

CHAPTER 16 – CONFINED SPACE ENTRY

16.1 SCOPE

This chapter establishes guidelines for the determination of health and safety procedures for entry and work in Permit-Required Confined Spaces at the NASA-Glenn Research Center (GRC). It is not intended to preclude the use of any additional safety measures that may be needed for a particular situation.

All GRC confined spaces shall be considered Permit-Required unless an evaluation has been made to the contrary. The Safety Branch (SB) and the Occupational Health Branch (OHB) at Lewis Field and the Plum Brook Management Office (PBMO) at Plum Brook Station shall perform this evaluation.

16.2 AUTHORITY

The authority for the Confined Space Entry Chapter is derived:

- 42 U.S.C. 2473, Section 203(c)(1) of the National Aeronautics and Space Act of 1958, as amended.
- 29 U.S.C. 668, Section 19 of the Occupational Safety and Health Act of 1970, as amended.
- 29 CFR Part 1960, “Basic Program Elements for Federal Employee Occupational Safety and Health Programs and Related Matters.”
- Executive Order 12196, dated February 26, 1980, “Occupational Safety and Health Programs for Federal Employees,” (3 CFR 1980 Compilation).

16.3 APPLICABILITY

The provisions of this chapter are applicable to all NASA employees and to all other agencies, organizations and contractor personnel that design, construct, inspect, operate, maintain or manage buildings and/or systems within the confines of the Glenn Research Center.

16.4 DEFINITIONS

- a. 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.
- b. Attendant - An individual stationed outside the confined space to monitor and control the PRCS area.
- c. Entrant - A trained individual whose work assignment requires entry into a PRCS.

- d. Blanking or blinding - The absolute closure of a pipe, line, or duct by fastening across its bore a solid plate.
- e. 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.

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.

- f. Engulfment - The surrounding and effective capture of a person by a liquid or finely divided solid substance.
- g. 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 any opening into the confined space.
- h. Confined Space Entry Permit (CSEP) (NASA Form C-199) - A printed document that authorizes entry and work by personnel into a confined space. The CSEP lists the hazards and associated controls for these hazards for the entry.
- i. Entry Supervisor - The designated individual who has charge of the entry into the confined space. The Entry Supervisor is responsible for ensuring the safety and entry requirements specified in the CSEP are met, authorizing the entry, overseeing entry operations, and terminating the CSEP.
- j. 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)
- k. Hot Work - All heat, spark, or flame producing operations. This is further defined Chapter 28 of the Glenn Safety Manual, Hot Work Authorization.

- l. 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.
- m. Isolation (Lockout/Tagout) - A process by which the confined space and systems within the confined space are removed from service, and protected against the inadvertent release of energy or material. This shall be performed in accordance with Chapter 9 of the Glenn Safety Manual, Lockout/Tagout.
- n. 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 is present. Lower Flammable Limit (LFL) is an equivalent term used by some professions.
- o. Oxygen-deficient atmosphere - An oxygen concentration of less than 19.5 percent by volume.
- p. Oxygen-enriched atmosphere. An oxygen concentration greater than 23.5 percent by volume.
- q. Permissible Exposure Limit (PEL) - The maximum 8-hour time-weighted-average (TWA) concentration of an airborne contaminant to which an employee may be exposed, specified in 29 CFR 1910, Subpart Z.
- r. Permit-Required Confined Space - A confined space which 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 LOTO provisions, need for personal protective equipment)
- s. 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.
- t. 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.

16.5 RESPONSIBILITIES

Specific responsibilities of individuals or organizations tasked with establishing or complying with safety requirements for confined space entries are as follows:

16.5.1 Safety Branch

The Safety Branch (SB) shall:

- a. Maintain this Chapter to meet current regulations and standards in accordance with guidance provided by the Occupational Safety and Health Administration (OSHA), NASA Headquarters, and other organizations providing nationally accepted consensus standards.
- b. Evaluate confined spaces to determine if they meet the criteria to be considered Permit-Required Confined Spaces (PRCS).
- c. Maintain an inventory of all identified PRCS's at Lewis Field.
- d. Provide assistance to the Entry Supervisors in the preparation of the Confined Space Entry Permit (CSEP), NASA C-199 and associated documents.
- e. Review and forward the CSEP to the OHB when the SB review is complete.
- f. Maintain the canceled CSEP's in accordance with established record-keeping procedures.
- g. Review the confined space program and associated documentation annually to ensure compliance with this chapter and current regulations.

16.5.2 SB First Responders

The SB First Responders (at Lewis Field) shall:

- a. Ensure the SB air monitoring equipment is within the acceptable calibration period and has been response-checked for that day.
- b. Conduct oxygen content, combustible gas, carbon monoxide, and hydrogen sulfide monitoring, as required by the CSEP.
- c. Ensure the entry requirements specified on the CSEP have been met.
- d. Ensure emergency gear specified on the CSEP is present and in good condition.
- e. Coordinate rescue and emergency operations as required.

