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Glenn Manual – Chapter 25

Combustible-Gas, Toxic-Gas, and Low-Oxygen Detection Systems w/Change 2 (9/30/2015)

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Change Record

Rev.	Effective Date	Expiration Date	GRC25, Change Request #	Description
B	6/4/2012	6/4/2017	99	Bi-Annual Review
Change 1	5/13/2014	6/4/2017	N/A	Administrative change to add front cover and change history log to comply with NPR 1400.1
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***Include all information for each revision. Do not remove old revision data. Add new rows to table when space runs out by pressing the tab key in the last row, far right column.*

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NOTE: *The current version of this chapter is maintained and approved by the Safety and Health Division (SHeD). The last revision date of this chapter was June 2012. The current version is maintained on the Glenn Research Center intranet at within the BMS Library. Approved by: Chief Safety and Health Division*

1.0 PURPOSE

This chapter establishes procedures and practices for determining the need for systems to detect low oxygen, combustible gases and vapors, and toxic gas and for installing and maintaining these systems at the NASA Glenn Research Center (GRC) at Lewis Field and Plum Brook Station.

2.0 APPLICABILITY

The provisions of this chapter are applicable to any operation at GRC (Lewis Field and Plum Brook Station) that involves the use of the following materials:

- Oxygen displacing gases (including gases used or stored in their liquid or solid phase), such as nitrogen, helium, argon, carbon dioxide and refrigerants.
- Flammable and combustible gases (including gases used or stored in their liquid or solid phase), such as hydrogen, methane, and acetylene
- Flammable and combustible liquids, such as solvents
- Oxidizers (including gases used or stored in their liquid or solid phase), such as oxygen, peroxides, chlorates, perchlorates, nitrates, and permanganates
- Toxic gases and liquids

This chapter does not address fire detection and fire suppression systems. Please contact the Safety and Health Division (SHeD) for information on these systems.

3.0 BACKGROUND

Test cells and laboratories, like confined spaces, may have limited means for entry and egress. In addition, they are enclosed so that natural or mechanical ventilation may not reduce air contaminants to safe levels if a material spill or release occurs. Entry into these areas without proper precautions could result in injury, impairment, or death due to

- An atmosphere that is flammable or explosive
- Lack of sufficient oxygen to support life
- Inhalation of toxic gases

The installation and use of detection systems provides an early warning of potential hazardous situations and allows occupants and responders to make informed decisions.

4.0 POLICY

It is GRC policy to protect personnel by installing, using, and maintaining detection systems where there is a potential for developing a hazardous atmosphere. Such detection systems shall be designed to give an early warning of potential hazards. Proper personnel and system procedures shall be developed to ensure adequate emergency response.

If a detection system is required, this will be noted as a condition of operation on the Safety Permit (see Chapter 1A of the Glenn Safety Manual), Laboratory Safe Operating Procedure (see Chapter 25 of Glenn Occupational Health Manual

- Laboratory Safe Operating Procedure

- Health and Safety Plan

5.0 RESPONSIBILITIES

5.1 Requester

It shall be the requester's responsibility to determine probable need for a detection system (see Section2.0). The entire process for obtaining a detection system is summarized in Appendix B. The requester's responsibilities are to:

- Evaluate the need for a detection system based on the potential for exposure, and the implementation of engineering and/or work practice controls to limit the exposure. Fill out the supporting documentation (see Appendix C) and forward it to SHeD for review.
- IF detection system is needed, initiate a work request with FD and provide supporting documentation (see Appendix D).
- Secure/provide the funding for the project
- Keep FD informed of the project's viability.
- Discuss with FD and SHeD the requirements for the detection system.
- Install engineering controls and implement work practice controls as specified during the evaluation of need for a detection system.
- Monitor progress of the task via the FD contact and keep the ASC informed.
- Send a copy of the evaluation of need for a detection system, including appropriate actions taken per the evaluation, to the ASC as part of the Safety Permit Request.
- At the completion of a process (research project, facility operation,) and when it is determined that an active sensor system is not longer needed (based on repeating aforementioned steps) the requestor shall initiate a deactivation process. The requestor shall first consult with the ASC and SHeD and then complete and submit a work request to FD for sensor system deactivation. .

