

NASA Glenn Safety Manual

CHAPTER 16 - CONFINED SPACE ENTRY

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16.1 SCOPE

This chapter establishes health and safety procedures for entry and work in confined spaces. It is not intended to preclude the use of any additional safety measures that may be needed for a particular situation.

All confined spaces shall be considered immediately dangerous to life and health (IDLH) until proven otherwise.

16.2 DEFINITIONS

Acceptable environmental conditions: The conditions that must exist in a confined space to allow entry and to ensure that authorized entrants can safely enter into and work within the space.

Area Representative: An individual who has knowledge of an area, system, or facility where a confined space is located and the hazards of the confined space. This person may be the Area Supervisor, Building Manager, or other knowledgeable person.

Standby person/attendant: An individual stationed outside the confined space, who is trained as required by this chapter, and who monitors the authorized entrants inside the confined space. The responsibilities of the standby person/attendant are specified in Section 16.4.2.

Authorized entrant: An individual who is trained as required by this chapter and is qualified to enter a confined space. The responsibilities of the authorized entrant are specified in Section 16.4.1.

Blanking or blinding: The absolute closure of a pipe, line, or duct by fastening across its bore a solid plate that completely covers the bore. The plate shall be capable of withstanding the maximum upstream pressure from the pipe, line, or duct with no leakage beyond the plate.

Confined space: A space that has each of the following three characteristics:

- Is large enough and so configured that an employee can bodily enter and perform assigned work
- Has limited or restricted access for entry or exit, making it difficult for someone to enter or to rescue an individual in case of emergency
- Is not designed for continuous worker occupancy

and has one or more of the following characteristics:

- Contains or has the potential to contain a hazardous atmosphere (e.g., oxygen-deficient, oxygen-enriched, flammable, explosive, toxic, or otherwise harmful)
- Contains a material that has the potential for engulfing an entrant
- Has an internal configuration such that an entrant could be trapped or asphyxiated because of inwardly converging walls or a floor that slopes downward and tapers to a smaller cross section
- Contains any other recognized serious safety or health hazard (e.g., need for lockout/tagout provisions, need for personal protective equipment)

Confined spaces include, but are not limited to, storage tanks, pits, vats, reaction vessels, ventilation and exhaust ducts, boilers, silos, sewers, manholes, tunnels, trenches, underground utility vaults, and pipelines.

Double block and bleed: The closure of a line, duct, or pipe by closing, locking, and tagging two in-line valves and by opening, locking, and tagging a drain or vent that is in the line between the two locked-closed valves

Emergency: Any occurrence (including failure of hazard controls, ventilation equipment, or monitoring equipment) or event internal or external to the confined space that could endanger entrants

Engulfment: The surrounding and effective capture of a person by a liquid or finely divided solid substance

Entry: The action by which a person passes through an opening into a confined space and any ensuing work in that space. Entry is considered to have occurred as soon as any part of the entrant's body breaks the plane of an opening into the confined space.

Entry Permit (NASA Form C-199): A printed document that authorizes a specific entry by personnel into a confined space. The Entry Permit lists the hazards and hazard controls for the entry and the individuals responsible for implementing the hazard controls.

Entry Supervisor: The designated individual who has direct charge of the entry into the confined space. The Entry Supervisor must be trained as required by this chapter. The

Entry Supervisor is responsible for meeting the safety requirements specified in Part 2 of the Entry Permit, determining if acceptable entry conditions are present in a confined space, authorizing the entry, overseeing entry operations, and terminating the entry. The responsibilities of the Entry Supervisor are specified in Section 16.4.3.

Hazardous atmosphere: An atmosphere that may expose employees to the risk of death, incapacitation, injury, acute illness, or impairment of one's ability to self-rescue from one or more of the following causes:

- A flammable gas, vapor, or mist in excess of 10 percent of the lower explosive limit (LEL)
- An airborne combustible dust at a concentration that obscures vision at a distance of 5 feet or less
- An atmospheric oxygen concentration below 19.5 percent or above 23.5 percent
- An atmospheric concentration of any substance for which exposure could occur in excess of its permissible exposure limit (PEL) or threshold limit value (TLV)
- Any atmospheric condition recognized as immediately dangerous to life or health (IDLH)

Immediately dangerous to life or health (IDLH): Any condition that poses an immediate or delayed threat to life or that could cause irreversible adverse health effects or that would interfere with an individual's ability to escape unaided from the confined space

Isolation: A process by which the confined space and systems within the confined space are removed from service, and completely protected against the inadvertent release of energy or material, by placing them in a zero mechanical state. This includes electrical lockout of all sources of power, mechanical disconnects, blanking or blinding, and double block and bleed systems.

Lower explosive limit (LEL): The minimum concentration (usually expressed in percent by volume at sea level) of a flammable gas or vapor in air that will ignite if an ignition source (sufficient ignition energy) is present

Oxygen-deficient atmosphere: An oxygen concentration of less than 19.5 percent by volume

Oxygen-enriched atmosphere: An oxygen concentration greater than 23.5 percent by volume

Permissible exposure limit (PEL): The maximum 8-hour time-weighted-average (TWA) concentration of an airborne contaminant to which an employee may be exposed as specified in 29 CFR 1910, Subpart Z. At no time shall the exposure level exceed the contaminant's ceiling concentration or the short-term exposure limit (STEL) specified in 29 CFR 1910, Subpart Z.

