

NASA Glenn Safety Manual

CHAPTER 25 - COMBUSTIBLE-GAS, TOXIC-GAS, and LOW-OXYGEN DETECTION SYSTEMS

Revision Date: 11/99

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25.1 SCOPE

This chapter specifies the policy and procedures for determining the need for systems to detect low oxygen, combustible gas, and toxic gas and for installing and maintaining these systems.

This chapter does not address fire detection and fire suppression systems. Please contact the Glenn Safety Office for information on these systems.

25.2 DEFINITIONS

- a. Ceiling concentration. The concentration of a chemical substance in air that shall not be exceeded at any time.
- b. Combustible/flammable gas. For the purpose of this chapter, a combustible/flammable gas is a gas that burns; this includes fuel gases, hydrocarbons, hydrogen, and carbon monoxide.
- c. Combustible/flammable liquid. For the purpose of this chapter, a combustible/flammable liquid is any liquid that may release vapors capable of igniting at or above 100 F.
- d. 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.

- e. 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.
- f. Inert material. A material that, under normal temperatures and pressures, does not react with other materials.
- g. Material Safety Data Sheet (MSDS). A substance fact sheet containing characteristics and hazards of a specific hazardous material. MSDS's provide precautionary information on safe handling of the material as well as emergency and first aid procedures. (MSDS Request)
- h. 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.
- i. Oxygen deficient atmosphere. An oxygen concentration of less than 19.5 percent by volume at sea level.
- j. Requester. As used in this chapter, the requester is the Project Manager, Research Engineer, Operations Engineer, or person who requests the detection system.
- k. Short term exposure limit (STEL). The 15-minute time-weighted-average exposure rate that shall not be exceeded at any time during the workday.
- l. Threshold limit value (TLV). The time-weighted-average concentration for a normal 8-hour workday and a 40-hour workweek; this is the amount to which nearly all workers may be repeatedly exposed, day after day, without adverse health effects.
- m. 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.

25.3 APPLICABILITY

The provisions of this chapter are applicable to any operation at Glenn Research Center (Cleveland Center and Plum Brook Station) that involves the use of the following materials:

- a. Inert gases (including gases used or stored in their liquid or solid phase), such as nitrogen, helium, argon, carbon dioxide, and Freon.
- b. Flammable and combustible gases (including gases used or stored in their liquid or solid phase), such as hydrogen, methane, and acetylene.
- c. Flammable and combustible liquids, such as solvents
- d. Oxidizers (including gases used or stored in their liquid or solid phase), such as oxygen, peroxides, chlorates, perchlorates, nitrates, and permanganates
- e. Toxic gases, liquids, and solids, such as beryllium, mercury, ammonia, and carbon monoxide

25.4 POLICY

It is Glenn policy to protect personnel by installing and using low-oxygen, combustible-gas, and toxic-gas 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 Ch. 1 of this Manual).

25.5 PROCEDURE

The entire procedure is illustrated in the flow chart in appendix A. (It is important that the requester submit the work request AT LEAST 3 MONTHS prior to the required activation date, so the Facilities and Test Engineering Division (FTED) can ensure that the detection system will be installed on schedule and at a minimum cost to the requester.)

25.5.1 Request to 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 25.1 (APPLICABILITY), the requester will prepare a work request (NASA C-709) to evaluate the need for and to design and install a detection system. In addition to the work request, the requester shall provide the following information (a form is included in appendix B to facilitate documentation of this information):

- a. A description of the system
- b. Preliminary design drawings
- c. General operational plans
- d. The type and maximum quantity of material(s) to be used or stored and a copy of the MSDS's
- e. The approximate dimensions of the room or test cell where the material will be used and/or stored (minus the approximate volume of equipment located in the room)
- f. A description of existing or planned engineering controls (e.g., interlocks, leak detection, fast-actuating valves, ventilation, explosion-proof equipment)
- g. Room ventilation flow rate (supply and return), ft³/min
- h. Type of local exhaust ventilation, if any (e.g., fume hood, ventilated cabinet)
- i. Local exhaust ventilation flow rate, ft³/min
- j. Volume of local exhaust ventilation hood

The work request shall be signed by the requester's division chief and the chairman of the appropriate Area Safety Committee (ASC). The work request and supporting documentation shall be submitted to the Facilities and Test Engineering Division (FTED).

The FTED will manage the work request and supporting documentation to formally initiate the assessment for the need for a detection system, will coordinate with the proper organizations all the required activities leading up to the activation of the detection system, including obtaining additional signatures, and shall forward the work request and supporting documentation to the Glenn Safety Office. The GSO engineer shall evaluate the need for the detection system.