16.5.3 Plum Brook Management Office

The SB at Plum Brook Station shall:

- a. Maintain an inventory of all identified PRCS's at Plum Brook Station.
- b. Evaluate confined spaces to determine if they meet the criteria to be considered PRCS's.
- c. Provide assistance to the Entry Supervisors in the preparation of the CSEP.
- d. Review the CSEP's for both Safety and Industrial Hygiene concerns.
- e. Maintain the canceled CSEP's in accordance with established record-keeping procedures.
- f. Review the confined space program and associated documentation annually to ensure compliance with this chapter and current regulations.

- g. Perform and document monitoring and sampling for exposure to chemicals and toxic substances.
- h. Maintain documentation for all monitoring and sampling performed by PBMO for confined space entries.
- i. Evaluate and recommend respiratory protection and PPE when exposure to chemicals or toxic substances is possible.
- j. Review and approve work procedures to be followed if any radiation hazards are present.
- k. Maintain a list of Plum Brook Station personnel who have been trained per this chapter.

16.5.4 Plum Brook Plant Protection

Plum Brook Plant Protection shall:

- a. Ensure air monitoring equipment is within the acceptable calibration period and has been response-checked for that day.
- b. Conduct oxygen content, combustible gas, carbon monoxide, and hydrogen sulfide testing, as required by the CSEP.
- c. Ensure the entry requirements specified on the permit have been met.
- d. Coordinates rescue and emergency operations as required.
- e. Use PPE and rescue equipment in accordance with established training and procedures.
- f. Practice making rescues from confined spaces at least once every 12 months. (The Plum Brook Management Office shall ensure involvement of the Perkins Township Fire Department in the practice rescues.)

16.5.5 Occupational Health Branch

The Occupational Health Branch (OHB) shall (at Lewis Field):

- a. Review the CSEP, associated documents, and the Operating Procedure.
- b. Provide assistance to the Entry Supervisors in the preparation of the CSEP, as required.
- c. Perform and document monitoring and sampling for exposure to chemicals and toxic substances.
- d. Maintain documentation for all monitoring and sampling performed by OHB for confined space entries.
- e. Evaluate and recommend ventilation, respiratory protection, and PPE when exposure to chemicals or toxic substances is possible.
- f. Ensures the Radiation Safety Officer reviews and approves work procedures to be followed if any radiation hazards are present or will be created.

16.5.6 Organization Development and Training Office

The Organization Development and Training Office (ODT) shall maintain the list of civil servant personnel who have been trained per this chapter.

16.5.7 Building and Facility Managers

Building and Facility Managers 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 previously unidentified confined spaces to the SB/PBMO.
- c. Notify the SB/PBMO of any alterations to a confined space to prevent violations of the Confined Space Entry Program.

16.5.8 Contracting Officer's Technical Representative

The Contracting Officer's Technical Representative (COTR) shall:

- a. Ensure the contractor(s) involved in confined space entries has completed a formal Confined Space Entry training class within the last 2 years and/or receive an on-site Confined Space Entry Briefing if the training was by an off-site source.
- b. Ensure the contractor(s) apply for and obtain a CSEP prior to entry into any Permit-Required Confined Space.
- c. Ensure the contractor personnel meet the requirements of the CSEP.

16.5.9 Entry Supervisor

The Entry Supervisor shall:

- a. Complete training in accordance with this chapter.
- b. Ensure that authorized entrants and attendants have the appropriate training for their responsibilities, including a Confined Space Entry class within the last two calendar years and/or a SB briefing if the training was performed off-site.
NOTE: The Entry Supervisor assumes responsibility for all individuals and their actions while they are using the Confined Space Entry Permit. The Entry Supervisor is not required to be the working supervisor for a particular person and may be employed by another employer.
- c. Identify the existing and potential hazards of the confined space.
- d. Develop an operating procedure for entry into and work in the confined space, if necessary.
- e. Initiate the CSEP.
- f. Contact the SB/PBMO to review and approve the CSEP.

- g. Sign the CSEP to verify that the requirements of the permit have been read, understood, and any questions or concerns have been answered.
- h. Ensure that the authorized entrants and attendants read and sign the CSEP after all questions and concerns have been answered.
- i. Maintain the approved CSEP in a location near the entrance of the confined space.
- j. Ensure necessary safety precautions have been taken. This includes properly identifying the PRCS while it is opened to prevent unauthorized entry.
- 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. A copy of the LOTO Planning Form should be attached to the CSEP to provide the details of the isolation methods and points.
- l. Ensure that atmospheric monitoring has been conducted and that the results meet the acceptable working standards prior to allowing the workers to enter the PRCS.
- 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 CSEP and that acceptable environmental conditions are present. Sign the CSEP, thereby affirming that all the safety measures listed on the CSEP 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. Ensure all equipment is explosion-proof in accordance with Section 500 of the National Electrical Code if the confined space is at or above the Lower Explosive Limit for combustible or flammable vapors.
- p. Ensure that any line-powered electrical equipment used for confined space work utilizes a ground fault circuit interrupter (GFCI).
- q. Ensures that appropriate barricades and signs are utilized to keep unauthorized persons away from the confined space and to protect entrants from external hazards.
- r. Ensure that the attendant remains outside of the confined space at all times during the entry operations.
- s. Cancel the CSEP and terminate entry if acceptable environmental conditions are not present or if the conditions or work procedures described on the CSEP or the Operating Procedure change. The Safety Branch/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 CSEP, once the work inside the confined space has been completed.
- u. Forward the CSEP to the SB/PBMO after the work inside the confined space is completed.
- v. Ensures appropriate measures are taken to remove unauthorized persons who are in or near the confined space. This may include contacting a COTR or Site Security for assistance.