Retrieval line: The equipment (including a retrieval line, chest or full-body harness, wristlets (if appropriate), and a lifting device or anchor) used for non-entry rescue of persons from a confined space

Short-term exposure limit (STEL): A 15-minute time-weighted-average (TWA) concentration specified in 29 CFR 1910, Subpart Z that shall not be exceeded even if the 8-hour TWA is below the PEL

Threshold limit value (TLV): The time-weighted-average (TWA) concentration for a normal 8-hour workday and a 40-hour workweek to which nearly all workers may be repeatedly exposed, day after day, without adverse effects

16.3 APPLICABILITY

This chapter applies to:

- a. All NASA Glenn Research Center (Cleveland Center and Plum Brook Station (PBS) organizations and employees.
- b. All Glenn contractors, other NASA contractors, non-NASA and non-contractor individuals present at Glenn in accordance with the terms of their contracts or agreements with NASA
- c. Other Government organizational elements who are tenants at Glenn or any other locations under Glenn jurisdiction

16.4 RESPONSIBILITIES

16.4.1 Entrants

Responsibilities of the entrants are to:

- a. Recognize potential hazards, including symptoms and consequences of exposure to the hazards.
- b. Complete training per Section 16.7 of this chapter.
- c. Sign the Entry Permit to verify that the requirements of the permit have been read and that the allow for safe entry into the confined space.
- d. Isolate the confined space and the equipment within the confined space as required by the Entry Permit and appropriate lockout/tagout procedures.
- e. Study the entrance and exit routes and ensure that entry into and exit from the confined space can be made readily.
- f. Use personal protective equipment properly if required by the Entry Permit.
- g. Verify that atmospheric tests have been conducted
- h. Enter the confined space only after ensuring that all the precautions listed on the Entry Permit have been taken.

- i. Maintain communications with the standby person/attendant, as necessary, once inside the confined space, thereby enabling the standby person/attendant to monitor the entrants.
- j. Alert the standby person/attendant and exit the confined space whenever
 - Any warning sign or symptom of exposure to a dangerous situation is recognized
 - A prohibited condition is detected
- k. Exit the space immediately if the standby person/attendant orders an evacuation or if danger is perceived.
- l. Notify the standby person/attendant prior to a self-initiated evacuation of the space.

16.4.2 Standby persons/attendants

Responsibilities of the standby persons/attendants are to:

- a. Complete training per Section 16.7 of this chapter.
- b. Sign the Entry Permit to affirm that the requirements of the permit have been read and that the yellow for safe entry into the confined space.
- c. Verify that communications equipment for the standby person/attendant and entrant is present and operational.
- d. Verify that communications equipment for summoning rescuers is present and operational.
- e. Monitor the entry of only one confined space at a time.
- f. Monitor the retrieval line, if there is one present.
- g. Recognize potential hazards, including symptoms and consequences of exposure to the hazards, and monitor activities inside and outside the confined space to ensure that it is safe for the entrants to remain in the confined space.
- h. Be aware of possible behavioral effects of exposure to low oxygen or toxic chemicals.
- i. Remain immediately outside the entrance to the confined space the entire time the confined space is occupied.
- j. Maintain an accurate count of all persons in the confined space as well as the time each entrant spends within the space.
- k. Maintain effective and continuous communication with the entrants while they are within the confined space.
- l. Order entrants to evacuate the confined space immediately if
 - A condition is detected that the Entry Permit forbids
 - Symptoms or behavioral effects of hazard exposure are detected
 - A situation that could endanger the entrants is detected inside or outside of the confined space
 - The standby person/attendant must leave the workstation or cannot effectively and safely perform these responsibilities.

- m. Summon rescue and other emergency aid as soon as it is determined that the entrants must escape from the confined space hazards. Note: The standby person/attendant shall not enter the confined space to rescue entrants.
- n. Warn unauthorized persons away from the confined space if they approach the confined space area.

16.4.3 Entry Supervisors

Entry Supervisors shall:

- a. Ensure that the requirements of this chapter have been properly implemented.
- b. Complete training per Section 16.7 of this chapter.
- c. Ensure that the entrants and standby persons/attendants have completed training per Section 16.7 of this chapter.
- d. Properly identify the hazards of the confined space, including symptoms and consequences of exposure to the hazards.
- e. Prepare Parts 1 and 2 of the Entry Permit.
- f. Contact the GSO/Plum Brook Management Office to review and approve the Entry Permit.
- g. Develop an operating procedure for entry into a confined space, if necessary.
- h. Ensure that the authorized entrants and standby persons/attendants read and sign the Entry Permit.
- i. Post the approved Entry Permit in a conspicuous location near the entrance of the confined space.
- j. Use the Entry Permit to ensure necessary safety precautions have been taken.
- k. Verify that the confined space and equipment within the confined space have been appropriately isolated and locked out/tagged out per Chapter 9 of this Manual, if required. List isolation points on the Entry Permit.
- l. Ensure that atmospheric tests have been conducted and that the results meet the acceptable environmental standards.
- m. Verify that the required alarms, ventilation equipment, monitoring equipment, communications equipment, and rescue equipment are present and operational.
- n. Ensure that entry operations are consistent with the terms of the Entry Permit and that acceptable environmental conditions are present. Sign the Entry Permit, thereby affirming that all the safety measures listed on the Entry Permit have been taken and that they allow for safe entry into the confined space.
- o. Ensure that electrical equipment used inside the confined space is properly insulated and grounded. If the confined space is subject to potential contamination by combustible or flammable vapors, ensure that the equipment is explosion-proof in accordance with Section 500 of the National Electrical Code.
- p. Ensure that any electrical power receptacle used in the confined space has a ground fault circuit interrupter (GFCI).

