Confined Space Entry Program

THE UNIVERSITY OF MICHIGAN
PLANT OPERATIONS

Ann Arbor, Michigan 48109
# PLANT OPERATIONS
## CONFINED SPACE ENTRY PROGRAM

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Plant Operations  
Confined Space Entry Program

I. PURPOSE AND SCOPE

A. Purpose: To provide a safe work environment for Plant Ops employees working in confined spaces.

B. Scope: All Plant Ops employees conducting entries into confined spaces, permit-required and non-permit-required.

II. DEFINITIONS

A. Attendant (spotter) - person stationed outside one or more permit spaces who monitors the authorized employees and performs attendant’s duties assigned in this policy.

B. Authorized Employee - person who has received confined space entry training (permitted and non-permitted).

C. Blanking or Blinding - means the absolute closure of a pipe, line, or duct by the fastening of a solid plate (such as a spectacle blind or a skillet blind) that completely covers the bore and that is capable of withstanding the maximum pressure of the pipe, line or duct with no leakage beyond the plate.

D. Combustible Gas - airborne concentration of gas or vapor which may present the risk of fire or explosion if an ignition source of sufficient energy is introduced. This term is synonymous with "flammable vapor" and "explosive gas".

E. Confined Space - a space that:

   1. Is large enough and so configured that an employee can bodily enter and perform assigned work.
   2. Has limited or restricted means for entry and exit (for example, tanks, tunnels, vessels, silos, storage bins, hoppers, vaults, and pits).
   3. Is not designed for continuous employee occupancy (for example, tanks, tunnels, vessels, silos, storage bins, hoppers, vaults, and pits).

F. Double Block and Bleed - the closure of a line, duct, or pipe by closing and locking or tagging two in-line valves and by opening and locking or tagging a drain or vent valve in the line between the two closed valves.

G. Engulfment - the surrounding and effective capture of a person by a liquid or finely divided (flowable) solid substance that can cause asphyxiation, or can exert enough force on the body to cause death by strangulation, constriction or crushing.

H. Entry Permit - written authorization for entry into a permit required confined space.
I. **Entry Supervisor** - first line foreman or designated lead person, responsible for: determining if acceptable entry conditions are present at a permit confined space where entry is planned; authorizing entry; overseeing entry operations; and terminating entry.

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

1. Flammable gas, vapor, or mist in excess of 10 percent of its lower flammable limit.
2. Airborne combustible dust that is at or approaching its lower flammable limit. This concentration may be approximated as a condition in which the dust obscures vision at a distance of 5 feet or less.
3. Atmospheric oxygen concentration below 19.5% or above 23.5%.
4. Any chemical or substance which may be at concentrations above the published federal or state permissible exposure limit. If chemical contamination other than above (para. 1-3) are suspected to be present, contact Occupational Safety & Environmental Health (OSEH).

K. **Hazardous Entry** - form of entry into a permit required entry space which presents the risk of engulfment or has an unknown or unacceptable air quality.

L. **Hazardous Substance** - a substance or mixture of substances, which may cause death, injury or illness.

M. **Hot Work Operations** - cutting, welding, brazing, or torch soldering of materials.

N. **Hot Work Permit** - specific written authorization to perform hot work operations in a confined space.

O. **Lower Explosive Limit (LEL)** - percent of concentration required to explode upon introduction of spark or flame. Note: 100% LEL is the lowest concentration of a combustible gas in air that will explode due to the introduction of open spark or flame.

P. **Non-Permit Required Confined Space** - confined spaces that do not contain or, with respect to atmospheric hazards, have the potential to contain any hazard capable of causing death or serious physical harm (refer to list of Confined Spaces).

Q. **Oxygen Deficient Atmosphere** - an atmosphere containing less than 19.5% oxygen by volume.

R. **Oxygen Enriched Atmosphere** - an atmosphere containing more than 23.5% oxygen by volume.

S. **Permit Required Entry Briefing** - conference held between employees and the Entry Supervisor prior to allowing employees to enter a permit entry space.
T. **Permit Required Confined Space** - confined spaces that have one or more of the following characteristics:

1. Contains or has the potential to contain a hazardous atmosphere.
2. Contains a material that has the potential for engulfing an entrant.
3. Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross-section.
4. Contains any other recognized serious safety or health hazard such as exposed electrical wiring or devices, pipes, ducts, vents or other portals of entry of potentially hazardous substances.

U. **Rescue Plan** - predetermined written set of actions that are to be taken when a rescue is necessary.

V. **Rescue Team** - one or more persons designated and trained to perform rescue work.

W. **Work Induced Hazard** - hazard created due to nature of work such as welding (generates fumes) and painting (generates solvents in the atmosphere).

### III. POLICY OVERVIEW

A. This program and the procedures outlined are intended to assure the safety of employees working and preparing to work in a confined space.

B. Employees whose job activities may require them to work in a confined space shall receive training in confined space recognition, and confined space entry procedures. Specific entry procedures will be provided to authorized employees by the entry supervisor. Training will be conducted by Occupational Safety & Environmental Health (see attached training outline, Appendix E). Records of all employees trained will be maintained by Plant Operations. All employees of a confined space work party must be authorized employees.

C. Entry supervisors (first line foremen or lead persons) are responsible for ensuring and verifying that authorized employees comply with procedures outlined in this program.

### IV. PROCEDURE

A. **Non-permit Required Confined Spaces.**

1. Prior to confined space work activities, the Entry Supervisor (designated lead person) must verify that the space is a non-permit confined space by using their self evaluation techniques and the University listing containing the classification of confined spaces located on campus. The Entry supervisor is also required to ensure that a non-permit required confined space will not be converted into a permit required confined space due to the creation or existence of work induced hazards.
2. If the non-permit confined space opening is at grade level, guards and cones are required to be installed around openings. Install flashing warning lights if the opening is in a traffic area.

3. All entrances into the non-permit required confined space are required to be opened to allow for natural ventilation. The utility tunnels are naturally ventilated and the need for opening all accesses is not required. (Exception: spaces designated as permit required confined spaces, within this tunnel system. Refer to Section B. below).

4. A minimum of two workers is required while working in permit required and non-permit required confined spaces.

5. Authorized Employees shall be equipped with radios. If an injury occurs, contact Public Safety on channel 1-A and give them location of the injured person. (If the location is in a tunnel, refer to the posted point of reference numbers POR's). Standby until help arrives.

6. A Permit-Required Confined Space Hot Work Entry Permit is required if welding, brazing, cutting, or torch soldering is to occur (See section IV, (E) Hot Work Permits, Permit-Required Confined Space Policy).

7. The Entry Supervisor shall approve any planned deviations from this procedure.

B. Permit Required Confined Spaces.

1. Preparation for Permit Required Confined Space Entry

   a. The procedure listed immediately below must be followed for all three types of Permit Required Confined Space Entries (i.e., General Entry, Hazardous Entry and Hot Work Entry).

   b. A pre-entry briefing using the "Pre-Entry Checklist" (see Appendix D) must be conducted by the Entry Supervisor for affected employees prior to entry. Hazards, potential hazards and proper procedures will be discussed.

   (1) The following items are to be reviewed:

      (a) pre-atmospheric monitoring
      (b) lighting
      (c) ventilation
      (d) lockout/tagout
      (e) personal protective equipment
      (f) communications
      (g) rescue/emergency procedures and equipment
      (h) review of current and past usage or contents of space
      (i) potential hazards such as biological, caustic solutions or solvent fumes
(j) verification that all employees have received training
(k) issuance of permit:

(i) permits to be issued by Entry Supervisor
(ii) permits will be kept on the job site and one copy will be kept the department supervisor for a period of one year. After this time, a review of the permits will be conducted in order to determine if policy revision are necessary.

c. The atmospheric monitoring procedure will be followed:

(1) Monitoring equipment shall be calibrated by authorized employees according to the manufacturer's instructions.
(2) Authorized employees will be trained by OSEH on proper methods and equipment for atmospheric testing.
(3) Atmospheric monitoring includes pre-atmospheric testing and continuous monitoring for: oxygen, lower explosive limit, carbon monoxide and hydrogen sulfide.
(4) The minimum acceptable air quality prior to confined space entry is:

(a) oxygen level: not less than 19.5% by volume nor greater than 23.5% by volume
(b) combustible gas: concentration shall not exceed 10% of the lower explosive limit (LEL) of any combustible material existing or introduced into a confined space.
(c) other contaminants: contact OSEH

(5) Types of continuous air monitors used:

(a) Industrial Scientific CMX-271: monitors for oxygen, carbon monoxide, and lower explosive limit (LEL). This monitor is to be used in areas that may be affected by exhaust emissions and sources of incomplete combustion products.
(b) Industrial Scientific HMX-271: monitors for oxygen, hydrogen sulfide and lower explosive limit (LEL). This meter is to be used in sewers and areas were petroleum products may be present.
(c) If it is determined that unacceptable air quality exists due to contaminants (other than lack of oxygen, excessive oxygen or combustible atmosphere) contact OSEH at 747-1142.

d. The authorized employee(s) entering the permitted confined space must wear a CMX-271 or HMX-271 meter. Continuous air monitoring will be utilized to ensure the air quality remains acceptable. If the alarm sounds, the authorized employee(s) shall leave the space immediately, not reenter and contact their
supervisor. If the air quality is not acceptable, the hazardous entry provision in this policy will be followed (Section 2.b.).

e. Protective equipment that may be required based on evaluation of specific confined space hazards include:

(1) face and eye protection.
(2) hearing protection.
(3) protective clothing, gloves, boots, blankets.
(4) communications equipment.
(5) head protection.
(6) atmospheric monitoring device.
(7) emergency portable lighting (flashlights).
(8) ground fault interrupters.
(9) low voltage transformers.
(10) full body safety harnesses and lifelines associated with retrieval equipment.
(11) fall protection.

f. The University of Michigan Plant Lock-Out/Tag-Out Procedure will be followed when applicable.

g. If the permit required confined space opening is at grade level, install guards and cones around the opening. Install flashing lights if the opening is in a traffic area and block traffic if necessary.

h. Ensure that all equipment is in good repair and functioning properly prior to entering the permitted confined space.

2. Permitted Entry

a. General entry permits.

(1) General permits are used to enter confined spaces where hazards can be controlled by using ventilation or other means and continuous air monitoring.

(2) General permit entry procedures must be followed when entering a confined space that presents no engulfment hazards and has the potential to develop unacceptable air quality or other hazard that can be controlled/isolated. (Examples include: 1. Identified permitted confined spaces within tunnels. 2. Electrical vaults that are entered only when a malfunction or renovation of equipment or constructions occurs.) The procedures listed below must also be followed when this type of entry is to be performed.

(a) A pre-entry briefing will be held by the Entry Supervisor. A permit will be issued by the Entry Supervisor and will expire at the time the work is completed.

(b) The Entry Permit will be posted at the work site. One copy of the permit will be kept by the departmental supervisor for a period of one year.
the third copy will be sent to OSEH for their record keeping.

(c) Pre-entry atmospheric testing must be conducted. If the testing indicates unacceptable air quality, refer to Section b. below.

(d) If hot work operations are to be performed, refer to Section c. below.

(e) The work party must consist of a minimum of two authorized employees both equipped with radios or a suitable alternative. One shall act as a spotter and remain directly outside the confined space opening at all times whenever another member of the work party is inside the confined space. The authorized employee acting as the spotter should not enter the confined space under any circumstances. A non-entry retrieval unit with harness is to be connected to the entrant. The harness does not have to be worn if it will inhibit rescue procedures or cause the entrant additional harm during extraction (this is to be verified by OSEH).

(3) The requirements for a spotter and retrieval system can be waived if the CMX meter indicates acceptable air quality and be providing:

(a) continuous mechanical ventilation and air monitoring.

(b) isolation of space from sources of combustible gases or hazardous materials (Example: blanking or blinding may be used to isolate a pipe that may transfer a hazardous substance into the area of work).

(c) Isolation of space from other recognized health and safety hazards.

(d) a minimum of two authorized employees working in the confined space (Buddy System).

(4) Install a remote antenna lead to the radio used by authorized employees entering the space. Check out the radio function with the spotter and/or Public Safety before entering. Re-verify radio communication after entering the confined space. (An appropriate alternative may be utilized if effective communication capabilities are ensured.)

(5) The authorized employee(s) entering the permitted confined space must wear a CMX-271 or a HMX-721 meter. At least one employee in each crew performing the same task in the same location shall wear a meter.

(6) Off-site rescue (AAFD) will be used if the spotter and retrieval system requirements are waived. At no time is the spotter to enter the confined space in order to perform a rescue. See Section 3. below, outlining rescue procedures.
(7) All requirements resulting from the pre-entry briefing and outlined on the permit issued are to be followed. Appropriate protective equipment must be worn.

(8) Issue and post the "General Entry Permit" (Appendix A) at the point of entry.

b. Hazardous entry permits.

(1) Hazardous permit entry procedures must be followed when entering a confined space that presents the risk of engulfment, has unknown air quality or does not have acceptable air quality. (Examples include: work required in a gas tank with greater than 10% of the LEL and the tank cannot be adequately ventilated to reduce the percentage.)

(2) A pre-entry briefing will be held by the Entry Supervisor.

(3) An OSEH representative must approve the entry before a permit is issued and conduct necessary atmospheric monitoring.

(4) The work party must consist of a minimum of three authorized employees equipped with intrinsically safe radios (battery has a green dot). One authorized employee shall act as a spotter and remain directly outside the confined space at all times. The second authorized employee shall standby outside the confined space with and SCBA available and be prepared to effect a rescue. See Section 3. below, for rescue procedures.