16.5.10 Attendants

The attendants shall:

- a. Complete training in accordance with this chapter.
- b. Sign the Entry Permit to verify that the requirements of the CSEP have been read, understood, and any questions or concerns have been answered.
- c. Verify that communications equipment for the attendant and entrant is present and operational.
- d. Verify that communications equipment for summoning rescuers is present and operational.
- e. Remain immediately outside the entrance to the confined space area the entire time the confined space is occupied and monitor the entry of only one confined space area at a time.
- f. Monitor the retrieval and other safety equipment.
- 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. Order entrants to evacuate the confined space immediately if:
 - A prohibited condition is detected.
 - 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 attendant must leave the workstation or cannot effectively and safely perform these responsibilities.
- 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 frequent communication with the entrants while they are within the confined space.
- l. Summon rescue and other emergency aid as soon as it is determined that the entrants cannot escape from the confined space hazards without assistance. The attendant shall not enter the confined space to rescue or assist entrants, but may use in-place retrieval methods such as a tripod, retrieval line, and harness.
- m. Warn unauthorized persons away from the confined space if they approach the confined space area. Contact the Entry Supervisor if the individual refuses to leave or is affecting the safety of the workers.

16.5.11 Entrants

The entrants shall:

- a. Recognize potential hazards, including symptoms and consequences of exposure to the hazards.
- b. Complete training in accordance with this chapter.
- c. Sign the CSEP, prior to entry, to verify that the requirements of the permit have been read, understood, and any questions or concerns have been answered.
- d. Isolate the confined space and the equipment within the confined space as required by the CSEP and appropriate lockout/tagout procedures.
- e. Inspect the entrance and exit routes and ensure that entry into and exit from the confined space can be made safely.
- f. Use personal protective equipment (PPE) in accordance with the manufacturers recommendations and training received.
- g. Verify that atmospheric tests have been conducted.
- h. Enter the confined space only after ensuring that all the requirements of the CSEP have been met.
- i. Maintain effective and frequent communication with the attendant while in the confined space.
- j. Notify the 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 attendant orders an evacuation or if danger is perceived.

16.6 IDENTIFICATION OF PERMIT-REQUIRED CONFINED SPACES

16.6.1 Permit-Required Confined Spaces shall be identified by a sign when opened or during an entry. At the GRC, the sign shall be a white, black and red “Danger” sign with the wording:

DANGER
PERMIT-REQUIRED CONFINED SPACE
DO NOT ENTER

16.6.2 Confined spaces that normally require a CSEP are listed on the Confined Space Inventory maintained by the SB/PBMO. Identification numbers have been assigned to those listed. These identification numbers should be permanently identified at the confined space access **whenever practical**.

16.6.3 Trenches and other excavations have some general rules applied for evaluation.

- a. All excavations, including trenches, below 4 feet in depth shall be considered confined spaces.
- b. Those excavations between 4 and twenty feet in depth shall be evaluated for the existing and introduced hazards. This evaluation shall be performed by the SB/OHB or the PBMO. This evaluation shall determine if an excavation shall be treated as a Permit-Required Confined Space.
- c. All excavations below twenty feet in depth shall be considered Permit-Required Confined Spaces and require a Confined Space Entry Permit for entry.

16.6.4 The Entry Supervisor shall perform a hazard analysis for all tasks assigned to a work group. This hazards analysis shall be used in the evaluation of a confined space for permitting requirements.

16.6.5 A confined space may become a PRCS if a hazard is introduced by the performance of the task or if another function in an adjacent area has the potential to introduce a hazard.

16.6.6 Among the hazards to be evaluated by the Supervisor are:

- a. Hazardous atmospheres such as oxygen deficient or enriched, flammable, corrosive, irritant or toxic atmospheres.
- b. Physical hazards such as chemical skin exposures, temperature, vibration and noise, electricity, entrapment, and operating equipment.
- c. Other hazards must be considered as well. These include steam and vapor leaks, communication problems, inadequate lighting, animals and insects, and radiation.

16.6.7 Removal or mitigation of the hazards must be determined after the hazards have been evaluated. Engineering controls or hazard removal must be considered before PPE or controlled exposures. Controlled exposures are sometimes considered where the PPE or control method may be more of a hazard than the original one.