5.2 Safety Committee

The SC shall sign the work request to evaluate the need for a detection system or to deactivate the system, and shall indicate on the Safety Permit the need for a detection system as a condition for operation.

5.3 Safety and Health Division

It is SHeD's responsibility to

- Review information provided by the requester and physically survey the area prior to evaluating the need for a detection system
- Review requestor provided Appendix C and make comments/recommendations.
- Contact the requester and the ASC for additional technical assistance during the assessment process
- Recommend the appropriate engineering controls; type of detection system, alarm response, alarm settings, location of sensors, alarms, and warning lights; specialized evacuation procedures; warning signs; barricades; and the required conditions of operation to be included on the Safety Permit
- Provide FD with an evaluation (Appendix D)
- Coordinate the development of specialized evacuation procedures with the building manager, SHeD, the ASC, and the requester
- Update the building evacuation plan

- Sign the work request for deactivation of the detection system

5.4 Facilities Division (FD)

The FD is responsible, through its appropriate branches, for the overall coordination and implementation of the work request for detection systems. Such responsibility includes the following actions:

- Coordinate the procedure for assessing the need for a detection system
- Create a biddable detection system design for the Procurement Division
- Keep the requester informed of the status of the work request
- Inform the ASC, SHeD, and the requester of system installation or system deactivation
- Maintain configuration control on all detection systems
- Maintain a file with all appropriate documentation on detection systems, including dates of installation and deactivation
- Design all changes to detection systems
- Activate the detection systems upon request (the initial activation shall take place while the installing contractor is present)
- Provide the necessary preventive maintenance and calibration to ensure proper operation of the detection systems
- Deactivate detection systems on request
- Manage the construction services for all new detection systems

5.5 Building Manager

The building manager shall inform building occupants and evacuation wardens of any modification to the building evacuation plan.

6.0 REQUIREMENTS

The entire procedure is illustrated in Appendix B.

6.1 Assess the Need for a Detection System

Once it becomes known that an activity will include the use of, or generation of, a material listed in Section 2.0, the requester shall evaluate the need for a detection system and contact SHeD for support. Utilize Appendix C (Supporting Documentation for Evaluating the Need for a Detection System) for the evaluation.

The SHeD engineer/IH shall review the evaluation of need for the detection system. If the need is established, the requestor shall prepare a work request (NASA GRC709) and provide supporting documentation in Appendix D to FD to design and install a detection system. It is important that the requester submit the work request at least 3 months prior to the required activation date so that FD can ensure that the detection system will be installed on schedule and at a minimum cost to the requester. The work request shall be signed by the requester's division chief and the chairman of the appropriate ASC.

6.2 SHeD Evaluation

SHeD shall review the information provided by the requester. This shall include a walkthrough of the area with the requester. A written report (see Appendix D) of the evaluation shall be provided. Copies of the written evaluation report shall be sent to the Chief of SHeD, the chair of the ASC, and the requester. Section 6.2.1 to Section 6.2.8 describe what this written report shall include.

6.2.1 Need for Detection System

Typically, the determination of need will be made by calculating the percent oxygen or the concentration of a toxic or combustible gas in the area after a total release of the material; that is, this calculation will assume a worst-case scenario (e.g., power failure or systems failure). The supporting documentation submitted with the Safety Permit Request shall include these calculations. If the evaluation indicates that a hazardous condition would not occur, no detection system is required.

6.2.2 Engineering Controls

SHeD will review the engineering controls specified in the preliminary design. SHeD may also recommend additional engineering controls in the evaluation report. Examples of engineering controls follow:

- Designing the operation or process so that no material is present in the lines unless the operation or process is in use
- Using an interlock connected to ventilation fans
- Using fast-actuating shutoff valves

6.2.3 Type of Detection System

SHeD will recommend the type of detection system needed.