(5) The Hazardous Entry Permit will be posted at the point of entry into the space. A copy of this permit will be kept by the department supervisor and OSEH for a period of one year.

(6) If hot work operations are to be performed, refer to Section c. below.

(7) At least one employee remaining at the outside entrance will be trained and certified in first aid and CPR procedures.

(8) A retrieval harness must be worn by the authorized employee entering the confined space. The harness is connected to a lifeline that is connected to a retrieval unit outside of the space. The harness does not have to be worn if it will inhibit rescue procedures or cause the entrant additional harm during extraction (this is to be verified by OSEH).

(9) The authorized employee entering the confined space must wear an SCBA or approved air line respirator with a 5 minute emergency escape bottle and have had the required training. SCBA training is to be given every six months by OSEH or a qualified vendor representative.

(10) Install a remote antenna lead to the radio used by authorized employees entering the space. Check out the radio function with the spotter and/or Public Safety before entering. Re-verify radio communication after entering the confined space. (An appropriate alternative may be utilized if effective communication capabilities are ensured.)
(11) If at any time the atmosphere exceeds 10% LEL or contains airborne dusts, mists, or fumes which may present an explosive hazard:

(a) All employees shall exit to a safe location. Contact OSEH in order to approve entry procedures and control techniques which may have to be utilized. If 50% LEL is exceeded than purging of the space with nitrogen will be required creating an oxygen deficient atmosphere. Employees entering the space will then be required to wear SCBA units in conjunction with additional personal protective equipment noted within this policy.

(b) All electrical apparatus; except those certified explosion proof, shall be disabled or removed until the explosive atmosphere has been eliminated.

(12) Issue the "Hazardous Entry Permit" (Appendix B)

c. Hot Work Entry Permits

(1) Hot work entry procedures must be followed when welding, cutting, brazing or torch soldering in any confined space.

(2) A pre-entry briefing will be held by the Entry Supervisor.

(3) The Entry Supervisor must ensure that the confined space is not a Hazardous Confined Space.

(4) Pre-entry atmospheric testing must be conducted. If the LEL is greater than 10% hot work must not be conducted until the level can be lowered to less than 10%.

(5) Ventilation is required. Fans/ventilators shall be used at the point of entrance of the confined space and adjacent to the work area. If the exhaust is not through an alternate access, necessary precautions will be taken so the exhaust is not affecting another work party that may be in the area. Note: Pressurized sources of oxygen shall never be used for ventilating purposes.

(6) The work party must consist of a minimum of three authorized employees equipped with radios. One authorized employee shall act as a spotter and remain directly outside the confined space at all times. The second authorized employee shall standby outside the confined space with a SCBA available and be prepared to effect a rescue if necessary. See Section 3. below, outlining rescue procedures to be followed.

(7) A retrieval harness must be worn by the authorized employee entering the confined space. The harness is connected to a life line that is connected to a retrieval unit outside of the space.

(8) For permit required confined spaces within tunnels, it may not be possible to attach the lifeline to the harness due to the distance of the work site from the point of entry. The
following procedure is to be used under these circumstances:

(a) Mechanical ventilation will be maintained.
(b) The authorized employee performing the work will wear a safety harness only.
(c) A retrieval unit (tripod and lifeline) will be in place at the point of entry.
(d) Requirements of Hot Work Entry Permit, except Part (7) above, shall be followed.

(9) The retrieval system and spotter can be waived if the following are provided and as long as the atmosphere remains at acceptable air quality:

(a) Continuous mechanical ventilation and air monitoring.
(b) Isolation of space from sources of combustible gases or hazardous materials (e.g., blanking or blinding may be used to isolate a pipe that may transfer a hazardous substance into the area of work).
(c) Isolation of space from other recognized health and safety hazards.
(d) A minimum of two authorized employees working in the confined space (Buddy System).

(10) Welders are to follow the applicable provisions of R 408.11261 and R 408.11262 (Fire precautions, welding drums, barrels, tanks, or other containers) and rule 3240 of MIOSHA regulations, Part 12 of the General Industry Standard, and R 408.40761 and R 408.40762 of the Construction Safety Standard.

(11) Gas cylinders or welding machines shall be leak tested and placed outside of the space where work is being performed (exception to this in tunnels where location of cylinders and machines should be placed as far away as practical and isolated from the work site).

(12) Gas and oxygen supply valves are to be shut off during breaks, lunch and after work has been performed.

(13) Where practicable, the torch and hose shall be removed from area during shut down periods.

(14) All welding leads shall be de-energized if work is suspended during the lunch period, overnight or any other prolonged unattended period.

(15) When a shielding gas is used in a confined space and welding is suspended during the lunch period, overnight, or any prolonged period, all valves for the shielding gas shall be shut off outside of the confined space.

(16) Special attention must be given if an authorized employee is arc welding on metal surfaces. In order to avoid the potential for electrical shock, all parts of the body which are in contact with metal surfaces shall be insulated with a dielectric material. This may be in the form of gloves,
boots, and/or blanket which would cover the contact surface.

(17) After welding has been performed in a confined space, a sign or warning shall be used to mark the hot metal.

(18) Issue the "Hot Work Entry Permit" (Appendix C) and post at the entry to the work site. Copies of this permit will be kept by the departmental supervisor and OSEH for a period of one year.

3. Rescue

a. Rescue measures will be necessary if the authorized employee in the confined space becomes incapacitated and is unable to exit the space without assistance. Under these circumstances the following rescue plan is to be used:

b. If using spotter, non-entry retrieval system, and standby personnel.

(1) At the first indication of a problem the spotter shall radio the Department of Public Safety on channel 1A and request assistance. Under no circumstances should the spotter enter the confined space.

(2) The Department of Public Safety will then contact the Ann Arbor Fire Department (AAFD) which has been informed of and has participated in the University's confined space emergency procedures and policies. AAFD will conduct their own atmospheric tests prior to entry in order to evaluate hazards associated with the space to be entered.

(3) If it can be ascertained that the authorized employee is incapacitated due to causes not related to the environment, he/she should not be moved until rescue personnel (AAFD) arrive and direct the removal. (Example: the employee is incapacitated with a broken leg.)

(4) If the authorized employee is incapacitated due to the environment and is wearing a safety harness, the spotter and standby employee shall use the lifting device to remove the employee from the confined space.

(5) If the use of the lifting device fails to extract the employee from the confined space, the standby employee wearing an SCBA shall enter the confined space to assist in the rescue effort only if an additional standby person with a SCBA is at the entrance to the space. Rescuer must evaluate the atmosphere for explosive hazards prior to entry.

(6) At least one person on the on-site rescue team shall be trained in CPR and first aid.

(7) A practice drill involving the on-site rescue personnel will be held annually.

c. If using spotter and non-entry retrieval system

(1) At the first indication of a problem the spotter shall radio the Department of Public Safety on channel 1A and request assistance. Under no circumstances should the spotter enter the confined space.
(2) The Department of Public Safety will then contact the Ann Arbor Fire Department (AAFD) which has been informed of and has participated in the University's confined space emergency procedures and policies. AAFD will conduct their own atmospheric tests prior to entry in order to evaluate hazards associated with the space to be entered.

(3) If it can be ascertained that the authorized employee is incapacitated due to causes not related to the environment, he/she should not be moved until rescue personnel (AAFD) arrive and direct the removal. (Example: the employee is incapacitated with a broken leg.)

(4) If the authorized employee is incapacitated due to the environment and is wearing a safety harness, the spotter shall use the lifting device to remove the employee from the confined space.

(5) If the use of the lifting device fails to extract the employee from the confined space, the spotter will wait outside of the confined space and direct AAFD to the affected party.

d. If there is no spotter, retrieval system, or standby person, then follow the University of Michigan First Aid Policy

V. RESPONSIBILITIES

A. Maintenance Services

1. Management

   a. Each supervisor shall instruct their employees regarding the recognition of confined spaces on an annual basis and as a part of new employee safety orientation. Training records shall be sent to and maintained by the Plant Occupational Health Coordinator.

   b. Each supervisor shall effectively enforce compliance of these procedures, including the use of disciplinary action, for any violations or deviations from the procedures outlined in this policy.

   c. Each supervisor shall assure that the equipment required for compliance with this procedure is in proper working order and made available for use by their authorized employees.

   d. Each supervisor shall promptly investigate, report, and inform the Plant Occupational Health Coordinator of all on-the-job accidents or job related health problems and request medical treatment if required. An OSHA 101 form shall be submitted to the Plant Health Coordinator when these events occur.

   e. Each supervisor shall ensure that contractors are apprised of this policy and procedure and the potential hazards that may be encountered while working within a permit required confined space. A copy of the University of Michigan Confined Space Entry Procedure and appropriate permits shall be provided to the contractor prior to the initiation of the project. The contractor has the option to use their own confined space entry program. If the
contractor chooses to use their own program, then a copy of this program is to be given to the University project representative. Copies of the permits used shall be given to the project representative who contracted the work to be performed and OSEH. The contractor will also be responsible for identifying any hazards to the project representative that they encountered that were not identified. The contractor notification form (Appendix G) shall be completed and signed by the appropriate parties. A copy of the contractor notification form shall be kept by the supervisor and OSEH.

f. Management shall hold a meeting after the completion of work to collect permits used (for filing purposes) and review conditions encountered during the work. All information is to be forwarded to OSEH.

2. Employees
   a. Employees shall comply with this procedure.
   b. Employees shall consult with their supervisor or other knowledgeable personnel when there are questions regarding their safety.
   c. Authorized employees shall check out, use, and care for meters, SCBA(s), and harness lifeline equipment when required by this procedure.
   d. Employees shall report any job related injuries or illness to their supervisor and seek prompt medical treatment.

B. Occupational Safety and Environmental Health
   1. OSEH shall provide technical assistance and approve plans and set-ups for entry when called upon.
   2. OSEH shall provide training for permit required confined space entry.
   3. OSEH shall provide for semiannual SCBA refresher training for authorized employees.
   4. OSEH shall inspect permits maintained pursuant to this policy.

VI. Special Controls to be Used When Performing Hot Work or Procedures Using Chemicals (example: painting) within Sections of Tunnels Not Considered Confined Spaces
   A. Ventilation is required. Fans/ventilators shall be used at the point of entrance and adjacent to the work area. If the exhaust is not through an alternate access, necessary precautions will be taken so the exhaust is not affecting another work party that may be in the area. Note: Pressurized sources of oxygen shall never be used for ventilating purposes.
B. Continuous air monitoring shall be conducted throughout the project using the CMX meter.

C. Welders are to follow the applicable provisions of R 408.11261 and R408.11262 (Fire precautions, welding drums, barrels, tanks, or other containers) and rule 3240 of MIOSHA regulations, Part 12 of the General Industry Standard, and R 408.40761 and R 408.40762 of the Construction Safety Standard.

D. Gas cylinders or welding machines shall be leak tested and placed outside of the space where work is being performed (exception to this in tunnels where location of cylinders and machines should be placed as far away as practical and isolated from the work site).

E. Gas and oxygen supply valves are to be shut off during breaks, lunch and after work has been performed.

F. Where practicable, the torch and hose shall be removed from area during shut down periods.

G. All welding leads shall be de-energized if work is suspended during the lunch period, overnight or any other prolonged unattended period.

H. When a shielding gas is used and welding is suspended during the lunch period, overnight, or any prolonged period, all valves for the shielding gas shall be shut off outside of the confined space.

I. Special attention must be given if an authorized employee is arc welding on metal surfaces. In order to avoid the potential for electrical shock, all parts of the body which are in contact with metal surfaces shall be insulated with a dielectric material. This may be in the form of gloves, boots, and/or blanket which would cover the contact surface.

J. After welding has been performed, a sign or warning shall be used to mark the hot metal.

K. If at any time the employees performing the work experience headaches, dizziness or any other signs and symptoms that they did not have prior to working within the tunnel, they are to leave the area and contact OSEH.
APPENDIX A
UNIVERSITY OF MICHIGAN CONFINED SPACE ENTRY PERMIT
(Valid for maximum of one eight hour shift and to be posted at work site)

Type of Entry Permit (check one): General: _____________  Hazardous: ____________  Hot Work _____________
(Contact OSEH 7-1142) (Issue Hot Wk Safety Permit)

Name of Entry Supervisor: _____________________________________________ Employee No.: _______________________________

Work to be Performed: _____________________________________________ Duration: __________________________________

Location of Permitted Confined Space: __________________________________________________________

Pre-Entry Briefing Conducted by: _______________________________________   __________________________________________
(Printed) (Signature)

Authorized Entrant(s):  ____________________________________________   __________________________________________
____________________________________________   __________________________________________
(Name) (Employee Number)

Attendant/Spotter Name:  ____________________________________________   __________________________________________
(if required) (Name) (Employee Number)

In Case of emergency, Attendant will call DPS at 911 or on Radio Channel 1A

Specific Hazards Which Will Be Encountered (see reverse):
______________________________________________________________________________________________________________
______________________________________________________________________________________________________________

Hazard Control Methods to be Used:
______________________________________________________________________________________________________________

Required Equipment to be Used: (inspected and operational)

Personal Protective: (respirator, clothing) _________________________________________________________________
Air Monitoring: _________________________________________________________________
Retrieval/Rescue: _________________________________________________________________
Purge/Ventilation: _________________________________________________________________
Communication: _________________________________________________________________
Special Tools: (approved elec. Equip, non-sparking tools, etc.) __________________________________________________
Supplied Air/Self-contained Respirators ________________________________________________________________

MONITORING RESULTS

<table>
<thead>
<tr>
<th>DATE/TIME</th>
<th>MONITORING PERFORMED BY</th>
<th>O₂ (%)</th>
<th>H₂S (PPM)</th>
<th>CO (PPM)</th>
<th>LEL (%)</th>
<th>OTHER</th>
<th>SAMPLE LOCATION</th>
</tr>
</thead>
</table>

This confined space has been evaluated in accordance with the confined space entry procedures. All persons participating in this confined space entry have been trained in confined space entry procedures. The creation or discovery of any work induced hazards or other unforeseen, actual, apparent or potential hazards, requires the space be re-evaluated, additional precautions taken, and a new permit issued, if appropriate. Hazardous entries must be reviewed and approved by OSEH.