16.7 CONFINED SPACE ENTRY PERMITS

16.7.1 Entry into a PRCS shall require a CSEP (NASA Form C-199) to be approved in advance of the entry. The CSEP is an authorization document that identifies the following:

- a. The confined space.
- b. The type of work to be done within the space.
- c. The known and potential hazards of the confined space and the work to be performed.
- d. The recommended protective measures to ensure the safety of the authorized entrants.
- e. The effective and termination dates denoting the authorized periods of entry.

16.7.2 The Entry Supervisor is responsible for initiating a CSEP. The NASA Form C-199, Confined Space Entry Permit, may be accessed at the NASA Glenn Electronic Forms page and either completed online or printed and completed manually.

16.7.3 The CSEP is reviewed and approved by the SB and OHB at the Lewis Field site. The PBMO performs this service at the Plum Brook Station.

16.7.4 A CSEP may have an active time period of up to one year.

- a. Personnel in the SB/OHB and PBMO approve CSEP's with an active period of up to 30 days.
- b. CSEP's requested to have an active period of more than 30 days (Extended CSEP) shall be approved by the Chief of the Safety Branch at Lewis Field or the Glen Safety Office at Plum Brook. These CSEP's have the restriction of not allowing hot work or hazardous chemical exposure without a Job Hazards Analysis being performed for the planned tasks.
- c. An Extended CSEP may be issued for up to one (1) year for routine operations or maintenance procedures where there is little possibility of a hazardous atmosphere being present or generated. The termination date of the Extended CSEP's should be no later than the end of the calendar year whenever practical. Extended permits require an operating procedure for all actions taken by the entrants to perform the required tasks within the confined space. This Operating Procedure and all associated documents shall be submitted with the CSEP request.
- d. The Chief of the SB may issue an extended CSEP for the duration of a project even though a hazardous atmosphere may be generated. The mitigation measures and the tasks being performed shall not deviate from those described in the CSEP or a new CSEP shall be required.
- e. Significant changes in job scope, working conditions, or the work procedure require the entry and CSEP to be terminated and a new one developed and approved.
- f. Only members of the SB/PBMO may make extensions to a CSEP. A CSEP may be extended only once, up to a period of 30 days, unless approved for a longer period by the Chief of the SB or the Manager of the PBMO. A copy of the extended CSEP will be maintained by the SB/PBMO. All field copies (for multiple entry points) must be made using the extended original to show the new termination date. All old copies will be maintained for inclusion into the document package returned to the SB/PBMO at the termination of the CSEP.

16.8 CONFINED SPACE ENTRY PROCESS

A flowchart of the following procedures is included in the appendices.

16.8.1 Entry Supervisor reviews the work area and the task scope:

- a. The Entry Supervisor determines if a work area is a confined space, has been or will need to be designated a PRCS, and entry is necessary to perform the desired task. Tasks should be accomplished without entry into a PRCS or any confined space whenever possible. The permanently designated PRCS database is accessible on a “read-only” basis from the link at the end of this Chapter.
- b. The Entry Supervisor assesses the current and potential hazards of the confined space and the task to be performed. If the work area is not ordinarily designated a PRCS but the work introduces hazards that would downgrade the area to that status, a CSEP will be required. If there is any question as to this, the SB/PBMO shall be consulted.
- c. A CSEP is required if the work area is designated a PRCS, whether permanently or for the task duration.

16.8.2 Entry Supervisor initiates the CSEP:

The NASA Form C-199, Confined Space Entry Permit, may be accessed at the NASA Glenn Electronic Forms page (<http://forms.grc.nasa.gov/Forms/PublicUser/index.cfm>). This form may be completed on-line and printed for submittal. Appendix A, Guide for the Completion of a Confined Space Entry Permit, provides additional direction for this completion. As a minimum, the following must be included on the CSEP prior to review:

- a. The location of the confined space. This needs to be as specific as possible, especially for a confined space that is not permanently designated as a PRCS.
- b. A description of the confined space.
- c. The PRCS identification number if it is known. Leave the space blank if there is no assigned number or it is unknown to the Entry Supervisor.
- d. A brief but thorough description of the task and task processes. This would include chemical usage methods, hot work, or any other process that may create a hazard for workers. Any special entry or work procedures should be addressed at this point also. If there is not enough room to document the procedures a separate work procedure may be attached to the CSEP to capture the required information.
- e. A list of chemicals either currently in or to be brought into the confined space. The MSDS for each chemical and its application must be attached or on file in the OHB/PBMO.
- f. A list of equipment to be used in the confined space for the task.
- g. The Hazards Checklist must be completed along with the mitigation or elimination method for each hazard, including the specific PPE to be used. Attach a copy of the Hot Work Permit, NASA C-form 7a, if one will be required for the work to proceed.
- h. A copy of the GRC Lockout/Tagout Planning Form, NASA Form C-3050, or similar LOTO list should be attached when a lockout/tagout (LOTO) will be

- required for the work to safely proceed. The same applies for an Area Clearance when one is required.
- i. Proposed monitoring requirements shall be given. This monitoring is based on the possible exposures to workers and may cause the CSEP to be considered part of the occupational health monitoring records. The Entry Supervisor may request the SB/OHB/PBMO to determine the required monitoring. An example of this would be if there asbestos removal were taking place in a PRCS. The monitoring data could include a copy of the CSEP work controls and exposure time.
 - j. The proposed effective and termination dates of the CSEP.
 - k. The CSEP should then be submitted to the SB/OHB/PBMO for review. The Entry Supervisor's name and telephone number shall be printed on the CSEP request.