- q. Use appropriate barricades to keep unauthorized persons away from the confined space and to protect entrants from external hazards.
- r. Ensure that the standby person/attendant remains outside of the confined space at all times during the entry operations.
- s. Cancel the Entry Permit and terminate entry if acceptable environmental conditions are not present or if the conditions or work procedures described on the Entry Permit or the Operating Procedure change. The GSO/Plum Brook Management Office must then be contacted to determine precautions for future entry.
- t. Take the necessary measures to conclude the entry operation, such as closing off the confined space and canceling the Entry Permit, once the work inside the confined space has been completed.
- u. Forward the Entry Permit to the GSO (MS 501-4) or Plum Brook Management Office after the work inside the confined space is completed.
- v. Take appropriate measures to remove unauthorized persons who are in or near the confined space. Contact the Security Branch if necessary.
- w. Report any new or unidentified confined spaces to the GSO/ Plum Brook Management Office.

16.4.4 Contracting Officer's Technical Representative (COTR)

The COTR shall:

- a. Ensure that contractors, including all entrants, standby personnel/attendants, and Entry Supervisors, have completed a formal Confined Space Entry training class within the last 2years. Provide the GSO/Plum Brook Management Office with proof of this training.
- b. Sign the Entry Permit, thereby affirming that all specified safety precautions have been taken.

16.4.5 GSO/Plum Brook Plant Protection

At Cleveland it is the responsibility of the Glenn GSO and at Plum Brook the responsibility of Plant Protection to:

- a. Complete training per Section 16.7 of this chapter.
- b. Ensure that air monitoring equipment has been calibrated.
- c. Conduct oxygen content, combustible gas, carbon monoxide, and hydrogen sulfide testing, as required.
- d. Check that the requirements specified in Part 2 of the Entry Permit, such as appropriate rescue equipment, have been met.
- e. Coordinates rescue and emergency operations when summoned. (At Plum Brook Station, Plant Protection coordinates and supports rescue and emergency procedures with the Perkins Township Fire Department.)
- f. Use personal protective equipment and rescue equipment properly.

- g. Maintain current certification in basic first aid and cardiopulmonary resuscitation (CPR) skills.
- h. Practice making rescues from confined spaces at least once every 12 months. (At Plum Brook Station, the Plum Brook Management Office shall ensure involvement of the Perkins Township Fire Department in the practice rescues.)

16.4.6 GSO/Plum Brook Management Office

GSO/Plum Brook Management Office personnel shall:

- a. Complete training per Section 16.7 of this chapter.
- b. Determine if an area meets the definition of a confined space per Section 16.2 of this chapter.
- c. Provide assistance to the Entry Supervisors in the preparation of the Entry Permit by advising on the potential hazards of the confined space and the necessary precautions for entry.
- d. Determine if a written Operating Procedure is required.
- e. Review and approve the Entry Permit and the Operating Procedure.
- f. Review the types of air monitoring tests required.
- g. Assign an expiration date to the Entry Permit.
- h. Maintain a file copy of approved Entry Permits and the canceled Entry Permits.
- i. Maintain an inventory list of all identified confined spaces.
- j. Review activities during confined space pre-entry and entry to ensure conformance to this chapter.
- k. Review the confined space program annually to ensure compliance with this chapter.
- l. Review canceled Entry Permits annually to ensure that the confined space program is adequate.
- m. Review calibration records periodically.

16.4.7 Area Safety Committee

Area Safety Committee members shall:

- a. Be aware of the presence of confined spaces in their respective areas and of the hazards of confined spaces.
- b. Report any new or unidentified confined spaces to the GSO/ Plum Brook Management Office.

16.4.8 Area Representative

Responsibilities of the Area Representative (as defined in Sec. 16.2) are to:

- a. Complete training per Section 16.7 of this chapter.
- b. Be aware of the presence of confined spaces in their respective buildings and of the hazards of confined spaces.
- c. Assist the Entry Supervisor in the completion of the Entry Permit.
- d. Monitor confined spaces so as to detect unauthorized entries.
- e. Ensure that confined spaces are properly identified with a "Caution" sign (see Sec. 16.9).
- f. Report any new or unidentified confined spaces to the GSO/Plum Brook Management Office.
- g. Notify the GSO/Plum Brook Management Office of any alterations to a confined space so they may ensure that the hazards of the confined space have not been affected.