Entry Supervisor Signature (Issued): _____________________________________________ Date and Time: ____________________

Entry Supervisor Signature (Closed): _____________________________________________ Date and Time: ____________________

OSEH Authorization (Hazardous Entry Only): _____________________________________________ Date and Time: ____________________

Please return this form to OSEH, CSSB, 1239 Kipke, Box 1010. Refer questions to OSEH at 647-1142. Revised: 10/97
APPENDIX B
CONFINED SPACE EVALUATION FORM

SPACE LOCATION: ________________________________________________________________________

SPACE DESCRIPTION: _____________________________________________________________________

Complete this form for any space which might be considered a confined space.
A confined space is defined as having those characteristics listed in questions #1 through #3 below.

YES NO 1. Is the space large enough and shaped so employee can enter and work?
YES NO 2. Does the space have a limited or restricted means for entry or exit?
YES NO 3. Is the space NOT designed for continuous employee occupancy?

If you answered “NO” to any of the questions 1-3 above, then the work space is not a confined space.
If you answered “YES” to all questions 1-3 above, then the space is a confined space, and continue with questions A through E below to determine if and what type of entry permit may be required to enter.

YES NO A. Does the space contain, or have the potential to contain, a hazardous atmosphere (e.g.,
oxygen deficiency, flammable vapors, toxic gases or dusts, etc.), or pipes, ducts, vents or
other entry points for potentially hazardous substances, or will volatile chemicals be used
in the space, or will painting or other work that could create a breathing hazard be done?
Specify potential or known hazards: ___________________________________________

YES NO B. Does the space contain a material with the potential to engulfment a worker (for example,
grain, sand or water)?
Specify potential or known hazards: ___________________________________________

YES NO C. Does the space contain physical obstructions, or have an internal shape such that a
worker could be trapped or suffocated by inwardly converging walls, floor or ceiling?
Specify potential or known hazards: ___________________________________________

YES NO D. Does the space contain other recognized safety or health hazards, such as: (check all that
apply)
___ hazardous energy sources;
___ mechanical hazards;
___ exposed or vulnerable electrical wires or energized equipment;
___ gas or chemical lines
___ extremely restrictive entrance or exit for entrants;
___ special hazards related to elevation or falling;
___ temperature extremes/heat stress; or
___ possible impediments to rescue operations.
Specify potential or known hazards: ___________________________________________

YES NO E. Will welding, cutting, torch work, or other hot work be done in the space?
Specify potential or known hazards: ___________________________________________

If you answered “NO” to all questions A through E, then the space is a Non-Permit Require Confined Space.
If you answered “YES” to question A, then a Hazardous Entry Permit with on-site rescue is required*.
If you answered “YES” to question B, then a General Entry Permit with retrieval system is required.
If you answered “YES” to question C or D, then a General Entry Permit is required.
If you answered “YES” to question E, then a Hot Work Entry Permit & a Hot Work Safety Permit are required.
* A General Entry Permit with off-site rescue may be used, if the space is purged and continuously ventilated,
and the air in the space is continuously monitored for the presence of probable atmospheric hazards.

Name: ____________________________________ Signature: ____________________________

Department: __________________________________________________________________________

Refer questions to OSEH at 647-1142. Revised: 10/7/97
APPENDIX C
University of Michigan Contractor Confined Space Entry Notification

In compliance with 29 CFR Part 1910.146 and applicable state regulations, when the contractor's work may involve entry into permit required confined spaces, the University of Michigan must notify the contractor and inform them of the hazards associated with these spaces.

In the scope of this project, the workplace contains confined spaces and entry is allowed only through compliance with a confined space entry program. Prior to entry, the contractor must submit a copy of their confined space entry program to the Department of Occupational Safety and Environmental Health (OSEH).

Specific Location of the Permit Required Confined Space(s) (building, street, cardinal direction, type of space):


<table>
<thead>
<tr>
<th>Atmospheric Hazards (existing or potential):</th>
<th>Health and Safety Hazards:</th>
</tr>
</thead>
<tbody>
<tr>
<td>_____ Oxygen content less than 19.5% or</td>
<td>_____ Mechanical</td>
</tr>
<tr>
<td>greater than 23%</td>
<td>_____ Electrical</td>
</tr>
<tr>
<td>_____ LEL greater than 10%</td>
<td>_____ Engulfment</td>
</tr>
<tr>
<td>_____ Hydrogen sulfide</td>
<td>_____ Entrapment</td>
</tr>
<tr>
<td>_____ Carbon monoxide</td>
<td>_____ Slip, Trip, Fall</td>
</tr>
<tr>
<td>_____ Other toxic gases or vapors</td>
<td>_____ Fire/Burn</td>
</tr>
<tr>
<td>_____ Combustible dusts</td>
<td>_____ Heat Stress or Cold</td>
</tr>
<tr>
<td>_____ Work induced hazards</td>
<td>_____ Other (specify)</td>
</tr>
<tr>
<td>(welding, hot work, painting,</td>
<td></td>
</tr>
<tr>
<td>use of chemicals, etc.)</td>
<td></td>
</tr>
</tbody>
</table>

Describe any precautions UM will utilize to protect nearby UM staff

Will UM personnel also be working in the confined space? Yes ____ No ____

If yes, a meeting to coordinate entry activities is required.

At the conclusion of the entry operations the contractor is required to discuss with the U of M representative the procedures followed and any hazards found or created during entry operations. Copies of permits used will be given to this representative and forwarded to OSEH, 1239 Kipke Drive, 1010, Attn: Industrial Hygiene & Safety.

____________________________________  ____________________________________
U of M Representative (print and sign)  Contractor Representative

Contractor Company Name and Address:  

Job or P.O. Number: ________________  Date: ______________________
Revised: 3/25/98
APPENDIX D
University of Michigan Ann Arbor Campus & Health System Confined Space List

Note: These are examples based on prior knowledge of the space. Supervisors may use this as a guideline in classifying spaces at the work site.

<table>
<thead>
<tr>
<th>Type of Space</th>
<th>Personnel Involved</th>
<th>Hazard</th>
<th>Most Likely Type of Permit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Certain sections of Utility Tunnels</td>
<td>Steam fitters, sheet metal workers, plumbers, asbestos workers, welders, pipe coverers, painters</td>
<td>Heat stress, restrictive spaces, high pressure (60 lb. pressure) steam lines, chemical use, welding</td>
<td>General Permit Required Confined Spaces identified within tunnel system (note listing)</td>
</tr>
<tr>
<td>Electrical Manholes</td>
<td>High voltage electricians</td>
<td>High voltage electricity, possible contaminant build-up (gases) due to location</td>
<td>General Permit Required Confined Space</td>
</tr>
<tr>
<td>Sanitary sewer system and manholes</td>
<td>Plumbers, electricians, masons</td>
<td>Combustible gases, hydrogen sulfide (use appropriate meter), slippery surfaces, biological contamination, flooding</td>
<td>Hazardous Entry Permit Required Confined Space</td>
</tr>
<tr>
<td>Storm sewer</td>
<td>Plumbers, electricians, masons</td>
<td>Carbon monoxide, oxygen deficiency, hydrogen sulfide</td>
<td>General Permit Required Confined Space</td>
</tr>
<tr>
<td>Underground storage tanks</td>
<td>Sheet metal workers, welders</td>
<td>Lack of ventilation, residual or stored chemicals and their vapors, explosive or flammable chemicals</td>
<td>Hazardous Entry Permit Required Confined Space</td>
</tr>
<tr>
<td>Above ground storage tanks</td>
<td>see above</td>
<td>see above</td>
<td>see above</td>
</tr>
<tr>
<td>Crawlspace</td>
<td>Electricians, welders, plumbers, painters</td>
<td>Restrictive work site</td>
<td>Non-Permit Required Confined Spaces. If lack of natural ventilation or safety hazard, then General Permit Required Confined Space</td>
</tr>
<tr>
<td>Boilers (steam sides and fire flu)</td>
<td>Welders</td>
<td>Heat, lack of ventilation, configuration</td>
<td>General Permit Required Confined Space</td>
</tr>
<tr>
<td>Sump stations</td>
<td>Plumbers, welders</td>
<td>Contaminants from sump system, hydrogen sulfide, biological contamination, electrical/mechanic, oxygen deficiency</td>
<td>General Permit Required Confined Space</td>
</tr>
<tr>
<td>Type of Space</td>
<td>Personnel Involved</td>
<td>Hazard</td>
<td>Most Likely Type of Permit</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>----------------------------------------</td>
<td>------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------</td>
</tr>
<tr>
<td>Electrical Vaults</td>
<td>Electricians</td>
<td>Electrical, lack of ventilation, restrictive work site</td>
<td>General Permit Required Confined Space</td>
</tr>
<tr>
<td>Telecommunications manholes</td>
<td>UM-Tel personnel</td>
<td>Vapors/gases can be carried by entrance ducts</td>
<td>General Permit Required Confined Space</td>
</tr>
<tr>
<td>Fume Hood Ductwork (interior)</td>
<td>Sheet metal, welders</td>
<td>Toxic or flammable gases or vapors, chemical residues, restrictive work site</td>
<td>General Permit Required Confined Space</td>
</tr>
<tr>
<td>Air Handling Units</td>
<td>HVAC personnel</td>
<td>Restrictive work site</td>
<td>Non-Permit Required Confined Space</td>
</tr>
<tr>
<td>Chimneys</td>
<td>Masons, powerhouse personnel</td>
<td>Depends on location</td>
<td>Non-Permit Required Confined Space.</td>
</tr>
<tr>
<td>Interstitial Spaces</td>
<td>Maintenance, HVAC, electrical personnel</td>
<td>Restrictive work site</td>
<td>Non-Permit Required Confined Space</td>
</tr>
</tbody>
</table>

* Sections of tunnel considered confined spaces: from POR 212 to North hall; from POR 615 to the President’s Residence; from POR 717 to Lorch Hall; and from the condensate meter area east of POR 811 to Kelsey Museum.

**Note:** A Hot Work Permit is required if performing cutting, welding, brazing, torch soldering, high speed metal grinding, or open flame tasks within any type of confined space.

If a space’s characteristics or hazards change, the type of permit required may also change. This is determined by re-evaluating the confined space.

Confined spaces may exist that are not identified within this chart. If there are any questions regarding the status of a space, it should be evaluated or re-evaluated, and entered according to procedures required for the hazards that are present.

Rev. 3/04
# University of Michigan Health System - Confined Space List

**Note:** This is a listing of specific locations. The UM Health System also contains many of the confined spaces identified in the General Listing.

<table>
<thead>
<tr>
<th>Location</th>
<th>Description</th>
<th>General Comments / Potential Hazards</th>
<th>*Most Likely Type of Permit</th>
</tr>
</thead>
<tbody>
<tr>
<td>UH Dock 5 Area</td>
<td>Fuel tank pump pit - 15,000 gallon tank - 2 enclosed pumps</td>
<td>Lack of ventilation, residual or stored chemicals and vapors inhalation or explosion hazard.</td>
<td>Hazardous Entry permit</td>
</tr>
<tr>
<td>UH Dock 5 Area</td>
<td>Manhole cover outside Dock 5. High voltage wiring = 15 feet deep.</td>
<td>Refrigerant gases located approximately 15 feet away could pose threat of oxygen deficiency.</td>
<td>General permit</td>
</tr>
<tr>
<td>UH Dock 5 Area</td>
<td>Sump pump - under truck well - Access by man hole cover - about 5 feet deep.</td>
<td>Possible biologicals or electrical/mechanical hazards, oxygen deficiency.</td>
<td>General permit</td>
</tr>
<tr>
<td>B2H264M</td>
<td>Condenser Pit - three separate</td>
<td>Three accesses – lack of ventilation, possible chemical hazards from water treatment, flooding hazard.</td>
<td>General permit</td>
</tr>
<tr>
<td>B2H264M</td>
<td>Electrical Vault Pit 10 feet deep</td>
<td>Lack of ventilation.</td>
<td>General Permit</td>
</tr>
<tr>
<td>TC Expansion – 4200Z Shaft</td>
<td>TC Elevator Penthouse</td>
<td>Lack of ventilation and falling hazard.</td>
<td>General permit</td>
</tr>
<tr>
<td>Near Helicopter Pad, and B2H264M</td>
<td>Thermal Basin</td>
<td>Possible engulfment, possible chemical hazards from water treatment.</td>
<td>Hazardous entry permit</td>
</tr>
<tr>
<td>F2232V (Shaft SF-232)</td>
<td>MCHC Gift Shop Exhaust Fan Room</td>
<td>Good drafting - door can't be opened from the inside, no lights.</td>
<td>Non-permit</td>
</tr>
<tr>
<td>MCHC – outdoors under canopy</td>
<td>Generator radiator pit - general exhaust for Taubman Center</td>
<td>Area has good drafting.</td>
<td>Non-permit</td>
</tr>
<tr>
<td>B2H264M</td>
<td>Day tank diesel fuel.</td>
<td>Disable fire system (auto shut door) when working in room.</td>
<td>Not a confined space</td>
</tr>
</tbody>
</table>

*Permit type may change if hazards in the area change.*

Revised: 3/04
CONFINED SPACE ENTRY TRAINING

FOR

THE UNIVERSITY OF MICHIGAN

The Department of Occupational Safety and Environmental Health
Campus Safety Services Building
1239 Kipke Drive
Ann Arbor, Michigan 48109-1010
Confined Space Entry Training Program
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Appendix A: Glossary
Appendix B: Confined Space Evaluation Form
Appendix C: Contractor Notification Form
Appendix D: Confined Space Entry Permits
Appendix E: Air Monitoring Equipment Use Directions
Appendix F: Confined Spaces List
INTRODUCTION

The University of Michigan has more than 500 confined spaces. This course is designed to provide workers with the knowledge and skills needed to prevent accidents and injuries in confined spaces. Every year workers are injured or killed because of failure to follow the safe work practices described in this course.