16.8.3 The CSEP is reviewed by the SB/OHB/PBMO:

The review process should be the same for all reviewers. All health and safety concerns must be addressed regardless of the reviewer's organization. The Entry Supervisor shall be contacted if there are any questions or concerns.

- a. The SB/OHB/PBMO shall review the confined space and proposed work procedure to determine if a CSEP will be required for the task. The CSEP shall be returned to the Entry Supervisor if no CSEP will be required.
- b. All section entries shall either be marked N/A or have an appropriate response.
- c. Verify the Identification Number if one is given for the PRCS. Investigate if there is a discrepancy between the database information and that given on the CSEP. Notify the Program Lead if the database requires correction.
- d. Review the work description.
- e. Review the chemicals and equipment being brought into or resident in the confined space.
- f. Review the other identified hazards and their associated controls, including PPE.
- g. Evaluate or determine the monitoring to be performed, who will perform the monitoring, and how the monitoring records will be maintained. As a minimum, a copy of the monitoring records will be attached to the original copy of the CSEP for records maintenance.
- h. The SB/OHB/PBMO shall sign the CSEP if approved. The Chief of the SB or the Manager of the PBMO must approve CSEP's with a requested active period greater than 30 days.

NOTE: Only members of the SB/PBMO may make extensions to a CSEP. A CSEP may be extended only once, up to a period of 30 days, unless approved for a longer period by the Chief of the SB or the Manager of the PBMO. A copy of the extended CSEP will be maintained by the SB/PBMO.

- i. A CSEP tracking number is assigned to the CSEP by the SB/PBMO. A copy of the CSEP will be maintained by the SB/PBMO for reference until the original documentation is terminated and returned.
- j. The CSEP shall be returned to the Entry Supervisor with attached comments if the CSEP is rejected for insufficient information or inadequate controls.

16.8.4 The Entry Supervisor reviews the approved CSEP:

- a. The Entry Supervisor shall review the CSEP to ensure all changes made by the SB/OHB/PBMO are understood. If there are any questions or concerns they should be addressed to the appropriate group at this time.
- b. After review, the Entry Supervisor shall sign the CSEP to indicate understanding of the approved requirements. The CSEP should not be signed if there are questions or concerns with the CSEP.

16.8.5 The Entry Supervisor reviews the approved CSEP with the authorized Entrants and Attendants:

- a. Only personnel with appropriate training and work knowledge shall be approved for work in a PRCS. Only the Entry Supervisor may approve Entrants and Attendants. This must be done prior to a worker's first entry into the PRCS.
- b. Each individual's name shall be signed and dated after the individual has had an opportunity to get questions and concerns with the CSEP resolved.

16.8.6 The PRCS is prepared for entry:

- a. The Entry Supervisor shall ensure that all required ventilation equipment, monitoring equipment, communications equipment, and rescue equipment are present and operational. Entrants and Attendants shall be trained in the proper use this equipment.
- b. The Entry Supervisor shall ensure that all required LOTO activities are completed prior to entry and a copy of the completed Planning Form is attached to the CSEP. These should be performed for electrical equipment, moving machinery, and piping that may allow hazards to enter the confined space.

NOTE: Special operating procedures may be required if LOTO is not possible due to system integrity or operational concerns. This must be addressed at the time of submittal to the SB/PBMO to ensure personnel safety in the PRCS.

- c. A Hot Work Permit is secured for any welding, grinding, or spark producing work in accordance with Chapter 28 of the Glenn Safety Manual. This shall be designated the CSEP.

NOTE: CO² fire extinguishers should not be used in or adjacent to confined spaces without the concurrence of the SB/PBMO.

- d. 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.
- e. 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 and tools are used, they shall be non-sparking.
- f. A barrier and warning sign are placed at the confined space entrance to ensure unauthorized personnel do not enter the confined space or interfere with the workers.
- g. SB/PBMO personnel are contacted to perform the initial air monitoring of the PRCS prior to the first entry. The monitoring shall consist of oxygen content in percentage, flammable or explosive gases expressed in percent of Lower Explosive Limit, carbon monoxide expressed in parts per million (ppm), and hydrogen sulfide expressed in ppm. Details are given in Appendix A.
- h. The OHB/PBMO is contacted if special atmospheric monitoring will be required.

NOTE: If the air sample results are not satisfactory, the Space may be ventilated and retested. The period of ventilation prior to retest will vary by size of the Space and the hazard detected. Continuous ventilation may be required. If the results are unsatisfactory after ventilation, the task must be evaluated with respect to the identified hazard and appropriate measures taken. A new CSEP must be submitted with the new controls detailed and further investigation as to the source of the contaminant.