16.4.9 Environmental Management Office/Plum Brook Management Office

Environmental Management Office/Plum Brook Management Office personnel with confined space program responsibilities shall:

- a. Complete training per Section 16.7 of this chapter.
- b. Perform testing and monitoring for toxic substances within the confined space, as necessary.
- c. Administer the Respiratory Protection Program and the Hearing Conservation Program when required.
- d. Retain copies of atmospheric testing results.
- e. Determine the precautions to be followed if any radiation hazards are present.

16.4.10 Technical and Administrative Training Office

The Technical and Administrative Training Office is responsible for maintaining a list of civil servant personnel who have been trained per this chapter. (The Plum Brook Management Office shall maintain a list of Plum Brook Station personnel who have been trained per this chapter.)

16.5 PROCEDURES FOR ENTRY INTO A CONFINED SPACE

A flowchart of the following procedures appears in the appendix.

16.5.1 Prior to Entry

Prior to entry into a confined space, the following provisions shall be met:

- a. The GSO/Plum Brook Management Office has determined that the space meets the definition of a confined space as specified in Section 16.2 of this chapter and a sign identifying the confined space has been posted (see Sec. 16.9).
- b. The Entry Supervisor has verified that entry into the confined space is necessary.
- c. The potential hazards of the confined space and the work to be performed in the confined space have been identified and assessed by the Area Representative and/or the Entry Supervisor.
- d. Training of the authorized entrants, standby persons/attendants, and Entry Supervisors per Section 16.7 has been completed and documented.
- e. An Entry Permit has been completed by the Entry Supervisor. If required, the Entry Supervisor shall also complete an Operating Procedure.
- f. Training of the Entry Supervisor, the authorized entrants, and the standby persons/attendants listed on the Entry Permit has been completed per Section 16.7.
- g. The GSO/Plum Brook Management Office has verified that the appropriate air monitoring tests have been specified on the Entry Permit.
- h. The GSO/Plum Brook Management Office has approved the Entry Permit and the Operating Procedure and assigned an expiration date. A copy of the approved Entry Permit has been filed in the GSO/Plum Brook Management Office.
- i. The Entry Supervisor has ensured that no source of ignition (flame, arc, spark, or static electricity) will be permitted in the confined space until tests conducted by the Glenn Safety Office/Plant Protection (PBS) have confirmed that no combustible gas or vapor mixtures exist.
- j. Oxygen content, combustible gas, and other required atmospheric testing have been conducted by the GSO/Plant Protection (PBS) and the Environmental Management Office/Plum Brook Management Office (if necessary), thereby ensuring that appropriate precautions are specified on the Entry Permit.
- k. Accidental introduction of hazardous materials, inert gases, dangerous air contamination, air pressure or vacuum into the confined space through interconnecting equipment such as piping, ducts, vents, drains, and such, has been prevented by appropriate means such as disconnecting, blanking,

blinding, or double blocking and bleeding. The Entry Supervisor has verified that this has been completed.

- l. To prevent injury to those entering the confined space, all fixed equipment containing moving parts within the confined space has been de-energized and locked and/or tagged out in accordance with Chapter 9 of this Manual. The Entry Supervisor has verified that this has been completed.
- m. Electrical circuits in confined spaces have been de-energized and locked and/or tagged out in accordance with Chapter 9 of this Manual. If electrical integrity of the system must be maintained, proper precautions have been taken to ensure personnel safety. The Entry Supervisor has verified that this has been completed. These precautions shall be specified in the Operating Procedure and included with the Entry Permit.
- n. The Entry Supervisor has verified the completion of atmospheric testing and that the results meet the acceptable environmental conditions.
- o. If necessary, the confined space has been purged and/or ventilated. The Entry Supervisor has verified that this has been completed.
- p. Atmospheric tests have been conducted a second time, if required (after the confined space has been purged and/or ventilated and prior to entry).
- q. The Entry Supervisor has ensured that electrical equipment used inside the confined space is properly insulated and grounded. If the confined space is subject to potential contamination by combustible or flammable vapors, gases, or particulates, the electrical equipment used must be explosion-proof in accordance with Section 500 of the "National Electric Code" (NFPA 70). If hand tools are used, they shall be non-sparking.
- r. The Entry Supervisor has ensured that all electrical equipment has a ground fault circuit interrupter at the power source, unless the power source is an ungrounded portable generator, an ungrounded battery source less than 28 volts, or an ungrounded isolation transformer of less than 28 volts(s) Provisions have been made by the authorized entrants and standby person/attendant for ready access to and exit from the confined space. Emergency egress must be made whenever an evacuation alarm is heard or whenever the standby person/attendant signals for an evacuation.
- s. The standby person/attendant has verified that communications equipment is present and operational.
- t. The standby person/attendant has verified that rescue equipment is present and operational.
- u. The Entry Supervisor has verified that all required ventilation equipment, monitoring equipment, communications equipment, and rescue equipment are present and operational.
- v. The Entry Supervisor has verified that any required alarms (such as for ventilation equipment, low oxygen detectors, etc.) are operational.
- w. The Entry Supervisor has verified that continuous monitoring equipment (if required) is calibrated, positioned correctly, and operational.
- x. Personal protective equipment has been inspected by the authorized entrants.
- y. The Entry Supervisor has ensured that appropriate pedestrian or vehicle barricades are in place.