In January 1993, the Occupational Safety and Health Administration (OSHA) released its confined space ruling (29 CFR 1910.146). This rule was subsequently adopted by reference by the State of Michigan under Part 90 of MIOSHA. This ruling holds employers specifically responsible for informing workers of the hazards associated with working in confined spaces and for training workers in the safeguards that can reduce the risk of accidents.

In this course you will learn how confined spaces are identified and evaluated. You will also learn the proper procedures and precautions to be taken prior to entering and while working in confined spaces. Definition and determination of a confined space, hazard evaluation, use of equipment, entry permitting, and safety and re-use procedures will be covered.

If your job requires you to assume the role of entrant, attendant, entry supervisor or standby rescue person, it is crucial that you become familiar with your designated responsibilities. Not following the procedures outlined in this program may put you or the lives of your co-workers in danger.

This is an on-going program and needs to be continually updated. If you find after this training session that there are spaces that are not identified in the confined space listings, or special cases that need to be addressed, please contact the Department of Occupational Safety and Environmental Health. Your input is important to make this an effective and comprehensive program.

Revised: 5/96
u:\keith\ceseman7c.doc
SECTION 1
What is a Confined Space?

A confined space is an enclosed area which:

1. Has limited openings for entry or exit, such as storage tanks, silos, tunnels, electrical vaults, boilers, sewers, etc.
2. Is large enough and shaped so that a person can enter and perform work.
3. Is not designed for continuous human occupancy.
Types of Confined Spaces

Non-Permit Required Confined Space:

- If a space meets the conditions listed in the definition of a confined space and:
  - Has mechanical or natural ventilation;
  - Does not contain any hazard capable of causing death or serious physical harm; and
  - Does not have the potential for a hazardous atmosphere to occur.

Permit Required Confined Space:

- If a space meets the conditions in the definition of a confined space and:
  - Does not have means for ventilation; and
  - Has one or more of the hazardous conditions listed below:
    - A hazardous atmosphere such as a lack of oxygen or the presence of a toxic gas, vapor, fume, mist or dust;
    - The potential for engulfment by loose particle matter or liquids (e.g. grain in a silo or a liquid in a vessel);
    - Converging walls or floor which might affect the concentration of potentially hazardous substances; or
    - Any other recognized serious safety or health hazard (e.g., electrical wiring or devices, pipes, ducts, vents or other portals of entry for potentially hazardous substances).
Types of Confined Space Permits

**General Entry Permit Required Confined Space:**

Presents no engulfment hazards but has the potential to develop unacceptable air quality. Also serious health and safety hazards may exist but are controlled during entry.

**Hot Work Entry Permit Required Confined Space:**

Must be followed if welding, cutting, brazing, torch work, or other hot work is to be performed in ANY type of confined space (this include non-permit required spaces).

**Hazardous Entry Permit Required Confined Space:**

Presents a known risk of engulfment, hazardous atmosphere, or serious safety or health hazard which cannot be isolated or controlled. Contact OSEH prior to entry in this type of space.
Confined Space Evaluation

Before entering any enclosed or restricted access work area, it should be evaluated to determine if it is a confined space and if an entry permit is required prior to entering.

A Confined Space Evaluation Form is included in Appendix B. By answering the questions on this form, you will be able to determine if a space is a confined space, as defined in the standard, if you need a permit to enter the space, and what type of permit you will need.

All spaces must be evaluated prior to entry. Spaces should be reevaluated when ever the situation in the space changes or a new or potential hazard is introduced or discovered. If there’s ever any question as to the accuracy or completeness of the evaluation, then do not enter the space, or leave the space immediately. Hazards in confined spaces can be deadly and should be properly addressed to insure adequate worker safety.

Anyone who has been trained in confined space entry should have adequate knowledge to make a preliminary evaluation of a space. If you must evaluate a space, but are unsure of what hazards may be present or how to eliminate a hazard, get help. It’s too late to prevent an accident once it’s happened.
The University of Michigan Confined Space Program

The University of Michigan has developed this program in order to provide employees with the knowledge and skills necessary to safely perform work in confined spaces. This program is designed to meet the requirements outlined in the OSHA standard (29 CFR 1910.146).

A Confined Space Entry Program must contain the following items:

1. **Procedures for preventing unauthorized entry**

   In order to prevent unauthorized entry into permit required confined spaces, one or more of the following techniques must be used:

   - Training of all employees on this policy and procedure
   - Providing information to contractors and visitors
   - Posting of warning signs
   - Erecting barriers
   - Installation of locks or a means of isolating points of entry

2. **Procedures for identifying space hazards**

   Each employee required to work in a confined space will be able to identify and evaluate existing and potential hazards before entering.

   Hazards to be identified and evaluated must include atmospheric, engulfment, mechanical, electrical, physical, heat, cold, noise, and other potentially serious hazards.

3. **Safe Entry Procedures**

   Including but not limited to:
   - Establishing acceptable entry conditions.
   - Isolating the permit space
   - Purging, inerting, flushing or ventilating the space
   - Providing barriers
   - Conducting pre-entry briefings
   - Controlling hazards by locking out energy sources, cleaning and purging
   - Testing and monitoring the air
   - Providing necessary safety equipment and insuring it’s used properly
   - Designating employee roles (attendant, entrant, entry supervisor)
   - Summoning Rescue and Emergency Services
   - Establishing a written permit system
   - Establish recordkeeping

4. **Procedures for concluding the entry**

   Permits are closed out and filed when work is finished

5. **Procedures for coordinating entry operations**

   Including
   - Testing (air monitoring)
   - Informing contractors of hazards
   - Coordinating activities inside space
   - Conducting debriefings

6. **Program Review Procedures**
Review entry operations
Revise the Program
Review the canceled permits

The University of Michigan Confined Space Entry Program addresses all of these areas. In addition, employees must follow all other existing safety procedures and policies that are currently in place when working in confined spaces.
Confined Space Entry Procedures

1. **Determine if space to be entered is a confined space under the definition (use the evaluation form).**

2. **Conduct hazard assessment/pre-entry briefing of the space:**
   
   a. Test atmosphere for existing, probable or potential contaminants
   b. Review space usage in order to determine safety and health hazards, such as:
      1) Mechanical
      2) Electrical
      3) Fire/Burn
      4) Heat or Cold
      5) Engulfment
      6) Entrapment

3. **Eliminate or isolate any unsafe conditions prior to entry (i.e., lock out/tag out):**
   
   b. Lock out/tag out all sources of energy.
   c. Install blanks in affected pipes where valves are not secure or seated.
   d. Clean and/or purge any chemical storage vessel (dispose of wastes properly).
   e. Wear appropriate personal protective equipment.
   f. Have lights or ladder available.
   g. Coordinate entry with contractors if necessary.
   h. Have appropriate MSDS's on site.
   i. Provide continuous air monitoring and ventilation for permit required confined space. If contaminant other than carbon monoxide, hydrogen sulfide, or flammables may be present, then provide monitoring.
   j. Determine start and end times for authorized entry (i.e., the duration of the permit).
   k. Assign roles and responsibilities (entrant, attendant, lead worker).
   l. Set up non-entry rescue equipment if applicable. There is no need to set up this equipment if the atmosphere can be controlled by providing continuous air monitoring, continuous ventilation, all safety hazards can be isolated, and a continuous line of communication is maintained at all times.
   m. Identify rescue service or procedures. If off-site rescue is planned, then a continuous line of communication with the off-site rescue team must be maintained.
   n. Determine communication method between entrant and attendant.
4. Determine from information above which entry procedure is appropriate:
   a. Non-Permit Required Confined Space:
      - No real or potential atmospheric hazards and no observable serious safety and health hazards.
   b. General Entry Permit Required Confined Space:
      - Presents no engulfment hazards but has the potential to develop unacceptable air quality. Also, serious health and safety hazards may exist but are controlled by ventilation or isolating the hazards during entry.
   c. Hot Work Entry Permit Required Confined Space:
      - If any hot work (i.e., welding, cutting, brazing or torch work is to be performed within ANY type of confined space).
   d. Hazardous Entry Permit Required Confined Space:
      - Presents a known risk of engulfment, hazardous atmosphere, or serious safety or health hazard which cannot be isolated or controlled.

5. Sign and post permit at the site.

6. Under the following conditions, personnel must exit the confined space, re-evaluate the hazards and modify entry procedures:
   a. Hazardous atmosphere detected after entry.
   b. Any health or safety hazard develops which was not anticipated.
   c. Attendant cannot perform their duties.
   d. Personnel in the confined space are experiencing symptoms from heat stress or exposure to atmospheric hazards.

7. When work is completed, return the space to its original condition.

8. Close out the permit and submit the completed permit to your supervisor.
Outside Contractors

When outside contractors are used, certain procedures must be followed when the contractor's employees will be working in confined spaces. In Appendix C there is a Contractor Notification Form that should be completed and kept on record. This form includes the items that a contractor should be notified of, include the following:

1. The confined spaces the contractor may encounter and that a confined space program must be used to enter.
2. The hazards of the confined spaces and the reason(s) these are considered confined spaces.
3. Any precautions or procedures that are in place to protect employees in confined spaces.
4. Coordination procedures of entry operations between the contractor and other employees that may enter the spaces.
SECTION 1 REVIEW

I. Recognizing Confined Spaces

Now that you have been provided with an overview of what is a permit and non-permit required confined space, let's take a look at some confined spaces.

Your instructor will show you a series of slides and provide background information on the space shown. For each slide please indicate whether the space would be a permit or non-permit required confined space. Be prepared to explain your answer.

<table>
<thead>
<tr>
<th>Slide 1</th>
<th>Permit</th>
<th>Non-Permit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slide 2</td>
<td>______</td>
<td>______</td>
</tr>
<tr>
<td>Slide 3</td>
<td>______</td>
<td>______</td>
</tr>
<tr>
<td>Slide 4</td>
<td>______</td>
<td>______</td>
</tr>
<tr>
<td>Slide 5</td>
<td>______</td>
<td>______</td>
</tr>
<tr>
<td>Slide 6</td>
<td>______</td>
<td>______</td>
</tr>
<tr>
<td>Slide 7</td>
<td>______</td>
<td>______</td>
</tr>
<tr>
<td>Slide 8</td>
<td>______</td>
<td>______</td>
</tr>
</tbody>
</table>
## II. Recognizing Type Of Permit To Be Used

There are three types of confined space entry permits: General Entry Permit, Hot Work Entry Permit, and Hazardous Entry Permit. For the following scenarios, please indicate which type of permit, if any, is required to enter point the space.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Type of Permit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Welding in utility tunnels.</td>
<td>__________________</td>
</tr>
<tr>
<td>2. Cleaning a sulfuric acid tank with a known hazardous atmosphere.</td>
<td>__________________</td>
</tr>
<tr>
<td>3. Working in sanitary sewers.</td>
<td>__________________</td>
</tr>
<tr>
<td>4. Working in storm sewers.</td>
<td>__________________</td>
</tr>
<tr>
<td>5. Performing maintenance work in storm sewers.</td>
<td>__________________</td>
</tr>
<tr>
<td>6. Installing electrical conduit in a crawlspace with natural ventilation and no potential hazards.</td>
<td>__________________</td>
</tr>
<tr>
<td>7. Walking through utility tunnels.</td>
<td>__________________</td>
</tr>
<tr>
<td>8. Torch soldering in an electrical manhole.</td>
<td>__________________</td>
</tr>
<tr>
<td>9. Pulling cable in a telecommunications manhole.</td>
<td>__________________</td>
</tr>
<tr>
<td>10. Replacing a motor in the interior of fume hood ductwork.</td>
<td>__________________</td>
</tr>
<tr>
<td>11. Repairing a plumbing trap in a crawlspace.</td>
<td>__________________</td>
</tr>
<tr>
<td>12. Performing maintenance work in an elevator shaft.</td>
<td>__________________</td>
</tr>
<tr>
<td>13. Performing maintenance work in an electrical vault.</td>
<td>__________________</td>
</tr>
</tbody>
</table>
III. Confined Space Program

Which of the following elements are included in a Confined Space Program.

1. Annual Review of Program
2. Coordination of Activities with Others
3. Methods for Concluding Entry
4. Preventing Unauthorized Entry
5. Identifying Permit Required Confined Space Hazards
6. A-E
7. A, D, E
8. None of the Above

IV. Process for Entering a Confined Space

Before anyone enters a confined space, you must evaluate the space. List the steps that must be followed before entry can occur.

__________________________________________________________________
__________________________________________________________________
__________________________________________________________________

V. Outside Contractors

List three types of information that must be provided to contractors whose employees will be working in permit required confined spaces.