25.5.2 GSO Evaluation

The GSO engineer shall review the information provided by the requester and evaluate the request. This shall include a walkthrough of the area with the requester. A written report (see appendix C) of the evaluation will be provided with the signed work request. Copies of the written evaluation report shall be sent to the chief of the GSO, the Glenn (or Plum Brook) Safety Officer, the chairman of the ASC, and the requester. This written report shall include the following:

- a. 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.
- b. Engineering controls: The GSO will review the engineering controls specified in the preliminary design. The GSO may also recommend additional engineering controls in the evaluation report. Examples of engineering controls are:
 - 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.
- c. Type of detection system: The GSO will recommend the type of detection system needed.
- d. 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:

Alarm Settings		
Type of detection system		
	Low	High
Combustible gas	20% LEL	40% LEL
Low Oxygen	19.5%	O2- - - -
Toxic gas	TLV	STEL

LEL = lower explosive limit.

TLV = threshold limiting value.

STEL = short term exposure limit

- e. Alarm response: The alarm response will be determined by the GSO in consultation with the requester. Alarm response includes issues such as room/area-evacuation alarm versus a building-wide-evacuation alarm, and a local-only alarm versus a Central Station alarm.
- f. Sensor, alarm, and warning light location: The GSO 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. Generally, audible alarms are placed inside the room/area, and a warning light is placed outside the room/area over the door.
- g. Warning signs and barricades: Warning signs are required near each warning light or audible alarm, to provide sufficient information regarding the hazard. The GSO shall specify the number of warning signs required, the appropriate wording on the sign, and the proper locations for the signs. The GSO shall also specify the need for any barricades.
- h. Evacuation procedures: Any specialized evacuation procedures will be included in the Building Evacuation Plan (see Annex E of the "Glenn Emergency Preparedness Plan" for further information regarding building evacuation plans). Specialized evacuation procedures will be developed on a case-by-case basis by the GSO, Building Manager, and the requester. The GSO shall ensure that the Building Evacuation Plan is updated as required.
- i. Condition of Operation on the Safety Permit.-The GSO 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

25.5.3 Design of the Detection System

The FTED representative will discuss with the requester the evaluation report issued by the GSO (the GSO will be available to 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 and sign the Process System Change Request (PSCR) prepared by the FTED representative. The FTED will then proceed to design the detection system. Any modifications to the requirements listed on the evaluation report shall require concurrence by the GSO.

25.5.4 Installation of the Detection System

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

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

The FTED shall inform the chairman of the Area Safety Committee, the Glenn Safety Office, and the requester that the detection system has been installed.

The GSO shall update the Building Evacuation Plan to include the installed detection system. The FTED 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/calibration.

25.5.5 Changes to a Detection System

To make any changes to the design and/or installation of an existing detection system, submit a work request to FTED, as described in Section 25.5.1. The procedure for making these changes is the same as the procedure described in Section 25.5. 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. (See LMI.8820.1A, "Configuration Control for Glenn Process Systems," for further instructions covering changes to systems under configuration control.)

25.5.6 Calibration and Maintenance of the Detection System

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

25.5.7 Detection System Deactivation

To have a detection system deactivated, the requester shall submit a work order requesting such and stating the reason for deactivation. The work request will be signed by the ASC and GSO and forwarded to FTED. The ASC, GSO, and the requester will be notified when deactivation is complete. The FTED shall update the drawings to reflect the deactivation of the system, and GSO shall update the Building Evacuation Plan.

25.6 RESPONSIBILITIES

25.6.1 Requester

It shall be the requester's responsibility to determine probable need for a detection system (see Sec. 25.3); prepare and send to FTED a work request signed by the requester's division chief and the chairman of the ASC, which evaluates the need for the design and installation of a detection system. Fill out the supporting documentation (see appendix B) and forward it with the work request (see Sec. 25.5). Identify the funding source for the task and indicate it on the work request. Keep FTED informed of the project's viability. Discuss with FTED and GSO the report evaluating the need for a detection system and the requirements for the detection system. Implement the recommendations for engineering controls as indicated in the GSO's evaluation. Sign the PSCR Monitor progress of the task via the FTED contact and keep the ASC informed. Send a copy of the GSO's evaluation, including appropriate actions taken per the evaluation, to the ASC as part of the Safety Permit Request. Initiate the deactivation process by completing and submitting a work request to FTED, with approval from the ASC and the GSO