6.2.4 Alarm Settings

Alarm settings shall be determined on the basis of the evaluation, the detection system manufacturer's recommendations, and applicable codes and standards. Typical settings follow:

TABLE 6.1.—ALARM SETTINGS

Type of detection system	Low	High
Combustible gas	10-percent lower exposure limit	40-percent lower exposure limit
Low oxygen	19.5 percent	Not applicable
Toxic gas	Threshold limit value	Short-term exposure limit or Ceiling Value

6.2.5 Alarm Response

The alarm response will be determined by SHeD in consultation with the requester. Alarm response includes variables such as a room/area evacuation alarm versus a building-wide evacuation alarm, and a local-only alarm versus a Central Station alarm.

6.2.6 Sensor, Alarm, and Warning Light Location

SHeD will recommend the number and location of the sensors. In general, the sensors should be placed as close to the potential hazard source as possible. The height at which the sensor is placed is typically based on the manufacturer's recommendations, but it may be altered (with approval of the jurisdictional authority) because of the specific configuration of the system and the properties of the material being used. In general, audible alarms are placed inside the room or area, and a warning light is placed outside the room or area over the door.

6.2.7 Warning Signs and Barricades

Warning signs are required near each warning light or audible alarm to provide sufficient information regarding the hazard. SHeD shall specify the number of warning signs required, the appropriate wording on the sign, and the proper locations for the signs. SHeD shall also specify the need for any barricades.

6.2.8 Evacuation Procedures

Any specialized evacuation procedures will be included in the building evacuation plan (see Glenn Emergency Preparedness Plan for further information regarding building evacuation plans at evac-Lewis Field or evac-PBS). Specialized evacuation procedures will be developed on a case-by-case basis by SHeD, the building manager, and the requester. SHeD shall ensure that the building evacuation plan is updated as required.

6.2.9 Condition of Operation on the Safety Permit

SHeD will specify on the Safety Permit that the detection system is a condition of operation. This information will be included with the Safety Permit Request.

6.3 Design of the Detection System

The FD representative will discuss with the requester the evaluation report issued by SHeD. SHeD will support this discussion on an as-needed basis. If the detection system is needed, the requester shall confirm the funding source noted on the original work request prepared by the FD representative. FD will then design the detection system. Any modifications to the requirements listed on the evaluation report shall require concurrence by SHeD.

6.4 Installation of the Detection System

Once the need for a detection system has been determined and the design has been completed, FD will oversee the ordering and installing of the equipment.

After the equipment is installed, tests shall be conducted to demonstrate that all of the detection system functional requirements have been met.

FD shall inform the chairman of the SC, SHeD, and the requester that the detection system has been installed.

SHeD shall update the building evacuation plan to include the installed detection system. FD will assemble a file on the installed detection system. The file will contain copies of the instruction manuals, the installation drawings, and the acceptance test results. It will be used for maintenance and calibration.

6.5 Changes to a Detection System

To have changes made to the design and/or installation of an existing detection system, the requester should submit a work request to FD, as described in Section 5.1. The procedure for making these changes is the same as the procedure described in Section 5. A change to the installed detection system could be as minor as the addition or deletion of a single component, such as a detector or a strobe/siren, or as major as a large expansion or complete deactivation of the detection system.

6.6 Calibration and Maintenance of the Detection System

Once a system has been activated, FD will automatically implement a program of periodic calibration and preventive maintenance, as recommended by the manufacturer.

6.7 Detection System Deactivation

For sensor system deactivation the requester shall submit a request to SHeD and ASC to evaluate the process and validate that deactivation is a safe course of action. Once validated, the requester shall submit a work request to FD, with supporting documentation, to have the system deactivated. FD shall update the drawings to reflect the deactivation of the system, and shall update the building evacuation plan.