__________________________________________________________________
__________________________________________________________________
__________________________________________________________________
SUMMARY

1. A confined space is large enough for an employee to enter, has limited or restricted means for entry or exit, and is not designed for continuous human occupancy.

2. A confined space will require a permit if certain hazardous conditions exist or could exist in the space.

3. A written program must be developed that is designed to protect employees who work in confined spaces.

4. A series of steps must be followed before any employee can enter a permit-required confined space.

5. Certain information on confined spaces must be given to contractors whose employees enter confined spaces, and work done inside the confined spaces must be coordinated.
SECTION 2
Hazard Recognition and Evaluation of Confined Space
Atmospheric Hazards

There are many hazards that may be present before and during a confined space entry. The employees must know about and understand these hazards prior to entry in order to ensure that no lives will be endangered.

After completing this unit, you will be able to:

1. Identify how hazardous chemicals enter the body.
2. Identify acute and chronic health effects and symptoms that may occur after exposure to hazardous chemicals.
3. Identify exposure limits that are set by OSHA to protect the health of employees.
4. Identify hazardous atmospheres that may occur in confined spaces.
5. Understand the terms upper and lower explosive limits.
6. Understand the importance of vapor density in recognizing hazards in confined spaces.
Chemical Routes of Entry Into the Body

The way that a chemical enters the body is called the "route of entry". The four routes of entry are skin absorption, inhalation (breathing), ingestion (swallowing) and injection. These four routes of entry must be considered whenever a chemical is present. The specific route of entry that is most harmful to the body is identified on the material safety data sheet (MSDS) for a specific chemical.

1. Skin Absorption

   Some chemicals may be absorbed through the skin directly into the bloodstream. If the skin is irritated, damaged, or punctured, the absorption rate is increased. The rate of absorption also varies with the area of the body that is contacted. Typically, head and torso skin areas absorb chemicals faster than the hands or feet, and the eyes absorb the fastest of all. The use of cosmetics or lotions can also increase the absorption rate. Always wash your face and hands before using cosmetics or lotions.

2. Inhalation (Breathing)

   If hazardous chemicals are present in the air, they may be deposited or absorbed through the lungs into the bloodstream. Inhalation is the major way that harmful substances get into your body. Typically, smoking greatly increases the hazards involved with inhalation exposures. Always wash your face and hands before smoking.

3. Ingestion (Swallowing)

   Because food and drink can absorb chemicals and contaminants, they should be kept away from areas where these hazards may be present. Always wash your face and hands before eating or drinking. Avoid chewing gum while working near chemical hazards.

4. Injection

   Injection may occur if the skin is punctured. Your skin provides you with some protection against exposure to hazardous chemicals. If the skin is punctured or damaged, then this protection is by-passed.
Acute and Chronic Health Effects

1. Acute Health Effects

Occur from an exposure to a hazard for a short period of time. With an acute effect, the reaction occurs either immediately upon exposure or after a short period of time. One example would be exposure to formaldehyde, which causes respiratory and eye irritation after a short exposure of high concentration.

If the hazard has good warning symptoms, then normally you can recognize these acute effects and remove yourself from the area. Some degreasers, for example, cause dermatitis or the central nervous system effects listed below. The following list provides some common reactions to hazardous chemicals. If you notice any of the following warning signs, leave the space immediately and re-evaluate the space. Do not re-enter the space until the proper controls are put in place.

**WARNING SIGNS**

- Dizziness
- Disorientation
- Weakness in Knees
- Shallow, Rapid Breathing
- Blurred Vision
- Profuse Sweating
- Chest Pains
- Headache
- Loss of Coordination
- Change in Heartbeat
- Ringing in Ears
- Skin Irritation

2. Chronic Health Effects

Results after a long term exposure to a chemical. Symptoms may develop slowly and over a long period of time. For example, an alcoholic may develop scarring (cirrosis) of the liver after 20-30 years of repeated exposures. Some chemicals can have both acute and chronic effects. Short exposures to high levels of carbon monoxide can cause death, while long term and repeated exposure, over many years, to low levels may cause increased risk of heart disease.
Atmospheric Hazards

A hazardous atmosphere means an atmosphere that may expose employees to the risk of death, incapacitation, impairment of ability to escape, or injury or illness from one or more of the following causes:

1. An atmosphere that contains an oxygen concentration of less than 19.5% or greater than 23.0%.
2. A flammable gas, vapor, or mist in excess of 10% of its Lower Explosive Limit (LEL).
3. An atmosphere that contains more than the Permissible Exposure Limit (PEL) for any substance as determined by OSHA.
4. An airborne combustible dust at a concentration that meets or exceeds its Lower Flammable Limit (LFL).
5. A condition recognized as immediately dangerous to life or health (IDLH).

There are four possible sources of hazardous atmospheres in confined spaces:

1. Entering an area with known hazardous chemical substances/gases.
2. Entering an area that lacks ventilation.
3. Entering an area that has the potential to transfer a hazardous atmosphere into the space to be entered. An example is telecommunication manholes that are connected via ductwork.
4. Creating a hazardous atmosphere due to the work operations to be performed (work induced hazards). Examples would be welding, painting, or using solvents or other chemicals.
Atmospheric Hazards
Permissible Exposure Limits (PELs)

The Occupational Safety and Health Administration (OSHA) has established permissible exposure limits (PELs) to protect workers from hazardous chemicals. PELs are the maximum average airborne exposure allowed for an employee for an eight hour work shift of a 40 hour work week. A PEL is usually expressed in parts per million (ppm) or milligrams per cubic meter (mg/m³) of air. If a chemical has a PEL, it will be listed on the MSDS. OSHA PELs are legally enforceable. The State of Michigan has also adopted and enforces the OSHA PELs, as well as some additional limits not enforced by OSHA.

By definition, PELs established by OSHA must be measured over an eight hour shift. In other words, the PEL is actually a time-weighted average. This means the actual short term concentration an employee is exposed to may exceed the PEL, as long as the average over eight hours does not exceed the PEL.

For some chemicals, OSHA has set a short-term exposure limit (STEL). This is the maximum allowable concentration an employee can be exposed to, averaged over 15 minutes.

For other chemicals, OSHA has set a ceiling limit. This is a maximum exposure concentration that cannot be exceeded at any point for any time. This limit is not based on time of exposure, but literally a ceiling that cannot be passed, ever.

Exposures to any chemical, whether limits have been set or not, should be limited. Exposure limits are based on exposure studies and are aimed at the average human with a reasonable safety factor. Individual sensitivity to chemicals varies. If you or a co-worker begins to experience any exposure symptoms, get to fresh air immediately and call for assistance. Many confined space monitors only check for the most common hazards (oxygen, flammable gases or vapors, and carbon monoxide or hydrogen sulfide). There is always the chance that other hazards may be present.

Contact OSEH so that the area may be properly evaluated with the correct air sampling equipment. This will be discussed further in the air monitoring section of this manual.
Atmospheric Hazards
Oxygen Deficient or Enriched Atmosphere

The average oxygen concentration in outdoor air is about 20.9%. If there is not enough oxygen in the atmosphere of a confined space, then employees can lose consciousness and die. This can happen within minutes. OSHA has set a limit of 19.5% as the lowest acceptable level of oxygen in a confined space.

The amount of oxygen in a confined space can be lowered in several ways:

1. It can be consumed, either by processes that may normally happen within the space (such as rusting metal, or decay of bio-matter), or by work induced processes (such as welding, cutting, brazing, or by chemical use within the space).

2. It can be displaced by other gases that are normally not harmful (such as nitrogen, carbon dioxide, argon, etc.), but reduces the percent oxygen present to harmful levels.

Anything that inhibits the ability of the body to breathe is asphyxiant. There are two classes of asphyxiants: simple and chemical.

A substance that displaces oxygen is called a simple asphyxiant. Simple asphyxiants cause a deficiency in the supply of oxygen to the body by displacing the oxygen in air. Examples include nitrogen, carbon dioxide, methane, and argon.

Chemical asphyxiants prevent the body from using or processing the oxygen that is present. Examples are carbon monoxide and hydrogen sulfide.

If there is not enough oxygen in the confined space, the space must be ventilated until acceptable levels are obtained. If ventilation cannot provide an acceptable oxygen supply then employees entering the space must wear a supplied air breathing apparatus. This space would be categorized as an immediate danger to life or health (IDLH) and would not normally be entered. Supplied air breathing apparatuses requiring specialized training and on-site rescue procedures would be necessary. Never enter an oxygen deficient environment without taking the most extreme precautions.

Oxygen enriched environments can be extremely hazardous. When there is too much oxygen in a space (more than 23.0%), there is an increased danger of fire and explosion. In an oxygen enriched atmosphere, clothing, hair, and other combustible materials are more easily ignited and will burn violently. This condition can persist even after leaving the enriched atmosphere. The oxygen can permeate your clothing and take some time to dissipate. **Never use oxygen to ventilate a confined space.**
<table>
<thead>
<tr>
<th>Oxygen Content % by Volume</th>
<th>Effects/Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>23.0% and above</td>
<td>Extreme Fire and Explosion Hazard</td>
</tr>
<tr>
<td>20.9%</td>
<td>Average percent oxygen in outside air</td>
</tr>
<tr>
<td>19.5%</td>
<td>Minimum Permissible Oxygen Level</td>
</tr>
<tr>
<td>15-19%</td>
<td>Decreased ability to work strenuously. Coordination may be impaired and may enhance pulmonary, coronary and circulatory problems.</td>
</tr>
<tr>
<td>12-14%</td>
<td>Respiration’s increase, pulse increases, impaired coordination, perception and judgment.</td>
</tr>
<tr>
<td>10-12%</td>
<td>Respiration’s increase further in rate and depth, poor judgment, blueness of lips.</td>
</tr>
<tr>
<td>8-10%</td>
<td>Mental failure, fainting, unconsciousness, ashen face, blueness of lips, nausea and vomiting.</td>
</tr>
<tr>
<td>6-8%</td>
<td>After 4-5 minutes, recovery with treatment possible; after 6 minutes, 50% fatal; after 8 minutes, 100% fatal.</td>
</tr>
<tr>
<td>4-6%</td>
<td>Coma in 40 seconds, convulsions, respiration’s cease, death.</td>
</tr>
</tbody>
</table>

These values are approximate and vary with the individual's state of health and their physical abilities.

Exposure to atmospheres containing 12% or less oxygen can cause unconsciousness without warning. So quickly that individuals cannot protect themselves or call for help.
Atmospheric Hazards
Combustible/Flammable Gases, Vapors and Aerosols

Combustible/flammable gases, vapors and aerosols can pose a significant threat of fires and/or explosion in confined spaces.

A gas is the state of a material that is found as a formless fluid that occupies the space in which it is located at normal room temperature and pressure.

A vapor is the gaseous state of a material normally found as a liquid or solid at room temperature and pressure. An example would be solvents with a low boiling point temperature.

An aerosol is a liquid or solid dispersed and suspended in air and includes mists, fogs, smoke, fumes and dusts.

The lowest concentration (air-fuel mixture) at which a substance can ignite is called its Lower Explosive Limit (LEL) or Lower Flammable Limit (LFL). Concentrations below this limit are too lean to burn. The highest concentration at which a substance can ignite is its Upper Explosive Limit (UEL) or Upper Flammable Limit (UFL). Above this concentration, the mixture is too rich to burn.

A substance is only explosive/combustible between its LEL (LFL) and UEL (UFL), but any concentration of combustible gas or vapor should be of concern when in a confined space. Lean mixtures can collect in an area and reach the LEL, or rich mixtures can be diluted with air to reach the UEL.

### Lower Explosive Limit (LEL) vs. Upper Explosive Limit (UEL)

<table>
<thead>
<tr>
<th>Material</th>
<th>LEL%</th>
<th>Flammable Range</th>
<th>UEL%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasoline</td>
<td>1</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>4</td>
<td></td>
<td>75</td>
</tr>
<tr>
<td>Benzene</td>
<td>1.4</td>
<td></td>
<td>7.1</td>
</tr>
<tr>
<td>Methane</td>
<td>5</td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>Acetone</td>
<td>2.6</td>
<td></td>
<td>12.8</td>
</tr>
<tr>
<td>Toluene</td>
<td>1.2</td>
<td></td>
<td>7.1</td>
</tr>
</tbody>
</table>

*Note: 1% = 10,000 parts per million (ppm)*
OSHA defines the term "flammable or explosive atmosphere" as an atmosphere in which flammable substances are present at a concentration greater than 10% of their Lower Explosive Limit. For example, the LEL for methane is 5%. An atmosphere containing 0.5% methane would be considered flammable. This percentage provides a safety factor. Spaces with 10% LEL should be ventilated until the level drops below 10%. If the level ever hits or returns to 10%, you should leave the space, re-evaluate the space and contact OSEH.

Flammable or explosive atmospheres can be generated from the vapors of flammable liquids that may be in the area. Flash point is the temperature at which a flammable liquid will give off enough vapor to form an ignitable mixture with air. Different liquids have different flashpoints. For example, gasoline has a flashpoint of -45°F, while methanol has a flashpoint of 54°F. Highly flammable materials have flashpoints less than 100°F. Combustible materials have a flashpoint between 100-200°F. If combustible or flammable liquids are stored or used within a confined space, general fire safety precautions must be followed as well as continuous ventilation and air monitoring for LEL levels.

Combustible dust may also pose a significant hazard to employees should the airborne concentration reach the lower explosive limit. Some common types of combustible/explosive dust include:

1. Food products, metal powders and wood products, such as grain dusts, aluminum, wood dust, flour, magnesium, cellulose, starches and zinc
2. Dry chemical powders such as sulfur.
3. Spices and other dusts, such as pepper, hard rubber, tea, plastic and cinnamon.

Many other organic as well as inorganic materials, if ground finely enough, will burn and support a flame.

OSHA suggests you approximate the condition visually. If the dust concentration obscures vision at a distance of five feet or less, the concentration is likely excessive and potentially hazardous and control measures are required.

If this occurs contact OSEH for assistance.
Common Toxic or Poisonous Atmospheres

The four most common toxic gases found in confined spaces are carbon monoxide, hydrogen sulfide, methane and carbon dioxide.

1. Carbon Monoxide (CO)

Carbon monoxide is a very toxic, colorless, odorless, combustible gas that is a product of incomplete combustion. It is generated by gasoline powered internal combustion engines (exhaust), arc welding where carbon dioxide is used as an inert gas, and fires. Carbon monoxide has a high affinity for the hemoglobin in blood and can quickly replace oxygen. In high concentrations carbon monoxide can cause chemical asphyxiation.

**Effects of Various CO Levels:**

<table>
<thead>
<tr>
<th>CO level in ppm</th>
<th>Effect on Humans</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td>Permissible Exposure Limit (PEL) for an 8 hour work shift</td>
</tr>
<tr>
<td>200</td>
<td>Mild frontal headache in 2 to 3 hours</td>
</tr>
<tr>
<td>400</td>
<td>Frontal headache and nausea after 1 to 2 hours</td>
</tr>
<tr>
<td>800</td>
<td>Headache dizziness and nausea in 45 minutes. Collapse and possible death in two hours</td>
</tr>
<tr>
<td>1000 and above</td>
<td>Immediately dangerous to life and health (IDLH).</td>
</tr>
</tbody>
</table>

Note: All effects are approximate and can vary depending on the individuals health and type of physical activity.

2. Hydrogen Sulfide (H$_2$S)

Hydrogen sulfide is a flammable, colorless gas with characteristic rotten egg odor and is soluble in water. It’s commonly found in areas where petroleum products are processed. It is released during the decay of sulfur-containing organic matter, and is encountered in sewers and sewage treatment plants. Hydrogen sulfide has a strong rotten egg odor that is noticeable at low concentrations. You will build up a tolerance and stop smelling hydrogen sulfide after continued exposure. Employees quickly lose the ability to smell this gas, even though it is still present within the space.
Effects of Various H₂S Levels:

<table>
<thead>
<tr>
<th>H₂S Level in PPM</th>
<th>Effect on Humans</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.13</td>
<td>Minimal perceptible odor</td>
</tr>
<tr>
<td>10.0</td>
<td>Beginning eye irritation. Permissible exposure level, 8 hours (OSHA)</td>
</tr>
<tr>
<td>27.0</td>
<td>Strong, unpleasant odor, but not intolerable</td>
</tr>
<tr>
<td>100</td>
<td>Coughing, eye irritation, lose of sense of smell after 2 to 5 minutes.</td>
</tr>
<tr>
<td>200</td>
<td>Marked eye irritation and respiratory tract irritation after one hour of exposure</td>
</tr>
<tr>
<td>300 and above</td>
<td>Immediately dangerous to life and health (IDLH).</td>
</tr>
</tbody>
</table>

Note: All values are approximate and effects can vary depending on the individuals health and type of physical activity.

3. Methane (CH₄)

Methane is a colorless, odorless, flammable gas. It is a simple asphyxiant and displaces air in a confined space. The natural decaying process of organic materials is the most common source. It is most commonly found within sewer systems and within gas lines. Natural gas is methane spiked with an odor giving compound to make it easy to smell.

4. Carbon Dioxide (CO₂)

Carbon Dioxide is a colorless, odorless and tasteless gas that is relatively non-toxic. It’s heavier than air and will act as a simple asphyxiant by displacing oxygen. We exhale about 4% carbon dioxide with every breath. Because we are constantly producing carbon dioxide it can accumulate in the low areas of a poorly ventilated space and create an oxygen deficient atmosphere.

5. Other Atmospheric Hazards

In addition to the above-mentioned atmospheric hazards, there are other substances which may also pose a danger to confined space entrants. These substances can result from materials that are already present in the space or from materials that are brought into the space. For example, residues remaining in vessels, cleaning solvents, and work such as painting, welding or sanding, can contribute to hazardous atmospheres.

A thorough review of the space history and use is essential. If specific contaminants are suspected, contact OSEH to review the information and offer recommendations to ensure that employee safety.
5. Vapor Density

Where gases and vapors will collect is determined by their vapor density. The vapor density of a gas or vapor is its weight compared to an equal volume of air (air = 1). If the vapor density is less than one, the material is lighter than air. If the vapor density is greater than one, the material is heavier than air.

Gases and vapors are usually in such constant motion that vapor density is not a factor when considering exposure. However, most confined spaces are very stagnant and unventilated. This will allow the various components of the atmosphere to separate into layers over time. Most common toxic and flammable gases or vapors are heavier than air and will settle to the bottom of a confined space. A few gases, most notably methane, are lighter than air and will be found at the top of the confined space. For this reason, it is necessary to test all areas (top, middle, bottom) of a confined space before entering.

Listed below are some of the most common toxic gases that are lighter than air:

- Acetylene (C₂H₂)
- Ammonia (NH₃)
- Carbon Monoxide (CO)
- Diborane (B₂H₆)
- Ethane (C₂H₆)
- Hydrogen (H₂)
- Methane (CH₄)
- Hydrogen Cyanide (HCN)
- Nitric Oxide (NO)

All of these compounds, except Nitric Oxide, are flammable. This should not be considered a comprehensive list. Always check a product’s MSDS. The vapor density and flammability of a chemical can be found on the MSDS.
SECTION 2 REVIEW

1. Name the four chemical routes of entry into the body
   ___________________   ________________________
   ___________________   ________________________

2. What is the difference between an acute and chronic health effect?
   ______________________________________________________________________________

3. What is a PEL?
   ______________________________________________________________________________

4. What is the hazard associated with an oxygen deficient atmosphere?
   ______________________________________________________________________________

5. What is the hazard associated with an oxygen enriched atmosphere?
   ______________________________________________________________________________

6. What is LEL and what does it mean?
   ______________________________________________________________________________

7. What are three common toxic gases?
   ______________________________________________________________________________

8. What determines if a gas will rise or sink?
   ______________________________________________________________________________

   ______________________________________________________________________________
SUMMARY

1. Chemicals may enter the body by four different routes of entry: absorption, inhalation, ingestion and injection.

2. An acute health effect is one caused by an exposure to a hazardous chemical over a short period of time. A chronic health effect is one caused by exposures over a long period of time.

3. OSHA has set permissible exposure limits for many chemicals that are used in the workplace. Most of these limits are set as 8 hour time-weighted averages, but others have short-term exposure limits (STEL) or ceiling limits.

4. Hazardous atmospheres include air in confined spaces that may be oxygen deficient or enriched, flammable or explosive, toxic, or immediately dangerous to life or health.

5. The lower and upper explosive limit for a chemical provides the range of concentrations in air where ignition could occur.

6. The vapor density for a chemical will tell you where vapors or gases will be found or migrate to inside a confined space.
Hazard Recognition and Evaluation of Confined Space Physical Hazards

Besides atmospheric hazards, there are other mechanical and physical hazards which may be encountered within a confined space. It is important that entrants and attendants recognize these hazards and take the appropriate action to prevent worker illness or injury.

After completing this unit you will be better able to:

1. Identify engulfment, entrapment, and configuration hazards that may be found in a confined space.
2. Identify mechanical and physical hazards that may be encountered within confined spaces.
Engulfment

Engulfment is the surrounding or capturing of an individual by a liquid or finely divided loose (flowable) solid substance. Examples include water, sand, grain and sawdust. These substances may be already in a confined space or inadvertently allowed to enter a space and engulf a worker.

Engulfment can cause suffocation or drowning blocking or plugging of the respiratory system, or compression of the torso. Particular care must be taken in solid storage containment areas where these materials may have air pockets which can collapse under the weight of an individual.

To prevent engulfment hazards, the liquid or fine bulk material should be removed from the confined space to eliminate the hazard prior to entry.

In situations where the material cannot be removed from the space, the entrant must wear a full body harness and retrieval line. Spaces should be isolated so there is no additional or uncontrolled filling of the space while occupied.

Isolation procedures include such means as:

1. Lock out/tag out all electrical circuits.
2. Disconnecting all lines entering the space and at a location as close to the space as possible.
3. Use double block and bleed techniques.
4. Insert blanks and blinds in flanges as close to vessels as possible to completely isolate it. Test for leaks.
Entrapment and Configuration

An entrapment hazard exists when a permit required confined space has an internal configuration that could entrap or asphyxiate an entrant. Configurations which promote this have inwardly converging walls or a floor which slopes downward and tapers to a small cross section.

Entrants can be trapped in the space, caught in machinery and injured, or succumb to exposure or suffocation before they can be freed. Examples may include a baghouse, or working within large pieces of machinery.
Mechanical Hazards

Accidents have occurred in confined spaces when equipment in the space was not isolated from sources of mechanical, pneumatic, hydraulic, or electrical energy. In most of these cases, death occurred when the worker was crushed by moving equipment.

When service or maintenance work is being done on machinery or equipment, proper lock out/tag out procedures are to be followed. General guidelines include: locking out or tagging out all electrical circuits, completely de-energizing all systems, verifying that all stored energy is removed from the equipment, blocking any equipment that could have stored energy or gravity activated parts, and guarding machinery. These procedures are covered in the lock out/tag out training program.

It is very important to evaluate any mechanical, hydraulic, pneumatic or electrical hazards in a permit required confined space and to ensure that the proper lock out/tag out procedures are being followed.

Examples of devices that may need to be locked or tagged out include mechanical systems such as compressing devices, drive shafts, gears, grinding equipment, conveyors, mixers and cutters.
Chemical Hazards

Physical hazards may be encountered when entering confined spaces containing chemicals or chemical residues. The chemicals can cause eye or skin irritation and burns. Personal protective equipment (clothing, gloves, boots, goggles, etc.) must be worn when these chemicals are present.
Temperature Extremes

Extremely hot or cold temperatures are potential hazards. Excessive heat in a confined space may cause varying degrees of heat stress. Lack of ventilation and PPE can increase the heat stress hazard.

The different degrees of heat stress are:

- **Heat Cramps:**
  
  Symptoms include varied breathing and pulse; weakness; moist, warm skin; heavy sweating; and rarely a loss of consciousness.

- **Heat Exhaustion:**
  
  Rapid shallow breathing; weak pulse; cold, clammy skin; heavy sweating; and sometimes loss of consciousness.

- **Heat Stroke:**
  
  The most severe form of heat stress with symptoms including deep, then shallow breathing, rapid pulse, weakness, dry, hot skin, little or no sweating, and often loss of consciousness.

Cold conditions can cause varying degrees of cold stress. Extreme cold can cause clumsiness, slow reactions, and fatigue. The different degrees of cold stress are:

- **Frost Bite:**
  
  Frozen skin and body tissues. Typically experienced on the fingers, toes, ears or face. The skin becomes numb and pale. Prolonged exposure to cold will kill frozen body parts.

- **Hypothermia:**
  
  Abnormally low body temperature. Symptoms are shivering, reduced mental alertness, reduced rational decision making ability, and loss of consciousness.
Noise

Although noise may not be a problem before a job begins, noise levels may become hazardous because of the nature of the work being performed.

The effects of excessive noise can include:

- Inability to hear shouted warnings.
- Physical damage to ears.
- Temporary and/or permanent hearing loss.

Noise and hearing protection should always be worn in areas where worker exposures may exceed 90 dbA. If there is a question of the type of ear protection to be worn or the level of noise in an area, contact OSEH for further recommendations. The basic rule of thumb is that if you have to shout to communicate with one another then hearing protection is required.

If hearing protection is worn, other means of communication is required. Hand signals, tugging on a rope or lifeline, or throat microphones are examples.
Slip, Trips and Falls, and Falling Objects

These types of hazards are common in confined space entry operations. Often these hazards can cause additional accidents to happen, such as slipping and falling against an electrical box or into a hazardous chemical. Care should be taken to reduce the risks as much as possible. Examples of ways to reduce the risks are:

1. Use good housekeeping practices (e.g., picking up tools around the confined space opening and interior).

2. Check ladders for slippery rungs and strength. If there is any danger of falling from a ladder, the worker should wear a fall arrest device. Typically, this is when the worker is 25 feet above ground, floor, water or other surface. This also applies if entering a manhole which is 25 feet or more in depth.

3. Tie off portable ladders.

4. Wear appropriate personal protective equipment (e.g., slip resistant boots, hard hats, etc.).

5. Lower equipment and tools safely by rope or baskets. Never climb a ladder while carrying tools.

6. Place barriers around the entrance to a confined space to protect the entrants and individuals which may be passing by the area.
Power Tools and Lighting

1. Make sure electrical tools are grounded and insulated.

2. Provide protection from electrical hazards when working in damp spaces or metal tanks. An insulating blanket should be used when arc welding on metal surfaces.

3. Use ground fault circuit interrupters when in wet conditions.

4. Adequate lighting should be provided in the confined space.

5. If a flammable or explosive atmosphere is possible, lighting shall be explosion proof.
SECTION 3 REVIEW

You have learned about several types of hazards that may be found in confined spaces: atmospheric, engulfment, mechanical or electrical, and physical.

Your instructor will show you a series of slides taken of confined spaces. For each slide, please check the potential hazards that might exist in that space.