25.6.2 Area Safety Committee (ASC)

The Area Safety Committee shall:

- a. Sign the work request to evaluate the need for a detection system or to deactivate the system
- b. Indicate on the Safety Permit the need for a detection system as a Condition for Operation

25.6.3 Glenn Safety Office (GSO)

It will be the responsibility of the GSO to:

- a. Review information provided by the requester and physically survey the area prior to evaluating the need for a detection system
- b. Evaluate the need for a detection system
- c. Contact the requester, the Environmental Management Office, and the ASC for additional technical assistance during the assessment process
- d. Recommend 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
- e. Provide FTED with an evaluation (appendix C) and the signed work request
- f. Coordinate the development of specialized evacuation procedures with the Building Manager, GSO, ASC, and requester. Update the Building Evacuation Plan
- g. Sign the work request for deactivation of the detection system

25.6.4 Environmental Management Office (EMO)

The EMO shall provide assistance to GSO on technical issues related to evaluation of the need for a detection system.

25.6.5 Facilities and Test Engineering Division (FTED)

The FTED 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:

- a. Coordinate the procedure for assessing the need for a detection system
- b. Use GSO's evaluation to create a biddable detection system design for Procurement
- c. Keep the requester informed of the status of the work request
- d. Inform the ASC, the GSO, and the requester of system installation or system deactivation
- e. Maintain configuration control on all detection systems
- f. Maintain a file with all appropriate documentation on detection systems, including dates of installation and deactivation.
- g. Design all changes to detection systems
- h. Activate the detection systems upon request (the initial activation shall take place while the installing contractor is present)
- i. Provide the necessary preventive maintenance and calibration to ensure proper operation of the detection systems
- j. Deactivate detection systems on request
- k. Manage the construction services for all new detection systems.

25.6.6 Building Manager

The Building Manager shall:

- a. Prepare/update the Building Evacuation Plan with the GSO on the basis of the GSO's evaluation
- b. Inform building occupants and building monitors of any modification to the Building Evacuation Plan.

25.7 APPENDIX A - DETECTION SYSTEM PROCESS

MS-Word version of this flow chart

- Activity involves the use of or operation of a material listed in Section 25.3
- Requester prepares and sends a work request to FTED to evaluate the need for and to design and install a detection system

- Requester completes supporting documentation (see appendix B of this chapter)
- Work request signed by division chief and chairman of the ASC
- Work request submitted to FTED
- FTED opens configuration management file
- FTED forwards work request to GSO
- GSO evaluates need for detection system
- GSO completes evaluation (see appendix --> Copies sent to C) requester and chairman of the ASC
- GSO signs work request
- GSO forwards work request and evaluation (appendix C) to COEB
- Detection system needed --->No - Requester informed -- Work request canceled
- FTED informs requester of need for detection system
- FTED sends PSCR to requester
- Requester signs PSCR and returns it to FTED
- FTED designs detection system
- FTED prepares design package for installation
- FTED prepares Form 347 (Supplies and Services) and forwards it to requester
- Requester signs Form 347 and returns it to FTED
- FTED oversees ordering and installing of equipment
- FTED's contractor tests system
- FTED notifies requester, GSO, and ASC that detection system has been installed
- FTED maintains configuration management file on the detection system
- GSO updates Building Evacuation Plan
- ASC adds detection system as a Condition of Operation on the Safety Permit
- FTED calibrates and maintains the detection system per manufacturer's recommendations
- Change/deactivation of detection system must be implemented via a work request that goes through the same process

Acronyms:

- ASC - Area Safety Committee
- FTED - Facilities Test Engineering Division
- PSCR - Process System Change Request
- GSO - Glenn Safety Office

25.8 APPENDIX B - SUPPORTING DOCUMENTATION FOR DETECTION SYSTEM WORK REQUEST

Work Request No. _____

Building: _____ Room/Area: _____

Requestor: _____ Date: _____

Description of System:

Attach preliminary design drawings or sketches.

Describe operational procedures:

List the materials to be used or stored and the quantity of each. Attach

MSDS's.

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

Describe existing or planned engineering controls, (e.g., interlocks, ventilation, 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:

25.9 APPENDIX C - EVALUATION OF NEED FOR DETECTION SYSTEM

Work Request No. _____

Building: _____ Room/Area: _____

Requestor: _____ Date: _____

GSO Engineer: _____

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:

Alarm Indicating Device(s) location:

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:

25.10 BIBLIOGRAPHY

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