6.0 The SHeD verification procedure for this section shall include assuring complete documentation throughout the detection system process, confirming that the specialized evacuation procedures are current and updated in the evac-Lewis Field and evac-PBS Building Specific Emergency Information web pages, and periodic site inspection for confirmation of current calibration tags on sensor panel boxes and periodic verification of sensor replacement within the manufacturers specified service life and exclusive sensor characteristics

7.0 RECORDS

- Supporting Documentation for Evaluating a Need for a Detection System (Appendix C)—Maintained by FD in their maintenance database as part of the original Safety Permit.
- Request for a Detection System (Appendix D)—Maintained by FD in their maintenance database as part of the original Safety Permit.

8.0 REFERENCES

Document number	Document name
GLM–QSA–1700.1	NASA Glenn Safety Manual, Chapter 1A—Safety Permit System
NPR 1800.1	NASA Procedural Requirement, NASA Occupational Health Program Procedures
OAC 3745.77	NASA GRC Title V Permit Information
ANSI Z88.2	American National Standards Institute. Practices for Respiratory Protection
ANSI/NFPA 53M	American National Standards Institute/National Fire Protection Association. Oxygen-Enriched Atmospheres, 1992.
ANSI/NFPA 71	American National Standards Institute/National Fire Protection Association. Signaling Systems for Central Station Service, 1989.
ANSI/NFPA 325M	American National Standards Institute/National Fire Protection Association. Fire Hazard Properties of Flammable Liquids, Gases, and Volatile Solids, 1991.
	Handbook of Compressed Gases. Third ed., Compressed Gas Association, Inc., Arlington, VA, 1990.
NFPA 30	National Fire Protection Association. Flammable and Combustible Liquids Code, 1993.
NFPA 50	National Fire Protection Association. Standard for Bulk Oxygen Systems at Consumer Sites, 2001.
NFPA 50A	National Fire Protection Association. Standard for Gaseous Hydrogen Systems at Consumer Sites, 1999.
NFPA 50B	National Fire Protection Association. Standard for Liquefied Hydrogen Systems at Consumer Sites, 1999.
NFPA 54	National Fire Protection Association. National Fuel Gas Code, 2006.
NFPA 72	National Fire Protection Association. National Fire Alarm Code, 2007.
NFPA 72G	National Fire Protection Association. Guide for the Installation, Maintenance, and Use of Notification Appliances for Protective Signaling Systems, 1989.
NFPA 495	National Fire Protection Association. Explosive Materials Code, 2006.
29 CFR 1910, Sec. 94	Occupational Safety and Health Standards. Ventilation.
29 CFR 1910, Sec. 134	Occupational Safety and Health Standards. Respiratory Protection.
29 CFR 1910, Sec. 146	Occupational Safety and Health Standards. Permit-Required Confined Spaces.
29 CFR 1910, Sec. 1200	Occupational Safety and Health Standards. Hazard Communication.
42 CFR 84	Occupational Safety and Health Research and Related Activities. Approval of Respiratory Protective Devices.

APPENDIX A.—DEFINITIONS AND ACRONYMS

Area safety committee (ASC)

Combustible or flammable gas.—A gas that burns—this includes fuel gases, hydrocarbons, hydrogen, and carbon monoxide.

Combustible or flammable liquid.—Any liquid that may release vapors capable of igniting at or above 100 ºF.

Detection system.—A device or collection of devices designed and installed to produce an alarm signal in the presence of a predetermined level of a specific hazardous material or condition.

Facilities Division (FD)

Glenn Research Center (GRC)

Hazardous material.—A material that is a physical hazard or a health hazard. This includes materials that are carcinogenic, toxic, irritating, corrosive, flammable, or reactive.

Inert material.—A material that, under normal temperatures and pressures, does not react with other materials.

Low-oxygen (or oxygen-deficient) atmosphere.—An oxygen concentration of less than 19.5 percent by volume.

Material Safety Data Sheet (MSDS).—A fact sheet containing characteristics and hazards of a specific hazardous material. MSDSs provide precautionary information on the safe handling of the material as well as emergency and first-aid procedures.

Oxidizer.—A substance that evolves oxygen and thus may initiate or promote combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases. This group includes chemicals such as peroxides, chlorates, perchlorates, nitrates, and permanganates.

Requester.—As used in this chapter, the requester is the project manager, research engineer, operations engineer, or person who requests the detection system.