- z. The Entry Supervisor has informed the standby person/attendant to remain outside the confined space at all times during entry operations.
- aa. The authorized entrants, standby persons/attendants, and Entry Supervisor have signed the Entry Permit to affirm that the requirements on the Entry Permit allow for safe entry.
- bb. The standby person/attendant is positioned outside the confined space entrance. The standby person/attendant shall keep a log of all the entrants as they go in or exit from the confined space and the time that each entrant spends in the confined space.
- cc. The Entry Supervisor has posted the Entry Permit in a conspicuous location close to the entrance of the confined space.

The Entry Supervisor is responsible for ensuring that all the requirements specified on the Entry Permit have been followed prior to entry. If the conditions or work procedures described on the Entry Permit or the Operating Procedure change, a new Entry Permit shall be completed and approved.

16.5.2 After the First Entry

Immediately after the first authorized entrant has entered the confined space, the following actions shall be performed:

- a. The communication system between the entrant and the standby person/attendant shall be tested to confirm its effectiveness.
- b. Communication between the entrant and the standby person/attendant shall be maintained to ensure the safety of the entrant.

If any of the conditions (e.g., configuration, procedures, materials, equipment, or personnel) specified on the Entry Permit change or if the nature of the work to be performed in the confined space changes, the entrants must exit the confined space and a new Entry Permit must be completed and approved prior to reentry.

16.5.3 After Work Is Completed

After completion of the work within the confined space, the following actions shall be performed:

- a. The standby person/attendant shall verify via his/her log that all entrants have exited the confined space.
- b. The entrants and Entry Supervisor shall restore the equipment to operational readiness.
- c. The Entry Supervisor shall cancel the Entry Permit and forward the permit to the Glenn Safety Office/Plum Brook Management Office.

16.6 CONFINED SPACE ENTRY PERMIT

Entry into a confined space will be by permit only. The Entry Permit (NASA Form C-199) is an authorization and approval form that identifies the confined space and the type of work to be done within the space. The Entry Permit certifies that all known hazards have been evaluated by a qualified person and that the necessary protective measures have been recommended to ensure the safety of the authorized entrants.

An Entry Permit is required for each entry into a confined space. The Entry Supervisor is responsible for completing the Entry Permit. A copy of an Entry Permit is shown in the appendix.

The GSO/Plum Brook Management Office is responsible for reviewing and approving the Entry Permit, and for establishing an expiration date for the Entry Permit. The permit typically will be valid for a maximum of two weeks; however, for some routine maintenance procedures, the GSO/Plum Brook Management Office may extend the expiration date up to a maximum of 1 year. All extended permits require the approval of the chief of the ISO or the GSO/Plum Brook Management Officer (see Sec. 16.6.1).

If any of the conditions (e.g., configuration, procedures, materials, equipment, or personnel) specified on the Entry Permit change or if the nature of the work to be performed in the confined space changes, the entrants must exit the confined space and a new Entry Permit must be completed and approved prior to reentry.

16.6.1 Extended Permits

An Entry Permit may be issued for up to a maximum of 1 year for routine operations or maintenance procedures where there is little or no possibility of a hazardous atmosphere. All extended permits will expire on January 15 of each year. Extended permits also require an operating procedure that includes all the actions taken by the entrants to perform the required tasks within the confined space. The operating procedure and the extended permit shall be approved by the chief of the ISO or the GSO/Plum Brook Safety Officer.

Once the extended permit is approved, only the authorized entrants listed on the permit may enter the confined space. The entrants may perform only the tasks specified on the permit. If, at anytime, there is a change in the procedures or conditions specified on the extended permit or the operating procedure, the Entry Supervisor must obtain a new Entry Permit.

16.7 TRAINING REQUIREMENTS

All Glenn employees and resident contractors involved with entry into or working in confined spaces shall have training in confined space entry. This training shall familiarize authorized personnel with the following:

- a. The types of confined spaces found at Glenn
- b. The physical and chemical hazards involved and the signs and symptoms of exposure to these hazards (per Glenn' Hazard Communication program), the need for atmospheric testing, and the appropriate methods of fire protection
- c. Entry and exit procedures
- d. Cleaning, purging, and ventilation
- e. Isolation and lockout methods per this Manual, Chapter 9
- f. Personal protective equipment
- g. Responsibilities of the standby person/attendant, entrant, Entry Supervisor, Area Representative, GSO, rescuers, and the Environmental Management Office
- h. Communication systems
- i. Rescue and emergency response procedures
- j. The Entry Permit
- k. Atmospheric testing and monitoring of the confined space

16.7.1 Contractor Training

COTR's shall ensure that all fixed-transient or fixed-price contractors involved in confined space entries have had formal OSHA confined space entry training within the last 2 years. In addition, these contractors shall attend a Glenn-specific, worksite-specific confined space entry review, provided by the GSO/Plum Brook Management Office, prior to confined space entry.

16.7.2 Training Records

Training records shall be documented and submitted to the Technical and Administrative Training Branch, who will maintain the Authorized Personnel Roster of trained civil service employees. The GSO shall maintain a file copy of the roster. The Plum Brook Management Office shall maintain a list of Plum Brook Station personnel who have been trained per this Chapter.

Contractors shall maintain a list of their employees who have completed Confined Space Entry training and the dates the training was completed.

16.7.3 Refresher Training

After the initial training, refresher training shall be completed every 2 years.

16.8 HAZARDS OF CONFINED SPACES

One of the most significant hazards of working in a confined space is the difficulty associated with rescue from the space. Other hazards are summarized in the following sections.

16.8.1 Hazardous Atmospheres

Flammable/oxygen-enriched atmosphere

A flammable atmosphere is generally due to enrichment with oxygen (which increases the flammability range of combustibles), vaporization of flammable liquids (such as acetylene, butane, propane, hydrogen, methane, natural gas, liquid hydrocarbons, etc.), byproducts of work procedures (such as spray painting or welding), chemical reactions, concentrations of combustible dusts, and desorption of chemicals from inner surfaces of the confined space.

Toxic atmosphere

A toxic atmosphere can result from a product stored in the confined space, from the operations being performed (such as welding or spray painting), or from chemicals brought into the space (such as cleaning fluids).

Irritant or corrosive atmosphere

Irritants include primary irritants such as chlorine, acids, and ammonia as well as secondary irritants such as benzene, carbon tetrachloride, and trichloroethane.

Oxygen-deficient (asphyxiating) atmosphere

The normal atmosphere is composed of approximately 20.9 percent oxygen and 78.1 percent nitrogen. An oxygen level below 19.5 percent can result in oxygen deprivation. A reduced oxygen level may be caused by consumption of the oxygen during chemical reactions (e.g., by combustion in welding, heating, cutting, or brazing or by rusting), by microbial growth, or by the displacement of oxygen by another gas such as argon, helium, nitrogen, or carbon dioxide.

16.8.2 Physical Hazards

General physical hazards

General physical hazards must be considered when determining appropriate precautions for entry into a confined space. These types of hazards include possible entrapment or engulfment, ladders or scaffolding, surface residues in the confined space, protrusions, baffles, bends in tunnels, and overhead structural members. These types of hazards not only put the worker at risk but also can impede rescue attempts.

Temperature

Work in hot and cold environments requires the use of protective, insulated clothing. Therefore, in addition to the physical hazards of hot and cold conditions, the worker has

added bulk that must be considered when allowing for movement in the confined space and for exit time.

Chemicals

Some chemicals can be absorbed through the skin. Therefore, personal protective equipment, engineering controls, and appropriate work practices must be used to prevent skin exposure to these chemicals. These chemicals are denoted with an "x" in the "Skin designation" column of table Z-1-A in 29 CFR 1910.1000.

Noise

Noise problems are typically intensified in confined spaces because the noise can reverberate within the space. Generally, hearing protection is required if the noise level is above 90decibels for any period of time or above 85 dBA for an 8-hour time-weighted average (per Ch. 15).The increased intensity of the noise within the confined space and/or within the worker's hearing protection can also disrupt the communication between the authorized entrant and the standby person/attendant; this should be considered when choosing communications equipment and defining communication procedures as specified in Section 16.13 of this chapter.

The Environmental Management Office/Plum Brook Safety Office shall be contacted to recommend proper hearing protection equipment.

Vibration

Vibration causes added stress to the worker inside the confined space and may decrease his ability to note potentially dangerous situations.

Electrical and mechanical equipment

If activation of electrical or mechanical equipment could cause injury, each piece of equipment shall be manually isolated, locked out and tagged out per Chapter 9 of this Manual to prevent inadvertent activation. If combustible or flammable gases, vapors, or particulates may be present in the confined space, all electrical equipment used shall be explosion-proof in accordance with NFPA 70, Section 500 of the "National Electric Code" (NEC). All electrical equipment brought into the confined space shall have a ground fault circuit interrupter (GFCI) at the power source (refer to Sec. 16.5.1.(r). If hand tools are used, they shall be nonsparking.

16.8.3 Other Hazards

Vapor leaks

To prevent vapor leaks, flashover, and the introduction of other hazards or hazardous materials, the confined space shall be completely isolated by blanking or disconnecting pipes (see Ch. 9 of this Manual).

Radiation

The Environmental Management Office shall be contacted if there is any potential radiation hazard.

Communication problems

In some confined spaces, visual contact between the entrant and standby person/attendant is not possible. If visual monitoring of the entrant is not possible, voice or alarm-activated types of communication systems shall be used.

Inadequate illumination

Suitable, approved illumination is required to provide sufficient visibility for the work being done in the confined space. If combustible vapors, gases, or particulates may be present, all lighting must be explosion-proof in accordance with NFPA 70, Section 500 of the "National Electrical Code" (NEC).

Entry and exit limitations

Entry and exit time can significantly affect the potential hazard of the confined space. Consideration for the following must be made: access to the entrance of the confined space, number and size of the openings, barriers within the space, occupancy load, time required to exit the space in case of an emergency, and time required to rescue injured entrants.

16.9 IDENTIFICATION OF CONFINED SPACES

Area Representatives are responsible for identifying confined spaces. The Glenn Safety Office/Plum Brook Management Office shall be notified whenever a new confined space is identified. If a confined space is altered, the Area Representative must notify the Glenn Safety Office/Plum Brook Management Office, who will determine if any of the hazards have changed.

The GSO/Plum Brook Management Office will maintain a list of identified confined spaces and their hazards. Each confined space will be identified by a unique identification code. The GSO/Plant Protection (PBS) and the Environmental Management Office will receive a copy of this list.

The Building Manager shall obtain a sign (via a work request) to identify the confined space and warn employees. The sign will contain such words as "CAUTION," "CONFINED SPACE," "ENTRY BY PERMIT ONLY," and "Contact the GSO at 3-3019 for permit." The specific confined space identification code shall also be identified on the sign.

The GSO/Plum Brook Management Office will recommend appropriate barricades and/or barriers to prevent unintentional entry into the confined space.

16.10 PERSONAL PROTECTIVE EQUIPMENT

The type of personal protective equipment required shall be specified on the Entry Permit by the Entry Supervisor, in accordance with Chapter 15, Personal Protective Equipment. The Glenn Safety Office/Plum Brook Management Office and the Environmental

Management Office, when necessary, shall then review the Entry Permit to aid the Entry Supervisor in determining the types of personal protective equipment required.

16.10.1 General Personal Protective Equipment

Types of personal protective equipment include eye and face protection, head protection, foot protection, protective clothing, hand protection, and hearing protection. These types of protective equipment and their proper use are described in Chapter 15 of this Manual.

16.10.2 Respiratory Protection

When results of atmospheric monitoring in a confined space prior to entry show the atmosphere to be potentially hazardous to life or health, then the space shall be ventilated to eliminate the hazard. If the hazard cannot be eliminated or reduced to the permissible exposure level (PEL) by mechanical means, the entrants shall wear respiratory protection. The Environmental Management Office/Plum Brook Management Office will determine the proper level of respiratory protection on the basis of the hazard(s) found inside the confined space. The Glenn Respiratory Protection Program shall provide the guidelines for entrants using respiratory protection.

Any changes in the atmosphere inside the confined space shall be reported immediately to the Glenn Safety Office/Plum Brook Management Office and the Environmental Management Office. The situation will be evaluated and respiratory protection changes will be made as required.

16.10.3 Rescue Equipment

The combination of a body harness with an attached lifeline may be used to facilitate non-entry rescue; however, these devices are not required if the retrieval equipment would increase the overall risk of the entry or would not contribute to the rescue of the entrant. Non-entry rescue may not be possible if there are equipment, machinery, bends, or other obstacles in the confined space. If the confined space has a vertical entry over 5 feet deep and a body harness with an attached lifeline is used, there shall also be some sort of mechanical device (e.g., a hand-powered winch and tripod) to facilitate non-entry rescue.

If corrosive materials are present, an emergency shower and eyewash unit must be accessible within 100 feet of the confined space opening (per ANSI Z 358.1).

16.11 TESTING AND MONITORING PROCEDURES

Entry into a confined space is prohibited until the atmosphere has been tested for oxygen content, flammability, and toxic materials. The oxygen content must be determined by appropriate testing prior to measuring the flammability. Testing for oxygen content, flammability, carbon monoxide, and hydrogen sulfide shall be conducted by the GSO at the Cleveland Center or by Plant Protection (or other trained personnel) at Plum Brook.

Testing for toxic materials shall be conducted by the Environmental Management Office/Plum Brook Management Office.

In a typical test, proceed as follows:

- a. Ensure that the air-monitoring equipment has been calibrated per the manufacturer's guidelines.
- b. Conduct atmospheric testing near the opening of the confined space prior to opening the accessway to the confined space.
- c. Open the access way to the confined space.
- d. From outside of the confined space, test the entry area and the area where the task will be performed. Obtain enough samples to be representative of the atmosphere within the confined space. Typically this will require sampling at all levels (top, middle, and bottom) of the confined space.
- e. Purge and/or ventilate the confined space, if necessary.
- f. Test the atmosphere again as described in step (d). **Note: Testing must be conducted before each entry.**

If the individual conducting air testing must enter the confined space in order to complete the atmospheric testing, the individual shall wear a supplied-air respirator or an SCBA, as well as a combination of a body harness (and/or safety belt) and an attached lifeline.

The Environmental Management and the GSO/Plum Brook Management Office, on the basis of the hazards in the confined space and the work being performed within the space, will determine if continuous air monitoring must be conducted. If welding or painting is being done, continuous air monitoring may need to be conducted. The Entry Supervisor or entrant may also request that continuous air monitoring be conducted.

Testing and monitoring equipment shall be calibrated in accordance with the manufacturer's guidelines. A record of each calibration shall be filed and be available for inspection for a period of 3 years from the calibration date.

16.12 VENTILATION EQUIPMENT AND PROCEDURES

Employees shall not be exposed to air contaminants in concentrations in excess of those specified in 29 CFR 1910, Subpart Z; therefore, it is frequently necessary to purge and ventilate the confined space prior to entry. The type of ventilation used can be general ventilation or local exhaust ventilation. Depending on the nature of the confined space and the contaminants, continuous ventilation may be required. If acceptable levels of oxygen and contaminants are maintained for three consecutive tests at 5-minute intervals, continuous ventilation is probably not required. If toxic atmospheres are produced as part of the work procedures, such as welding or painting, then continuous ventilation is required. Local exhaust ventilation may be provided when general ventilation is not effective because of restrictions in the confined space or when high concentrations of contaminants are present in the workers' breathing zones.

If welding is being done inside of the confined space, forced air ventilation or use of supplied-air respirators is required.

For entries requiring continuous ventilation, air flows must be measured before each entry to ensure adequate air flow. If the confined space is categorized as immediately dangerous to life and health (IDLH), audible and/or visual warning devices will be needed to indicate ventilation failure.

Exhaust systems shall be designed so that workers in the surrounding areas are protected from the contaminated air.

When combustible or flammable gases or vapors may be present, ventilation equipment (if required) must be explosion-proof and must comply with NFPA 70, Section 500 of the "National Electric Code" (NEC). In addition, the bonding requirements of NEC Section 250 must be met. When combustible dusts or ignitable fibers or particulates may be present, ventilation equipment must comply with Sections 502 and 503 of the NEC.

Blower controls should be kept at a safe distance from the confined space.

16.13 COMMUNICATIONS EQUIPMENT

The entrants, standby persons/attendants, Entry Supervisors, and rescuers must be familiar with the communication system being used for each entry.

16.13.1 Communication With Entrant

The standby person/attendant shall maintain constant verbal communication with the authorized entrant. If voice communications are inadequate because of noise, distance, personal protective equipment, or other conditions, an alternate communication system such as visual contact, rope signals, radios, light, or other electrical or electronic alarm devices shall be used.

16.13.2 Rescue Communications

The standby person/attendant shall have a pre-arranged communication link (radio or immediate access to a telephone) with the GSO/Plant Protection (PBS) in the event of an emergency. The emergency phone number, 911, must be posted at the telephone(s) from which rescue would be summoned. If a telephone or radio is not immediately accessible, an emergency alarm signal device must be kept near the standby person/attendant and used to summon rescuers.

16.14 RESCUE PROCEDURES

The GSO is responsible for rescues from confined spaces at the Cleveland Center. At Plum Brook Station, Perkins Township Fire Department will perform rescues from confined spaces.

The standby person/attendant is not responsible for the actual rescue of an injured entrant; he/she must summon the specified rescuers by dialing 911 or by using some other pre-arranged communications method (see Sec. 16.13.2).

If an entry is classified as immediately dangerous to life and health (IDLH), a person certified in first aid and CPR must be in attendance at the confined space during the entry.

16.15 COMPLETION OF WORK IN THE CONFINED SPACE

When the required work is completed within the confined space, the Entry Supervisor is responsible for ensuring that the space is returned to its normal state. This includes verifying that all entrants have exited the space; reinstating equipment to operational readiness; and canceling the Entry Permit and forwarding it to the GSO (MS 501-4) or the Plum Brook Management Office.

16.16 MEDICAL SURVEILLANCE

Authorized entrants who are required to use respirators must undergo a medical evaluation per 29CFR 1910.134 (b)(10) and Glenn' Respiratory Protection Program. Authorized entrants must also demonstrate an ability to see and hear warnings.

16.17 RECORDKEEPING

Approved and canceled Entry Permits will be retained on file in the GSO/Plum Brook Management Office.

Training records will be kept on file by the Technical and Administrative Training Office/Plum Brook Management Office for a minimum of 3 years.

Calibration records for testing and monitoring equipment will be kept on file by the appropriate organization for a minimum of 3 years.

Results of inspections and reviews as described in Section 16.18 of this chapter will be kept on file by the GSO/Plum Brook Management Office for a minimum of 3 years.

Atmospheric testing results will be retained by the Environmental Management Office/Plum Brook Management Office in accordance with 29 CFR 1910.20.

16.18 INSPECTIONS AND REVIEWS

The GSO/Plum Brook Management Office will randomly inspect confined spaces to ensure compliance with this chapter during the pre-entry and entry activities.

The GSO/Plum Brook Management Office will randomly review monitoring equipment calibration records.

The confined space program will be reviewed annually by the GSO/ Plum Brook Management Office for conformance to this chapter. Results will be documented and kept on file in the GSO/Plum Brook Management Office.

16.19 APPENDIX CONFINED SPACE ENTRY PERMIT AND FLOWCHART

Confined Space Entry Permit Flow Diagram
Confined Space Entry Permit

16.20 BIBLIOGRAPHY

- ANSI Z117.1 American National Standards Institute. Safety Requirements for Confined Spaces.
- ANSI Z358.1 American National Standards Institute. 1990. Emergency Eyewash and Shower Equipment.
- NFPA 70, Ch. 2, Sec. 250. National Fire Protection Association. 1990. National Electric Code Wiring and Protection. Grounding.
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- NIOSH Publication No. 87-113. A Guide to Safety in Confined Spaces.
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- Sec. 20 et seq. Access to Employee Exposure and Medical Records.
- Sec. 134. Respiratory Protection Requirements for a Minimal Acceptable Program.
- Sec. 146. Permit Required Confined Spaces.
- Sec. 1000. Air Contaminants.
- Pt. 1926, Sec. 21. First Aid and Medical Attention.
- Sec. 353. Ventilation and Protection in Welding, Cutting, and Heating.

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