- i. The attendant is positioned outside the confined space entrance. The attendant shall maintain the Confined Space Entry log (Appendix B) for the entrants whenever exposure monitoring is performed. This is to document entry and exit time for each entrant as required for hazard monitoring purposes.

16.8.7 Entry into the PRCS

The following actions shall be performed immediately upon entry into the PRCS:

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

- b. Working conditions shall be verified to be those noted on the CSEP. If any of the critical conditions (e.g., configuration, procedures, materials, or required equipment) 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. A new CSEP may be required prior to reentry.

16.8.8 Entry Termination

The following actions shall be performed when the work within the confined space has been completed:

- a. All work materials and equipment shall be removed when no longer required in the PRCS.
- b. The attendant shall verify that all entrants have exited the confined space.
- c. The PRCS shall be closed or barricaded and posted to prevent unauthorized entry.
- d. If all work is completed, the Entry Supervisor shall ensure the equipment is restored to operational readiness.
- e. If appropriate, the Entry Supervisor shall terminate the CSEP and forward it and all associated documentation to the SB/PBMO.

16.9 RESCUE PROCEDURES

Rescue methods shall be addressed at the time the CSEP is requested.

- a. Rescue planning takes into account the internal configuration of the confined space. Trap points, supports, probes, and other projections may require an entry rescue due to possible further injury by non-entry retrieval methods.
- b. Non-entry rescue is the preferred method to be used for removal of an injured or incapacitated worker. This is typically done using a body harness and retrieval line. For vertical lifts a tripod and winch system is used to provide motive power for the removal. Horizontal retrievals may require the worker to be pulled out of the PRCS by hand via the harness and line.
- c. Only trained and designated personnel may perform entry rescues. These personnel are provided by off-site municipal fire departments for both the Lewis and Plumbrook sites. The requirement for an entry rescue should be designated on the CSEP to reduce response time.
- d. Any rescue requires the immediate notification of the Emergency Dispatch. Radio is the preferred method for contacting the emergency Dispatcher, but a telephone may be used. The internal telephone number is 911 for both sites. Outside telephone numbers, such as when using a cellular telephone, are **(216) 433-8888 at Lewis Field** and **(419) 621-3222 at Plumbrook**.

NOTE: Only the Emergency Dispatch at Lewis Field or Plumbrook shall summon offsite personnel. This is to prevent confusion and delay of response teams as well as maintain the security of both sites.

16.10 TRAINING

16.10.1 Training Requirements

All GRC employees and contractors involved with entry into or working in confined spaces shall have training in confined space entry. This may be an off-site course that has been found acceptable to the SB. Refresher training shall be completed every 2 years.

NOTE: Sub-contractors shall attend a GRC-specific, worksite-specific confined space entry review, provided by the SB/PBMO, prior to their initial confined space entry at GRC.

The training and review shall familiarize personnel with the following:

- a. The PRCS's found at GRC and how to identify them.
- b. Potential hazards involved with confined space entry, including the signs and symptoms of exposure to these hazards.
- c. Monitoring atmospheric and other conditions within and around the PRCS.
- d. Various methods of mitigating the effects of hazards, including ventilation, PPE, and LOTO.
- e. The procedures that may be required for work within a PRCS.
- f. Responsibilities of the Attendant, Entrant, Entry Supervisor, SB/PBMO, and the Occupational Health Branch.
- g. Methods of communication.
- h. Response procedures for emergencies and abnormal conditions.
- i. Completing the CSEP.

16.10.2 Training Records

Training for civil servants shall be documented and submitted to the Organizational Training and Development Office. The SB shall maintain a file copy of the roster of all classes for a period of two years. The PBMO shall maintain a list of Plum Brook Station personnel who have received training.

Contractors shall maintain a list of their employees who have completed Confined Space Entry training and the dates the training was completed. This training list shall be made available to the SB/PBMO upon request.

16.11 RECORDKEEPING

A log of active CSEP's should be maintained in the SB/PBMO.

All original, terminated CSEP's and all associated documentation shall be returned to and maintained by the SB/PBMO in accordance with established criteria for a minimum of three years. The storage and maintenance requirements will be hazard specific if exposure monitoring was performed.

The ODTO shall maintain training records for NASA-GRC civil servants for a minimum of 3 years.

Calibration records for testing and monitoring equipment shall be maintained by the appropriate organization(s) for a minimum of 3 years.

The SB shall maintain results of inspections and reviews for a minimum of 3 years.

The OHB/PBMO in accordance with 29 CFR 1910.20 will retain atmospheric testing results.

16.12 INSPECTIONS AND REVIEWS

The SB shall routinely monitor confined space activities to ensure compliance with this chapter. The SB Chief shall be notified in writing of any major discrepancies. The "Confined Space Entry Permit Log" (Appendix C) is kept by the SB.

The confined space program shall be reviewed annually by the SB for compliance with this chapter. Results shall be documented and maintained by the SB for a minimum of three years.

16.13 APPENDICES

Appendix A Guide for the Completion of a Confined Space Entry Permit

Appendix B Confined Space Entry Log

Appendix C Confined Space Entry Permit Log

16.14 BIBLIOGRAPHY

- Title 29, Code of Federal Regulations, Part 1910, Occupational Safety and Health Standards.
- Title 29, Code of Federal Regulations, Part 1926, Occupational Safety and Health Standards.
- ANSI Z117.1 American National Standards Institute. Safety Requirements for Confined Spaces.
- NIOSH Publication No. 87-113. A Guide to Safety in Confined Spaces.

APPENDIX A

GUIDE FOR THE COMPLETION OF A CONFINED SPACE ENTRY PERMIT

I. IDENTIFICATION OF PERMIT-REQUIRED CONFINED SPACES (PRCS)

The SB is responsible for the final determination of a PRCS. The determination may be permanent or job specific.

The SB shall maintain an inventory of all permanently designated PRCS's for the Glenn Research Center. Entry into these areas shall automatically trigger the requirement of a Confined Space Entry Permit.

Whenever practical, the PRCS's within a building should be labeled with the assigned Confined Space I.D. number. This number shall be either the system number of the space or have the building I.D. format. At Lewis Field, this is the three (3) digit building number followed by a three-digit Confined Space number. For example: Building 12, Confined Space number 1 would be designated 012-001. It may be impractical for some PRCS's to be permanently labeled. The inventory list shall be used to determine the number in these cases.

The description and location of the confined space needs to be accurate for a valid evaluation by the SB.

Activities in adjacent areas may not be readily apparent to persons unfamiliar with the building or area containing the confined space. The Entry Supervisor should discuss planned activities with the Building Manager or other knowledgeable person if this is the situation.

A confined space may become a PRCS due to introduced hazards or abnormal conditions. This situation does not require the permanent identification of the confined space as a PRCS, but it does require the use of a CSEP.

A sign shall identify an open Permit Required Confined Space. At the GRC, the sign shall be a "Danger" sign with the wording equivalent to:

DANGER
PERMIT-REQUIRED CONFINED SPACE
DO NOT ENTER

H. Barricades or barriers should also be used to designate boundaries around opened PRCS's and to prevent unauthorized entry into a PRCS or interference with workers performing a task under a CSEP.

I. Determinations of confined space status should be documented and maintained by the SB as part of the Program files.

II. EVALUATION AND CONTROL OF KNOWN AND POTENTIAL HAZARDS

A. The Entry Supervisor shall evaluate the hazards associated with the task, the confined space, and the adjacent areas. Tasks being performed outside the confined may have a dramatic effect on the conditions inside. Those hazards listed below are a starting point for evaluation, not a full list. The evaluation must include not only the hazard but the source of the hazard. Controls associated with hazards must start with removal or prevention of the hazard and then go to mitigation.

1. Hazardous Atmospheres

- a. Flammable/explosive
- b. Toxic
- c. Irritant or corrosive
- d. Oxygen-deficient or oxygen-enriched

2. Physical Hazards

- a. Temperature
- b. Corrosive chemicals
- c. Noise
- d. Vibration
- e. Electrical and mechanical equipment

3. Other Hazards

- a. Steam leaks
- b. Radiation
- c. Communication problems
- d. Inadequate illumination

B. Material Safety Data Sheet (MSDS)

1. The MSDS for each chemical residing in or brought into the confined shall be attached to the CSEP when submitted to the SB. Ensure the MSDS is appropriate for the way the chemical will be used or treated. The way the chemical is being used may change the identified hazards.
2. The MSDS for all chemicals residing in or brought into a confined space must be evaluated for hazards to the workers.
3. Hazards and control measures associated with the chemical are given on the MSDS.

C. Personnel Protective Equipment

1. The recommended PPE and handling methods are given on the MSDS.
2. Personal protective equipment (PPE) such as gloves or respirators cannot be automatically used as the first line of defense against hazards.
3. PPE may be used only if engineering controls and administrative controls do not eliminate the hazard. PPE is only intended to provide supplemental protection to proper engineering and administrative controls.
4. The Entry Supervisor shall recommend the PPE to be used on the CSEP, in accordance with guidance provided by Chapter 15 of the Glenn Safety Manual, Personal Protective Equipment, and Chapter 12 of the Environmental Programs Manual, Respiratory Protection Program. This selection is approved or corrected during the review process.

D. Atmospheric and Chemical Monitoring

1. Entry into a PRCS is prohibited until the atmospheric monitoring has been completed for oxygen level, LEL %, CO, CO₂, and any toxic chemicals designated on the CSEP. Oxygen level shall be determined prior to or concurrent with LEL determination.

NOTE: It is recommended that continuous monitoring be used during all confined space entries. The Entry Supervisor shall justify why intermittent monitoring should be considered acceptable.