Short-term exposure limit.—This is a 15-min time-weighted average exposure that should not be exceeded at any time during a workday. Exposures above the time-weighted average up to the short-term exposure limit should not be longer than 15 min and should not occur more than 4 times per day. In addition, there should be at least 60 min between successive exposures in this range.

Threshold limiting value.—The time-weighted-average concentration for a normal 8-hr workday and a 40-hr workweek; this is the amount to which nearly all workers may be repeatedly exposed, day after day, without adverse health effects.

Toxic substance.—A chemical substance with properties that may cause impairment of the central nervous system, illness, or death from exposure via inhalation, absorption, or ingestion.

APPENDIX B.—DETECTION SYSTEM PROCESS

The process for obtaining a detection system follows:

- Activity involves the use of or operation of a material listed in Section 2.0.
- Requester completes supporting documentation evaluation of need for a detection system (see Appendix C) and forwards it to SHeD.
- SHeD reviews the evaluation of need for a detection system (Appendix C).
- SHeD completes evaluation (see Appendix D) --> Copies sent to requester and chairman of the ASC.
- If detection system is needed, SHeD instructs requester to initiate a work request with FD.
- Requester initiates a work request with FD.
- Requester, SHeD and FD meet to discuss scope of effort.
- FD generates a Statement of Work, attaches it to work request, and obtains a cost estimate
- FD notifies requester of cost
- Requester provides funding
- FD oversees the procurement and installation of the detection system
- FD tests system with SHeD and requester present
- FD maintains configuration control drawings of the detection system.
- SHeD updates building evacuation plan.
- ASC adds detection system as a condition of operation on the Safety Permit.
- FD calibrates and maintains the detection system per manufacturer's recommendations.
- Change or deactivation of the detection system must be implemented via a work request that goes through the same process.

APPENDIX C.—SUPPORTING DOCUMENTATION FOR EVALUATING THE NEED FOR A DETECTION SYSTEM

Building: _____ Room/Area: _____

Evaluator: _____ Date: _____

Description of system (include preliminary design drawings or sketches):

Operational procedures:

Materials to be used or stored and the quantity of each (attach Material Safety Data Sheets):

Approximate dimensions of the room, test cell, cabinet, and etc., where the chemicals will be used or stored. Subtract the approximate volume of **large** equipment located in the same room or test cell:

Existing or planned engineering controls (e.g., interlocks, ventilation, or leak detection):

Room ventilation flow rate (cfm): Supply: _____ Return: _____

Type of local exhaust ventilation, if any (e.g., fume hood or ventilation cabinet):

Ventilation flow rate of local exhaust ventilation (cfm):

Volume of local exhaust ventilation hood or cabinet:

Calculate the percent oxygen or the concentration of a toxic or combustible gas in the area (room/cell volume) after a total release of the material; that is, this calculation will assume a worst-case scenario (e.g., power failure or systems failure):

Compare these “worst-case scenario” results to:

10 % & 40 % of the lower explosive limit (LEL) for the combustible gas being used

Loss of habitable atmosphere (LOHA) at an oxygen level < 19.5 %

Toxic gas exposure limit values including time-weighted averages, short-term exposure limits and ceiling values

APPENDIX D.—REQUEST FOR A DETECTION SYSTEM

Work request no.: _____

Building: _____ Room/Area: _____

Requestor: _____

Signature of Requestor:_____ Date: _____

SHeD reviewer: _____

Detection system needed: ___Yes ____No

Worst-case concentration: _____

Allowable concentration: _____

Recommended engineering controls:

Type of detection system:

Alarm setting(s): Low _____ High _____

Alarm response:

_____ Room evac. or _____ Bldg-wide evac.

_____ Local only or _____ Fire station

Number of sensors required: _____

Sensor(s) location(s):

Alarm indicating device(s) location(s):

Number of warning signs required: _____

Wording:

Location:

Evacuation procedures:

Building evacuation plan updated: ____Yes ____No

Conditions of operation (to be included on the safety permit):

Barricades required:

Additional comments: