 55, Standard for the Storage, Use and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders and Tanks
- r. OSHA 29 CFR 1910.104: Oxygen; Bulk Oxygen Systems; Distance between Systems and Exposures; Fire Resistive Structures
- s. GSFC 23-81, Cryogenic Systems Hazards Analysis Checklist
- t. GSFC 23-82, Dewar Personnel Certification

P.5 CANCELLATION

None

P.6 SAFETY

None

P.7 TRAINING

Training for cryogenic personnel is covered in Section 5.0.

P.8 RECORDS

Documentation of training and certification is the responsibility of the appropriate management organization. See GPR 3410.2.

Record Title	Record Custodian	Retention
Liquid Nitrogen filling station user Certifications	Responsible Branch Head	*NRRS 3/33G Destroy 5 years after separation of employee or when no longer needed.
Record of Cryogenic Safety Committee (CSC) Minutes and Attendance	CSC chair	*NRRS 1/14B1(a) Permanent. Retire to FRC when 2 years old. Transfer to NARA when 20 years old.
CSC Cryogenic Safety Audit Records	CSE	*NRRS 1/14B1(b) Destroy when 3 years old or when no longer needed for reference, whichever is sooner.

DIRECTIVE NO. GPR 8710.7
EFFECTIVE DATE: March 4, 2008
EXPIRATION DATE: March 4, 2013

Liquid Oxygen Personnel Certification Record	Responsible Branch Head/Project Supervisor	*NRRS 3/33G
GSFC 23-81 Cryogenic Systems Hazards Analysis Checklists	Responsible Branch Head/Project Supervisor	*NRRS 1/14B1(b)
GSFC 23-82 Dewar Personnel Training Records	Responsible Branch Head/Project Supervisor	*NRRS 3/33G

*NRRS – NASA Records Retention Schedules ([NPR 1441.1](#))

P.9 METRICS

Metrics will include the percentage of personnel working with cryogenics who have completed cryogenic training, and percentage of operating systems that are in compliance with the cryogenic policy described herein. This data will be reported quarterly to the Goddard Safety Council.

P.10 DEFINITIONS

- a. Cryogenic – Operating at or below -150 °C or 123° K.
- b. Cryogenic System – An item of equipment or multiple items operating together that contain at least one component that operates at cryogenic temperature. Closed cycle refrigerators or cryo cooler setups are examples of cryogenic systems.
- c. Dewar- A glass or metal container that may have an annular vacuum space for thermal isolation, which is used especially for storing components or gases at cryogenic temperature.
- d. Oxygen Deficient Atmosphere– Occupational Safety and Health Administration (OSHA) defines an oxygen deficient atmosphere as one having less than 19.5% oxygen by volume
- e. Qualified Personnel- Having sufficient knowledge, expertise and training required to complete a task, as deemed by the authority responsible for safe operations of the equipment with which that task is associated.

P.11 ACRONYMS

COTS – Commercial Off the Shelf
CSE – Cryogenic Safety Engineer
CSC – Cryogenic Safety Committee
GHe – Gaseous Helium
GN₂ – Gaseous Nitrogen
GSC – Goddard Safety Council
GSFC – Goddard Space Flight Center
LHe – Liquid Helium
LN₂ – Liquid Nitrogen

CHECK THE GSFC DIRECTIVES MANAGEMENT SYSTEM AT
<http://gdms.gsfc.nasa.gov> TO VERIFY THAT THIS IS THE CORRECT VERSION PRIOR TO USE.

DIRECTIVE NO.	<u>GPR 8710.7</u>
EFFECTIVE DATE:	<u>March 4, 2008</u>
EXPIRATION DATE:	<u>March 4, 2013</u>

LO₂ – Liquid Oxygen
NARA – National Archive and Records Administration
NRRS – NASA Records Retention Schedule
ODH – Oxygen Deficiency Hazard
OHO – Occupational Health Officer
OJT – On the Job Training
OSHA – Occupational Safety and Health Administration
PPE – Personal Protective Equipment
RECERT –Recertification Program
S&E – Safety and Environmental

PROCEDURES

In this document, a requirement is identified by “shall,” a good practice by “should,” permission by “may” or “can,” expectation by “will” and descriptive material by “is.”

1.0 Roles and Responsibilities

1.1 GSC shall oversee overall direction of GSFC’s Health and Safety Program, including the Cryogenic Safety Program.

1.2 Chief, Safety and Environmental (S&E) Division shall:

- a. Designate the Chair of the Cryogenic Safety Committee (CSC);
- b. Provide notification to the Agency Occupational Health Officer regarding any cryogenic or low oxygen atmosphere injury or incident; and
- c. Appoint and maintain the position of Cryogenic Safety Engineer (CSE).

1.3 Branch Heads/Supervisors shall:

- a. Designate custodians of cryogenic systems and Oxygen Deficiency Hazard (ODH)-designated areas;
- b. Maintain a record of individuals trained on any cryogenic system;
- c. Identify persons capable of providing the on the job training(OJT) specified in this document and, upon request of the CSC or CSE, provide justification that said persons are qualified to administer this training;
- d. Ensure that all facilities and equipment are properly maintained;
- e. Ensure that applicable employees are trained and knowledgeable in the hazards associated with cryogenic systems and potential oxygen deficiency;
- f. Ensure that cryogenic safety requirements are in place on dewars used by their organization but owned by another organization;
- g. Ensure potential ODH areas are analyzed and classified according to S&E requirements and procedures;

DIRECTIVE NO.	GPR 8710.7
EFFECTIVE DATE:	March 4, 2008
EXPIRATION DATE:	March 4, 2013

- h. Ensure that hazard warning signs required by this directive are procured and posted by the user organization under the guidance of the CSE; and
- i. Ensure that oxygen monitors within their jurisdiction are maintained and calibrated as defined in GPR 8730.1.

1.4 CSC – The CSC will consist of representatives identified by their directorates as having varying areas of expertise. The CSC is responsible to the GSC and shall:

- a. Oversee implementation and maintenance of GSFC’s Cryogenic Safety Program, part of which is the ODH program;
- b. Meet quarterly, or more frequently if necessary, to accomplish its responsibilities;
- c. Ensure that the cryogenic safety program at GSFC minimizes the health and safety risks to government and contractor employees and the public as well as any risks to NASA hardware and facilities;
- d. Halt any cryogenic operation if the requirements of this GPR are not met.
- e. Ensure that GSFC and other Federal regulations, professional standards, and sound health physics practices are met;
- f. Review and approve new or altered cryogenic systems prior to their first operation for adherence to the requirements described in section 3.1 and, if necessary, prescribe conditions and requirements to minimize cryogenic hazards. The CSC may designate a person or persons to give approval for routine requests;
- g. Review and approve ODH calculations as per section 8.1;
- h. Review all cryogenic areas prior to startup of operations and after each approved alteration;
- i. Specify posting and entry requirements for entry into designated ODH areas;
- j. Develop and maintain the cryogenic working group charter; and
- k. Develop and maintain an inventory of all cryogenic systems and ODH designated areas at GSFC.

1.5 The Chair of the CSC shall:

- a. Be appointed by the Chair of the S&E Division for a term of 2 years;
- b. Convene the CSC as necessary to meet the requirements of this GPR;
- c. Maintain a record of CSC attendance and meeting minutes; and
- d. Act on behalf of the CSC as necessary.

1.6 The CSE shall:

- a. Audit cryogenic safety records and evaluate compliance with CSC requirements;
- b. Maintain appropriate records of inspections and evaluations;
- c. Act on behalf of the CSC as necessary. All actions shall be reported to the CSC at the next meeting;
- d. Require the immediate cessation of operations of any cryogenic systems or ODH area determined to pose an imminent threat to personnel safety; and

DIRECTIVE NO.	GPR 8710.7
EFFECTIVE DATE:	March 4, 2008
EXPIRATION DATE:	March 4, 2013

- e. Conduct periodic inspections of cryogenic or ODH areas for compliance to this GPR and to Industry standards for cryogenic safety.

1.7 Users/Custodians – Users work directly with cryogenics or cryogenic systems. Custodians are users who have primary responsibility for a cryogenic system:

- a. All users of cryogenics shall take the required cryogenic training described in this document and follow the directives and instructions described herein;
- b. Custodians shall ensure that cryogenic safety hazards are reduced to as low a level as is reasonably achievable. This includes scheduling a safety analysis and review of their systems prior to first operation as described herein;
- c. Custodians shall ensure alterations to any previously reviewed system which could possibly impact worker safety are reviewed by the CSC; and
- d. Custodians shall ensure that all safety documentation is updated and consistent with the operating system it is associated with, and be prepared to demonstrate this to the CSC or CSE upon request.

1.8 Ancillary Personnel – Ancillary personnel work in the immediate vicinity of cryogenics or cryogenic systems but do not work directly with them. They may also be personnel required to enter ODH designated areas as part of their normal work duties. Examples are security or custodial workers. Ancillary personnel shall take the required ODH and/or cryogenic training described in this document and follow the directives and instructions therein.

1.9 Contractor and Guest Cryogenic Operators – Contractors and other personnel operating at GSFC facilities are subject to all provisions of the GSFC Cryogenic Safety Program. Contractors may be exempt from training requirements if their cryogenic training program is reviewed and approved by the CSC.

2.0 Requirements for Fabricated, Purchased, or Loaned Cryogenic Equipment

2.1 Commercial Off the Shelf (COTS) Products

COTS items shall be clearly designated for use at cryogenic temperatures. These items shall be used in strict accordance with manufacturer's specifications and operated as described in this GPR. Any modification to a COTS item is subject to review by the CSC as described herein. If a COTS product meets pressure vessel criteria as per NPD 8710.5, GPR 8710.3, or NASA-STD-8719.17 it shall be tracked as per Goddard Recertification (RECERT) requirements.

2.2 Custom Fabricated Equipment

Custom fabricated equipment which will operate at cryogenic temperature shall be designed and constructed in accordance with good cryogenic safety practices and made as safe as practicably possible. Pressure vessels shall conform to RECERT requirements documented in NPD 8710.5, GPR 8710.3, and NASA-STD-8719.17. All specifications for custom fabricated equipment shall

DIRECTIVE NO.	<u>GPR 8710.7</u>
EFFECTIVE DATE:	<u>March 4, 2008</u>
EXPIRATION DATE:	<u>March 4, 2013</u>

be reviewed by the CSE (or designee), and all operating cryogenic systems shall be reviewed by the CSC as set forth in this document. The responsible experimenter is required to supply any applicable safety documentation described in the CSC review section (3.1).

2.3 Legacy Systems

Operating legacy cryogenic systems shall meet all applicable cryogenic safety requirements and be brought into compliance with current standards as much as practicable. Safety aspects of any exception to current standards shall require a waiver as per NPR 8715.3 and shall be reviewed in detail by the CSC in conjunction with the center CSE. Legacy systems that meet pressure vessel criteria must be tracked as per RECERT requirements.

2.4 Loaned Cryogenic Equipment

When equipment is on loan from another branch/organization, the safety responsibility lies in the branch/organization using the borrowed equipment. This includes ensuring that a safety peer review process (see Section 3.0) is done if any substantial changes are made to the initial system safety documentation. The branch/organization lending the equipment is obligated to provide any necessary instruction and documentation to support safe operation of that equipment. This includes but is not necessarily limited to: equipment documentation, operating procedures, maintenance requirements, and OJT.

3.0 CSC Peer Reviews

To verify compliance with GSFC cryogenic safety requirements, cryogenic equipment and systems shall be subjected to a safety review by the CSC prior to their first operation. Reviewed systems shall not operate without formal approval from the CSC.

3.1 CSC Review Documentation

At least 1 week prior to first operation of any cryogenic system, all of the following applicable documents shall be supplied to the CSC as part of the peer review process:

- a. Schematics and piping and instrumentation flow diagrams as required providing a complete and accurate functional description of the system;
- b. Sufficient documentation to show that the components and materials used are appropriate for cryogenic temperatures;
- c. A description of operating procedures;
- d. A description of any necessary operator training;
- e. A list of all valves and ports which have the potential of discharging cold gas or cryogenics to the atmosphere (the possibility of such a discharge causing personnel injury should be evaluated);
- f. A description of any maintenance requirements;

DIRECTIVE NO.	GPR 8710.7
EFFECTIVE DATE:	March 4, 2008
EXPIRATION DATE:	March 4, 2013

- g. An analysis demonstrating the adequacy of pressure relief valve sizing under worst-case failure conditions; and
- h. A completed ODH analysis evaluating the risk presented under worst-case failure conditions. See Section 8.1.

The CSC may request additional documentation unique or specific to any cryogenic system under review.

3.2 CSC Review Process

The chair of the CSC shall convene the group and meet with the responsible system operator after reviewing the safety documentation package. The CSC shall also conduct a walkthrough of the cryogenic test setup prior to operations to ensure safety requirements are met. A hazard analysis checklist, form GSFC 23-81, shall be completed by the operator and shall be available for review by the CSC prior to system operation. Periodic safety audits, occurring no less than annually, of operating cryogenic systems shall be conducted to ensure that safety documentation is consistent with the operating system with which it is associated. Any operating system configuration change that significantly alters the safety documentation requires review and approval by the CSC.

4.0 Personal Protective Equipment (PPE)

Appropriate PPE is required when handling, transferring, or working with cryogenic fluids. PPE shall include:

- a. Eye protection – Safety goggles are required when handling or transferring fluids which might result in exposure to cold boil off gases. Full face shield is recommended. Safety glasses with side shields are acceptable when working with closed cryogenic systems. Eye protection shall be in conformance with ANSI Z78;
- b. Hand protection - Safety gloves rated for use with cryogenic fluids are required when working with cryogens. Loose nylon insulating gloves are acceptable;
- c. Clothing - Long-sleeved, non absorbent shirts and non absorbent long pants are acceptable. Shorts or skirts that can potentially expose bare skin are not permitted. Lab coats or aprons are recommended; and
- d. Footwear - Non absorbent footwear is required. Sandals or open-toed shoes are not permitted.

5.0 Training of Cryogenic Personnel

5.1 Training Requirements

All personnel working with cryogenic fluids shall be thoroughly familiar with the hazards involved. They shall also be familiar with all emergency measures that may be required in the event of an accident. Thus, all employees who work in potential ODH areas shall take ODH training and all persons working with or in proximity to cryogenic fluids shall take general hazards training. Any

persons involved in the design or procurement of cryogenic components, hands-on use of sub-atmospheric liquid helium systems, or liquid oxygen (except personnel strictly associated with administrative or procurement aspects) are required to take additional training covering the associated safety aspects. Finally, each employee shall be given OJT specific to any cryogenic equipment or system he or she is expected to use. Table 1 summarizes cryogenic training requirements. Any contractor organization that has an equivalent training program may be exempt from these training requirements with approval of the CSC. ODH training is required to be taken at 2 year intervals.

Table 1. Training Requirements

	ODH	BASIC HAZARDS	DESIGN, CONSTRUCTION AND OPERATIONS	OJT
Entry into ODH Designated Areas	√			
Working with or around cryogenics basic use of LN2, or LAr or LHe	√	√		√
Cryo system designers, liquid oxygen users, hands-on operators of sub-atmospheric LHe dewars	√	√	√	√

5.2 Dewar User OJT Requirements

Prior to operation on any cryogenic systems, users shall be instructed in the following:

- a. Description of the equipment;
- b. Operating procedures including PPE requirements;
- c. Maintenance schedule and procedures;
- d. Hazards specific to a the particular test setup;
- e. Location of ODH alarms and routes of egress in the event of an alarm; and
- f. Procedures for reporting of incidents.

It is the responsibility of the branch/organization head to ensure that persons administering OJT are duly qualified. Requests for qualifications for OJT trainers may be made by the CSE or CSC. Form GSFC 23-82, Dewar Personnel Certification, may be used as a model for qualifying trainers. OJT group certification is possible on a series of dewars if they are similar in hazards, design and operations.

DIRECTIVE NO.	<u>GPR 8710.7</u>
EFFECTIVE DATE:	<u>March 4, 2008</u>
EXPIRATION DATE:	<u>March 4, 2013</u>

Training shall be documented and records kept within respective branches. The documentation shall include: 1) content of training, 2) date, 3) name of trainer, and 4) a dated training attendance list showing names of the trainees and their signatures. The CSE or CSC may request to review user certification documentation for any operating cryogenic system.

5.3 User Certification for Liquid Nitrogen Filling Stations

All users of liquid nitrogen filling stations shall be certified on that particular station. The certification process shall require:

- a. A review of the fill procedure, including any PPE requirements;
- b. A description of the Dewar inspection process as prescribed by the CSC;
- c. An explanation of the emergency procedures associated with cold contact burns and frostbite; and
- d. A demonstration of the filling process by the user.

Users of liquid nitrogen filling stations need to be recertified if a modification is made to the filling station which effects its operation or potential hazards.

All stations shall have the name of responsible trainers and an operating procedure posted. It is the responsibility of the branch or organization owning the filling station to designate a responsible person and to maintain a record of certified users for each station. The responsible person for a LN2 filling station shall be the primary certifier for new users at that station, and shall ensure that safety postings are maintained and an up to date operating procedure is available.

6.0 System Maintenance and Inspection

Cryogenic systems and equipment shall be maintained by qualified personnel to ensure safety. Maintenance shall be conducted as per equipment manufacturer or applicable NASA requirements. The schedule and nature of the maintenance shall be recorded as part of the safety documentation listed in section 3.1. Dewars shall also be inspected monthly for unusual or excessive ice buildup, which can potentially block relief paths or may be a sign of a compromised insulating vacuum.

In addition to periodic in-service inspections by RECERT, cryogenic systems and equipment shall be inspected by the operator prior to and during system operations and after system shutdown. Inspection shall also take place after any unusual incident which might affect the integrity and safety of an item of cryogenic equipment. Documentation of this maintenance shall be kept with the responsible organization.

7.0 Liquid Oxygen (LO₂) Safety

7.1 Applicable Standards

DIRECTIVE NO.	GPR 8710.7
EFFECTIVE DATE:	March 4, 2008
EXPIRATION DATE:	March 4, 2013

Because of the unique hazards associated with liquid oxygen, additional safety requirements are required to ensure safe operations.

7.1.1 Design Standards

LO₂ systems built, designed, or operated at Goddard shall conform to either: ASTM MNL 36: Guidelines for Oxygen System Design, Material Selection, Operations, Storage, and Transportation or all applicable of the following:

- a. ASTM G88-05: Standard Guide for Designing Systems for Oxygen Service;
- b. ASTM G63-99: Standard Guide for Evaluating Nonmetallic Materials for Oxygen Service;
- c. ASTM G94-05: Standard Guide for Evaluating Metals for Oxygen Service; or

7.1.2 Cleanliness Standards

LO₂ systems or components shall be cleaned in accordance with: ASTM G93-88: Standard Practices for Cleaning Methods for Materials and Equipment Used in Oxygen enriched Environments; or Compressed Gas Association's (CGA's) Pamphlet G-4.1 : Cleaning Equipment for Oxygen Service.

7.2 LO₂ Storage

7.2.1 Fixed or Permanent Storage - Fixed or permanent LO₂ storage requirements are determined by the amount of cryogen stored. Break points are at 13000 cubic feet and 25000 cubic feet. A typical 160 liter liquid oxygen dewar is approximately 5000 cubic feet.

- a. LO₂ storage that is less than the equivalent of 13000 cubic feet shall be stored in accordance with NFPA 55: Standard for the Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks
- b. LO₂ storage that is more than the equivalent of 13000 cubic feet shall be stored in accordance with : 29 CFR 1910.104 (OSHA) Oxygen; Bulk Oxygen Systems; Distance between Systems and Exposures; Fire Resistive Structures
- c. LO₂ storage that is more than the equivalent of 25000 cubic feet shall be stored in accordance with: NFPA 50 Standard for Bulk Oxygen Systems at Consumer Sites and OSHA 29 CFR 1910.104

7.2.2 Portable Dewar Storage

- a. All temporary oxygen dewars shall be separated from flammables and combustibles by a minimum of 20 feet. "No Smoking" and "No Open Flames" signs are to be posted at the storage location.
- b. Smoking and open flame are prohibited within a minimum of 20 feet of any oxygen Dewar or purge system.

DIRECTIVE NO.	<u>GPR 8710.7</u>
EFFECTIVE DATE:	<u>March 4, 2008</u>
EXPIRATION DATE:	<u>March 4, 2013</u>

- c. LO₂ dewar storage areas shall have fixed monitoring for high oxygen levels. These monitors shall alarm at 21.5% oxygen by volume.

7.3 User Certification for Liquid Oxygen Systems

All users of LO₂ shall be certified. The list of OJT-required topics described in section 5.2 shall be expanded to include:

- a. An explanation of oxygen material compatibility issues;
- b. Combustion/flammability issues associated with LO₂ dewar storage areas;
- c. A description of the hazards of high flow velocities in oxygen systems;
- d. A description of the cleanliness requirements for oxygen systems; and
- e. Proper procedures for handling leaks and spills.

Certification records for liquid oxygen purchasers and users shall be kept by the responsible supervisor or branch head.

7.4 CSC Review Process for LO₂ Systems

Any system using liquid oxygen shall be reviewed by the CSC. For any LO₂ system review the following shall be added to the list of required safety documentation described in section 3.1:

- a. Identification of designated Dewar or bulk LO₂ storage areas;
- b. A plan for mitigation of combustion hazards;
- c. Analysis of material compatibility with O₂;
- d. Cleanliness procedures;
- e. Analysis of piping design for minimization of flow velocities; and
- f. Electrostatic discharge risk mitigation plan.

8.0 Oxygen Deficiency Hazard (ODH)

8.1 ODH Risk Assessment – An ODH assessment shall be conducted whenever an area containing enough displacing gas to pose a potential oxygen deficiency is established or modified, and whenever cryogenics are used, stored, or dispensed. The goal of the ODH risk assessment is to estimate the increase in the rate at which fatalities will occur in a given area so that appropriate controls can be established to mitigate the hazard. The level of risk is based on the volume of cryogen in a given area as well as the expected component failure rates for the cryogenic or other equipment that presents an oxygen deficiency hazard. The S&E Division shall designate the proper procedure for assessing the ODH hazard of a given area as well as the proper ODH alarm response procedure.

Personnel shall not enter or occupy an area where the oxygen level is less than 19.5% by volume.

DIRECTIVE NO.	<u>GPR 8710.7</u>
EFFECTIVE DATE:	<u>March 4, 2008</u>
EXPIRATION DATE:	<u>March 4, 2013</u>

8.2 ODH Postings - Areas determined to have a potential for oxygen deficiency shall be identified by postings. All entrances shall be posted. Persons authorized by the CSC or CSE can post and de-post areas if the hazard is temporary and an ODH analysis considering the change in potential displacing gas has been made. The ODH alarm response policy, as determined by the CSC, shall be posted adjacent to any fixed ODH alarm sensor or at the entrance to any ODH designated areas while the ODH threat is present.

8.3 Visitor Requirements. Visitors or temporary workers who have not had ODH training may enter a posted ODH area ONLY after the ODH hazard has been explained to them by personnel familiar with the hazards in the area and who have themselves taken the ODH training course. Visitors may not enter specially designated high hazard ODH areas without taking ODH training and following all CSC requirements.

8.4 Oxygen Monitoring

8.4.1 Fixed Monitors. Fixed Oxygen monitors shall alarm at an oxygen concentration of 19.5% and have a siren and flashing strobe light. The siren and strobe shall be distinctive from other alarms in the immediate area, such as fire alarms. Oxygen monitors shall be installed with consideration of the buoyancy of the displacing gas. Fixed oxygen monitors shall not be disabled except by qualified personnel, in conjunction with the CSE.

8.4.2 Personal Oxygen Monitors. Personal oxygen monitors shall be available adjacent to ODH designated areas. Portable oxygen monitors will alarm at 19.5% oxygen. The organization issuing personal oxygen monitors is responsible for compliance with this requirement.

8.4.3 Maintenance and Calibration of Stationary and Portable Monitors. Monitors shall be calibrated in accordance with GPR 8730.1 and manufacturer's recommendations, but not less than annually. Calibration shall be done using a known sample gas, which shall verify the alarm set point of 19.5 %. Personal oxygen monitors shall not be used beyond the date they are due for recalibration. If past due, the monitor shall be returned to the organization that issued it for recalibration.

DIRECTIVE NO. GPR 8710.7
EFFECTIVE DATE: March 4, 2008
EXPIRATION DATE: March 4, 2013

CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes
Baseline	March 4, 2008	Initial Release