2. Trained individuals shall perform the initial daily monitoring for oxygen content, flammable gases, carbon monoxide, and hydrogen sulfide.
3. If the individual conducting air testing must enter the confined space in order to complete the atmospheric testing, the individual shall “lead” with the instrument and terminate the confined space entry at the first indication of unsafe atmospheric conditions.
4. Toxic chemicals monitoring shall be performed or directed by the OHB, whether airborne or surface contamination. This is done in accordance with the Glenn Environmental Programs Manual.
5. All air monitoring results shall be documented and attached to the CSEP. A copy of the monitoring records shall also be maintained in the individuals’ monitoring files if toxic chemicals monitoring is performed.
6. Surface monitoring of contamination or chemicals shall be documented and attached to the CSEP.
7. The general procedure for air monitoring for a PRCS follows:
 - a. Ensure that the air-monitoring equipment has been calibrated and the daily response checks have been performed in accordance with the manufacturer's guidelines.

- b. Conduct atmospheric testing near the opening of the confined space prior to opening the confined space access.
- c. Open the confined space access and monitor the entry area and, if possible, the work area. This may require monitoring at different heights of the area, especially if there is a large vertical change. This monitoring shall be performed without entry whenever practical.
- d. If the monitoring indicates an unsatisfactory atmosphere for expected contaminants, ventilate the confined space and retest. Ventilation requirements for confined space are approved by OHB or the Plum Brook Safety Officer.

E. Ventilation and Respiratory Protection

1. Approval for the use and method of respiratory protection and/or ventilation is given by the OHB. This is done in accordance with the Glenn Environmental Programs Manual Chapters 12 and 16, respectively.
2. Respiratory Protection is a form of PPE and thus falls under the requirement of implementing engineering or administrative controls before PPE to control or mitigate the hazard whenever possible.
3. Removal of the contaminant source is the preferred control with ventilation as a viable alternative.
4. The space shall be ventilated to eliminate or reduce the hazard if atmospheric monitoring indicates airborne contaminants to be at or above the PEL or immediately hazardous to life or health (IDLH).
5. Respiratory protection shall be used if the hazard cannot be eliminated or reduced below the PEL by ventilation or removal of the source. Selection shall be performed in accordance with Chapter 12 of the GRC Environmental Programs Manual, Respiratory Protection Program.
6. If an IDLH condition exists after ventilation, the entry shall be terminated and the situation investigated. A specific procedure addressing the situation, a new CSEP, and approval from the Chief of the SB will be required for the work to proceed in that PRCS.
7. Adverse changes in the atmospheric or other conditions shall require termination of the entry and be reported immediately to the SB. These changes may result in the termination of the CSEP. Changes in the conditions and protective measures will be evaluated and necessary changes made.
8. General Ventilation Procedures
 - a. Ventilation may be either general area or local exhaust ventilation. This is dependant on the confined space, the contaminants involved, and work to be performed. Local exhaust ventilation is typically required when general area ventilation is not possible due to restrictions in the confined space or when high concentrations of contaminants are present only in the workers' breathing zones.

NOTE: Ventilation systems shall be designed to protect workers in the surrounding areas from the exhaust. Approval of the ventilation layout shall be approved by the OHB or the Plum Brook Safety Officer.

- b. Airflow measurements may be required prior to each entry to ensure adequate ventilation. If the confined space is categorized as immediately dangerous to life and health (IDLH), audible and/or visual warning devices shall be required to indicate ventilation failure.
- c. When combustible or flammable gases or vapors may be present, ventilation equipment (if required) shall be explosion-proof and comply with NFPA 70 and 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.

III. COMMUNICATIONS

- A. Communications shall be maintained between entrants and attendants. If voice communications are inadequate due to noise, distance, personal protective equipment, or other conditions, an alternate communication system such as visual contact, rope signals, radios, light, or other alarm devices shall be used.
- B. Loss of communications constitutes a valid reason for terminating the entry. Entries may resume after the communications problem has been resolved.
- C. Communications with the emergency response organizations must also be addressed. The contact method for an emergency must be determined and addressed in the communication section of the CSEP.

IV. RESCUE PROCEDURES

Rescue methods shall be addressed at the time the CSEP is requested.

- A. Rescue planning takes into account the internal configuration of the confined space. Trap points, supports, probes, and other projections may require an entry rescue due to possible further injury by non-entry retrieval methods.
- B. Non-entry rescue is the preferred method to be used for removal of an injured or incapacitated worker. This is typically done using a body harness and retrieval line. For vertical lifts a tripod and winch system is used to provide motive power for the removal. Horizontal retrievals may require the worker to be pulled out of the PRCS by hand via the harness and line.
- C. Only trained and designated personnel may perform entry rescues. These personnel are provided by off-site municipal fire departments for both the Lewis Field and Plum Brook sites. The requirement for an entry rescue should be designated on the CSEP to reduce response time.

- D. Any rescue requires the immediate notification of the Emergency Dispatch. Radio is the preferred method for contacting the emergency Dispatcher, but a telephone may be used. The internal telephone number is 911 for both sites. Outside telephone numbers, such as when using a cellular telephone, are (216) 433-8888 at Lewis Field and (419) 621-3222 at Plum Brook.

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