<table>
<thead>
<tr>
<th>atmospheric</th>
<th>engulfment</th>
<th>mechanical</th>
<th>physical</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>slide 1</td>
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</table>

1. What is an engulfment hazard?

________________________________________________________________________

2. What is an entrapment or configuration hazard?

________________________________________________________________________

3. What is a mechanical hazard and how is it isolated?

________________________________________________________________________

4. Name four types of physical hazards?

________________________________________________________________________

SUMMARY

1. Engulfment hazards include conditions in which an employee may be trapped or surrounded by dry bulk material. Engulfment hazards may cause suffocation or drowning from a liquid or fine solid material trapping an individual.

2. Mechanical or electrical hazards can occur when equipment or machinery have not been isolated from sources of mechanical or electrical energy. These hazards can be controlled by locking out power sources.
3. Physical hazards in confined spaces may be created by temperature extremes, noise, insecure footing, power tools and lighting.
SECTION 4
Evaluation and Elimination of Hazards in Confined Spaces

After completing this section you will be able to:

1. Identify the types of hazardous atmospheres that may be tested with available equipment.
2. Understand the use of direct reading monitors and their limitations.
3. Use and understand ventilating techniques as a form of control for atmospheric hazards.
4. Understand the use of on-site rescue equipment and its limitations.
5. Understand how to control and eliminate hazards.
Evaluation and Elimination of Potential or Known Hazardous Atmospheres

Hazardous, or potentially hazardous atmospheres, can be effectively evaluated and eliminated by using the following three techniques:

1. Air monitoring equipment.
2. Ventilating, flushing or purging techniques.
3. Supplied air respirators and negative air pressure respirators.
Evaluation and Elimination of Potential or Known Hazardous Atmospheres - Air Monitoring

Dangerous concentrations of gases and vapors may exist in a confined space and it is important to realize that these hazards may not be detected by sight or smell. Air monitoring should be performed prior to entering permit required confined spaces.

There are two major types of direct reading atmospheric monitoring equipment: electronic gas detectors; and gas detector tubes. Electronic gas detectors are portable units which can be carried by hand or worn on a belt. Gas detector tubes are small glass cylinders that are connected to a hand operated pump to draw a specific volume of air through the tube.

Most electronic monitors sample for three or four parameters: % oxygen, % LEL, carbon monoxide concentration, and/or hydrogen sulfide concentration. These four parameters account for the majority of all atmospheric hazards encountered in confined spaces. It’s very important that all entrants understand how to use the monitor in their space. The specific directions for the monitors presently being used are located in Appendix E. Listed below are the standard alarm setting that should be set on the monitors, based on present OSHA requirements:

**Table of Air Monitor Attributes:**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Alarm Setting</th>
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<tbody>
<tr>
<td>Oxygen (O₂)</td>
<td>≤ 19.5% and ≥ 23.0%</td>
</tr>
<tr>
<td>Flammables (LEL)</td>
<td>≥ 10%</td>
</tr>
<tr>
<td>Carbon Monoxide (CO)</td>
<td>≥ 35 ppm</td>
</tr>
<tr>
<td>Hydrogen Sulfide (H₂S)</td>
<td>≥ 10 ppm</td>
</tr>
</tbody>
</table>

If the monitor alarm goes off at any time, leave the space immediately and contact OSEH for further assistance. If other contaminants are known or suspected to be present in a confined space (i.e., not specific for the use of these meters), contact OSEH, so that proper air monitoring techniques and devices can be used to assess the air quality. Other chemical contaminants can be identified by reviewing what has been stored or used in the space, what the space is connected to, or what chemicals may be used while working in the space.
Air Monitoring Procedure

The following is the procedure to be used when conducting air monitoring of confined spaces:

1. Ensure that the instrument has been properly calibrated according to manufacturer's recommendations (at least once a month). Turn the meter on and let it warm up.

2. With the meter in normal atmospheric conditions verify that it is functioning properly. O₂ level indicated should be around 20%-21%, and LEL and other toxic contaminants should be at 0 (zero).

3. Insure that the section of the meter which contains the sensors is clear, so air can diffuse into the meter. In order for the meter to function properly the sensor heads should always be clear of debris and left exposed to the atmosphere to be tested. Otherwise, the meter will not be able to detect the presence of a hazardous atmosphere.

4. The space should be tested before opening any cover, hatch or door. If entering a space from the top, any lighter than air gases (e.g., methane) will be at the top of the space. If there are elevated levels of combustible gases in the space, any sparks created while opening the space could create an explosion. Place the monitor against any small openings into the space or attaching a sampling pump with a length of tubing to the sensor head portion of the meter and insert the tubing into the opening. Place the end of the tubing as far as possible into the space and observe the meter read-outs. Oxygen should always be the first air concentration monitored. Oxygen deficient atmospheres will cause the LEL to incorrectly read lower than actual. If an oxygen-deficient atmosphere is encountered, contact OSEH immediately. If the meter indicates acceptable levels, then open the space. If the meter reads elevated levels of contaminants, then do not open the space unless this can be done safely. Contact OSEH for recommendations if necessary.

5. Ensure you monitor for long enough for the sensors to react and display accurate readings. Because of the mechanism used by various sensors, it can take up to two minutes for a typical electronic monitor to display the actual readings it exposed to.

6. Test the atmosphere inside the opening of the confined space. If there is a horizontal opening to the confined space, take readings in the space by attaching the meter or the end of the sampling tube to a pole and placing as far as possible into the space to be entered. If you are putting the entire meter into the space, carefully listen for the meter alarms while it’s inside the confined space.

7. If there is a vertical overhead opening to the confined space, use a pole or sampling pump and extend the meter or end of tubing as far as possible into the space.

8. If there is a vertical opening down into the space, lower the meter on a rope or the end of the tubing into the space.

9. Readings/monitoring should be conducted every four feet into the confined space to be entered. If a full evaluation of the space is not possible (i.e., the space is too long) then monitoring should be performed to the extent possible, and if conditions are acceptable, the entrant may enter the space. Before going beyond the area monitored, repeat the above procedures in the un-monitored areas of the space.

10. Attach the meter to the entrant. The meter will be worn or taken into the space at all times and will remain with the person performing the work (entrant). If the meter alarms at any time the entrant is to leave the space immediately and try to determine the problem. Do not re-enter the space until it’s determined to be safe or the space has been reevaluated.

11. Record the monitoring results on the permit.

12. This procedure is to be followed before work begins, at the beginning of each shift, after lunch, and following an extended work break.
Limitations of air monitoring equipment:

1. A zero reading on the LEL display can mean three things:
   a. There is no flammable gas present.
   b. Concentrations are so high that they are above the UEL
   c. There is insufficient oxygen to provide a correct reading.

2. Electronic meters are susceptible to incorrect calibration. Even correctly calibrated meters can provide inaccurate readings. Each meter is calibrated for a specific gas, but not all gases have the same LEL. If the gas present in the confined space is different than the calibration gas, then the actual concentration present in the space may be higher than what the meter indicates.

3. Battery operated equipment has a limited operating time before requiring recharge.

4. Electronic sensors wear out and need to be replaced periodically.

5. Electronic equipment is susceptible to radio frequency interference. Certain gases can interfere with the accuracy of electronic sensors and detector tubes. Harsh environments, such as high or low temperature or high humidity, can also interfere with readings.

6. Water will damage electronic meters and ruin detector tubes. All meters should be re-calibration if physically damaged or submerged in water. Detector tube should be thrown out if damaged or if past their expiration date.
Ventilating or Flushing Techniques

Ventilation

Once a confined space has been determined to contain or potentially contain a hazardous atmosphere, steps must be taken to ventilate the space before personnel are allowed to enter. Ventilation can be accomplished by natural and mechanical means for the purpose of:

1. Controlling atmospheric contaminants.
2. Prevention of fire and explosion hazards.
3. Control of heat and humidity.

There are two types of ventilation: natural and mechanical. Natural ventilation is where a "natural" fresh air source is allowed to ventilate the space. Mechanical ventilation uses blowers and fans to direct the supply of air to the desired location. Typically, confined spaces are ventilated mechanically to control a known or potential hazardous atmosphere.

Air monitoring is used to determine when the space has been sufficiently ventilated. If unacceptable air quality is found during the initial air monitoring procedure, ventilate the space until within acceptable limits.

Mechanical Ventilation

There are two types of mechanical ventilation: general and local.

1. General Exhaust Ventilation (forcing fresh air into the space)

   This technique is to be used for General Permit Required Confined Spaces. For Hazardous Permit Required Confined Spaces, the ventilating technique to be followed will be determined by the on-site OSEH representative who will calculate required air flow volumes, ventilating times, and resultant contaminant concentrations.

   Use the following procedure:
   a. Perform air monitoring and record results.
   b. Use flex duct attached to the blower/fan unit to direct the ventilation into the space to be entered.
   c. Open all access points to the confined space.
   d. Keep the duct as short and straight as possible. Lengthy ducts and numerous bends decrease the fans' capability to force air into the space.
e. The duct opening should be directed to ventilate the immediate area where an employee will be working.

f. Ventilate the space during the entire time that the entrant is working within the confined space.

g. Ensure that the intake for the fan is not near sources that may draw a contaminant into the space. For example, don’t place the fan near the tailpipe of a running vehicle.

h. Allow the unit to ventilate the space for 15 minutes prior to entry. After this, monitor the atmosphere again to ensure acceptable air quality is present.

2. Local Exhaust Ventilation

Local exhaust ventilation is used when the work you perform is generating a contaminant that otherwise has acceptable air quality. For example, welding operations. Contaminant generation is at a specific point in the space and not dispersed throughout the space. Spray painting a large area would not qualify for this. Local exhaust ventilation is very effective at removing work induced contaminants. A local exhaust system should be left on during the entire work operation. The duct opening is to be placed as close as possible to the point of contaminant generation.
General Safety Measures To Be Followed When Using Ventilation Techniques

1. Ventilate with fresh air only. Never use oxygen because this can create a fire hazard. Use explosion-proof equipment if needed.

2. Make sure that the exhaust air is not being drawn back into the confined space. Place intake and exhaust duct openings away from confined space opening.

3. Make sure ventilation air is reaching all areas of the confined space.

4. Always use air monitors/meters in conjunction with ventilating techniques.

5. Make sure the ventilation system is not blocking the exit from the confined space.

6. Always consider the following five points:
   a. Type of Atmosphere Within Space
   b. Type of Work to be Performed
   c. Size and Shape of Space
   d. Space Openings
   e. Power Source - if there’s no electrical outlet and a gas powered blower is being used, make sure motor exhaust is placed as far away from the opening as possible.

Flushing/Purging/Cleaning of Space

Residues of hazardous chemicals or materials capable of decomposing (e.g., food products or waste materials) must be cleaned from the space as much as possible prior to entering. These materials can generate a hazardous atmosphere or may also present a physical hazard.

1. Some basic steps of pre-entry cleaning are:
   a. Lock out/tag out all material feed lines.
   b. Drain and pump out contents.
   c. If possible, flush the space with water, steam, or other purging agent until all material and residue has been removed.
   d. Ventilate the space until an acceptable atmosphere is indicated.
Respiratory Protection

If the atmosphere cannot be controlled by using the previously mentioned methods, then respiratory protection will be used. This will be used in conjunction with the other methods.

Supplied air respirators provide a source of breathing air separate from the air in the space. The source of breathing air will either be from a cylinder (self contained breathing apparatus (SCBA)), or from an air compressor (air line). These are only to be used in atmospheres that do not have acceptable oxygen concentrations and/or have a high concentration of a toxic atmosphere.

Special training is required before you can wear this type of equipment. Personnel designated as requiring this type of equipment will receive specialized training and instruction.

Negative air pressure respirators are used when contaminant concentrations are present but not in concentrations that are immediately dangerous to life and health (IDLH). This type of respirator uses cartridges that filter out the contaminant. Contact OSEH if your air monitor alarms, if you are entering a known hazardous atmosphere, or if you suspect that a contaminant other than CO or H2S is present, or if the LEL is outside acceptable range.
Elimination of Other Physical and Health Hazards
Engulfment, Entrapment/Configuration and Mechanical

1. Engulfment Hazards/Entrapment or Configuration Hazards

*Hazard:*

Engulfment hazards have the potential to bury or submerge an individual in a solid or liquid. This can lead to asphyxiation or crushing of the body.

Entrapment or configuration hazards have the potential for the entrant to become stuck in the confined space.

*Control:*

In circumstances with this potential, on-site rescue equipment (i.e., retrieval unit) is to be used. The worker entering the confined space will be attached to a lifeline which allows the outside spotter/attendant to retrieve the person without entering the space in the event of an emergency. Special training is given to individuals using this equipment and consists of a review of the retrieval units' limitations and the components of the system that are to be reviewed prior to entry.

2. Mechanical Hazards

*Hazard:*

Exposed machine parts that are energized can cut, maim, crush or kill. The potential energy to be controlled can be pneumatic, hydraulic, electrical, chemical, mechanical, thermal or gravitational.

*Control:*

Follow University lock out/tag out procedures.
Elimination of Other Physical and Health Hazards
Chemical and Temperature

1. Chemical Hazards

*Hazard:*

Hazards for the various chemicals that may be encountered are spelled out within material safety data sheets. Chemicals can affect and be hazardous to any part of the body. They can be present in the atmosphere and as a residue within the confined space surfaces.

*Control:*

Obtain MSDS's. Once the hazards have been identified, the appropriate personal protective equipment can be used. The equipment may include safety glasses/goggles, gloves, chemical resistant suits, face shields, respirators or boots. Keep the chemical off your body and out of your lungs.

2. Temperature Extremes

*Hazard:*

Hot and cold environments can pose serious health and physical effects to the body as defined in the hazard evaluation and control section of this manual.

*Control:*

Mechanically ventilate the environment with heaters, fans or air conditioners. See the heat/cold stress guidelines. Employees should be trained on the recognition of the signs and symptoms of overexposure to these environments and should leave the area if they are experiencing them.
Elimination of Other Physical and Health Hazards
Noise, Slips/Trips/Falls and Electrical

1. Noise
   
   **Hazard:**
   
   May cause hearing damage or interfere with outside personnel communications.
   
   **Control:**
   
   Provide appropriate hearing protection such as ear plugs, ear muffs, or both. If hearing protection is used, an alternate means of communication to the attendant/spotter or co-entrant needs to be used. An example of this is hand and arm signals.

2. Falling/Tripping /Insecure Footing
   
   **Hazard:**
   
   Can cause broken bones or bruises or even death depending on the height between the point of the fall to the surface.
   
   **Control:**
   
   When descending a ladder to a depth of 30 feet or greater, an on-site retrieval system must be used. Good housekeeping practices should be followed. Ladders should be tied off. Equipment and tools should be lowered by ropes or baskets. Slippery surfaces should either be made non-slippery or slip-resistant boots worn. Hard hats should be worn where a slip, trip, or fall hazard exist.

3. Electrical:
   
   **Hazard:**
   
   Electrocution and electrical shock.
   
   **Control:**
   
   Use lock out/tag out procedures to shut systems down. Use insulating materials, such as blankets, gloves and boots. Barriers or partitions of a non-conductive material may be used to isolate the hazard. Use ground fault circuit interrupters in damp or wet areas. Workers performing these operations are to be trained as "qualified persons" under the electrical safety standard.
Elimination of Other Physical and Health Hazards
Lighting and Other General Considerations

1. Lighting

Hazard:
Lack of lighting can pose slip, trip and fall hazards.

Control:
Provide portable lighting, and if working in a flammable or explosive atmosphere, this lighting should be explosion-proof.

2. General Considerations

Appropriate personal protective equipment (PPE) should be worn.

   a. If debris or flying objects can get in your eyes or face, wear safety glasses/goggles and a face shield.
   
   b. If in a tight space and you can bump your head, or if something can fall on top of your head, wear hard hats.
   
   c. If there is a potential for a material to be dropped on your foot, or roll onto your foot, wear safety shoes.
SECTION 4 AIR MONITORING PROCEDURE REVIEW

1. What do most electronic monitors test for?  _______________________
   _______________________
   _______________________

2. What should you always monitor for first?  _______________________

3. What are the alarm limits for oxygen?   _______________________
    LEL?   _______________________
    CO?   _______________________
    H₂S?   _______________________

4. What should you do if the meter alarms?   _______________________

5. What should you do if you encounter an airborne contaminant that your meter does not monitor for?  _______________________

6. You should monitor the space every _________ feet.

7. How long can it take an electronic monitor to react and display an accurate reading?  _______________________

8. Who should wear the meter?   _______________________

9. When is air monitoring performed (how often)?  _______________________

10. What should you do if after ventilating a space LEL monitoring data still indicates a concentration greater than 1%?  _______________________

SECTION 4 FLUSHING AND RESPIRATORS REVIEW

1. What are the two types of ventilation? _____________________________

2. What are the two types of mechanical ventilation? _____________________________

3. What determines if the space has been adequately ventilated?

4. What precautions must be taken when ventilating a confined space?

5. What is local exhaust ventilation and when should it be used?

6. What is General ventilation and when should it be used?

7. When is flushing/cleaning of the confined space required?

8. What are the two types of respirators? _____________________________

9. When are supplied air respirators used?

10. When are negative air respirators required?

11. What are air monitors, ventilation, flushing equipment, or respirators used to control?

SECTION 4 ELIMINATION OF PHYSICAL AND HEALTH HAZARDS REVIEW

1. What is the control method for engulfment, entrapment, or configuration hazards?

2. What is a mechanical hazard and how is it eliminated?

3. How are chemical hazards eliminated?

4. How may electrical hazards be eliminated?

5. How may electrical hazards be isolated?

6. When should safety glasses/goggles be worn?

7. When should hard hats be worn?

8. Give some examples of methods of control for hot environments?
SUMMARY

1. Atmospheric hazards are evaluated and eliminated using air monitoring, ventilation and respiratory protection.

2. All confined spaces should be monitored prior to opening, while entering, and periodically while inside.

3. Always monitor for oxygen content first, then flammable gases and vapors, and then toxic contaminants.

4. Air filtering respirators can only be used to filter out a known contaminant. Supplied air respirators or self contained breathing apparatuses must be used in oxygen deficient atmospheres.

5. Other physical and health hazards should be eliminated as much as possible prior to entering a confined space.
Employee Roles and Confined Space Entry Permits

The confined space program, the hazards that could be present and how to control them have been reviewed. This section will explain the permitting procedures.

After completing this unit, you will be able to:

1. Designate employee roles.

2. Follow the proper procedure when using a General, Hot Work or Hazardous Entry Permit.

3. Be familiar with the different types of permits and how to fill them out properly.
Employee Roles

Once the hazards in a confined space have been identified and evaluated, the proper permit is selected.

Next, the roles of the employees participating in the entry are identified. This is dependent on the type of space to be entered.

Employees may assume different roles during entry. There roles are:

1. Attendant (spotter)

   Person stationed outside the permit space who monitors the authorized employees (entrants) and performs attendant's duties assigned in this policy. The spotter remains directly outside the confined space opening any time another member of the work party is inside the confined space. The authorized employee acting as the spotter should not enter the confined space under any circumstances. The attendant has the following duties:

   a. Communicates with entrants as necessary to monitor status and need for evacuation or rescue.
   b. Monitors activities inside and outside space to ensure the safety of the entrants.
   c. Summons rescue and emergency services when necessary.

2. Authorized Employee (entrant)

   Person who has received confined space entry training (permitted and non-permitted) and can enter confined spaces.

3. Entry Supervisor

   Foreman, supervisor or designated lead person. The person “in-charge” of the confined space entry. They are responsible for the following:

   a. Verifying that acceptable entry conditions are present
   b. Authorizing entry
   c. Filling out the permit
   d. Overseeing entry operations
   e. Terminating entry when operation is complete or if unsafe conditions arise.

   The entry supervisor also conducts the pre-entry briefing. All members of the confined space entry team participate in the briefing and in evaluating the hazards of the space and controls to be used. Note: The entry supervisor and the attendant can be the same person.

4. Rescue Personnel

   Personnel trained in the use of a SCBA unit, first aid, CPR, or other rescue requirements as needed for the space being entered. Their duty is to stand by and be prepared to conduct a rescue if necessary.

   Depending on the type of entry permit used, rescue personnel can be either on-site or off-site.
Pre-Entry Briefing

A pre-entry briefing, using the Confined Space Evaluation Form and the Confined Space Entry Permit, must be conducted by the Entry Supervisor and authorized employees prior to entry. Hazards, potential hazards, proper procedures, equipment use, rescue procedures, and probable contingencies are to be discussed.

The following items are to be reviewed:

1. Monitoring the atmosphere in the space prior to and during entry
2. Lighting
3. Ventilation
4. Lockout/tagout procedures
5. Personal protective equipment and other safety equipment needed (e.g., insulating blankets, fall arrest devices, etc.)
6. Method of communication
7. Rescue/emergency procedures and equipment
8. Review of current and past usage or contents of space
9. Potential hazards
10. Verification that all employees have received training
11. Control of identified health and safety hazards to the extent feasible
12. Issuance of a permit:
   a. Permit is issued by the Entry Supervisor
   b. Permit will be kept on the job site until closed out. Copies of closed out permits will be kept by the department and forwarded to OSEH. These will be kept of file for one year. Permits will be reviewed annually, to determine if policy revisions are necessary.
Non-Permit Required Confined Space Entry Procedures

Non-permit confined spaces require the buddy system (i.e., two workers) and means of communication be maintained (in order to summon rescue).

Non-permit required confined spaces can be reclassified as a permit required confined space if work-induced hazards (e.g., hot work, painting, use of chemicals, sandblasting, etc.) are to be performed within these areas. If any work induced hazards are present, the space should be re-evaluated and, if necessary, the appropriate permit issued and procedures followed.
General Permit Required Confined Space Entry Procedures

1. Personnel Required:
   2 authorized employees (one designated as entry supervisor).

2. A general entry permit requires the following provisions to be addressed:
   a. Conduct pre-entry briefing and post permit
   b. Means of communication
   c. Pre-entry testing
   d. Continuous monitoring
   e. Personal protective equipment, as appropriate
   f. Employee training
   g. Lockout/tagout, as appropriate
   h. Restriction of the work area
   i. Maintenance of equipment
   j. Lighting
   k. Buddy system
   l. Two authorized employees
   m. Off-site rescue

3. If control of all the hazards in the space cannot be accomplished through such means as lockout/tagout, blanking, bleeding, flushing, etc., the following provisions must be addressed:
   a. 1 attendant/spotter and 1 authorized employee entrant. Attendant/spotter on outside of space
   b. Retrieval system (worn if feasible)
Hot Work Permit Required Confined Space Entry Procedures

A Hot Work Permit confined space is a confined space where welding, burning, cutting or torch work is being performed.

In addition to all of the provisions for General permit, the following provisions must be addressed:

1. Special safety precautions for welding.

2. If contaminant generation cannot be controlled through ventilation and continuous air monitoring, the following provisions must be addressed:
   a. Retrieval system, if feasible
   b. On-site rescue
   c. Attendant (spotter)
Hazardous Permit Required Confined Space Entry Procedures

A Hazardous Entry Permit confined space is one where the atmospheric health hazard cannot be controlled through ventilation.

In addition to all of the provisions for General Permit, the following must be addressed:

1. OSEH Representative at worksite.
2. On-site rescue, including one employee standing by with SCBA.
3. Retrieval system.
Rescue

Rescue measures will be necessary if the authorized employee in the confined space becomes incapacitated and is unable to exit the space without assistance. Under these circumstances, one of the following three rescue plans is to be used:

1. If using a spotter, non-entry retrieval system, and on-site rescue:
   a. At the first indication of a problem the spotter shall radio the Department of Public Safety (channel 1A) and request assistance. Under no circumstances should the spotter enter the confined space.
   b. The Department of Public Safety will contact the Ann Arbor Fire Department, who have been trained in confined space emergency procedures.
   c. If it is determined that the authorized employee is incapacitated due to causes not related to the environment, they should not be moved until rescue personnel arrive and direct the removal. (Example: the employee is incapacitated with a broken leg from a fall.)
   d. If the authorized employee is incapacitated due to the environment, use the retrieval system to remove the employee from the confined space.
   e. If the retrieval system fails to extract the employee from the confined space, the on-site rescue personnel wearing SCBA shall enter the confined space to assist in the rescue effort. Additional rescue personnel with SCBA must be on-site for additional rescue efforts. Rescuers must evaluate the atmosphere for explosive and toxic hazards prior to entry.
   f. At least one person on the on-site rescue team shall be trained in CPR and first aid.
   g. A practice drill involving the on-site rescue personnel will be held annually.

2. If using a spotter, non-entry retrieval system, and off-site rescue:
   a. At the first indication of a problem, the spotter shall radio the Department of Public Safety (channel 1A) and request assistance. Under no circumstances should the spotter enter the confined space.
   b. The Department of Public Safety will contact the Ann Arbor Fire Department, who have been trained in confined space emergency procedures.
   c. If it is determined that the authorized employee is incapacitated due to causes not related to the environment, they should not be moved until rescue personnel arrive and direct the removal. (Example: the employee is incapacitated with a broken leg from a fall.)
   d. If the authorized employee is incapacitated due to the environment, the spotter shall use the retrieval system to remove the employee from the confined space.
e. If the use of the retrieval system fails to extract the employee from the confined space, the spotter will wait outside of the confined space until rescue personnel arrive.

3. If using a spotter and off-site rescue only:

   a. At the first indication of a problem, the spotter shall radio the Department of Public Safety (channel 1A) and request assistance. Under no circumstances should the spotter enter the confined space.

   b. The Department of Public Safety will contact the Ann Arbor Fire Department, who have been trained in confined space emergency procedures.

   c. The spotter will remain outside the confined space until rescue personnel arrive.
### SECTION 5 REVIEW

1. **What is an attendant/spotter?**
   
   __________________________________________________________

2. **What are the responsibilities of the entry supervisor?**
   
   __________________________________________________________

3. **What is a pre-entry briefing?**
   
   __________________________________________________________

4. **When are on-site rescue personnel required?**
   
   __________________________________________________________

5. **What types of people and equipment are needed for entering a non-permit required confined space?**
   
   __________________________________________________________

6. **When is a spotter and retrieval system required for a general permit required confined space?**
   
   __________________________________________________________

7. **What is a work induced hazard?**
   
   __________________________________________________________

8. **When is a hot work permit required?**
   
   __________________________________________________________

9. **When is a hazardous permit required?**
   
   __________________________________________________________
SUMMARY

1. Each employee involved with a confined space entry has a specific role. The four key types of roles are: Attendant (spotter); Authorized Employee (entrant); Entry Supervisor; and Rescue Personnel.

2. A Pre-Entry Briefing must be held before entering a confined space to insure all equipment is available and operational, all participants know how to use their equipment, and all procedures and contingencies are understood.

3. A Confined Space Entry Permit must be filled out and signed prior to entering a permit required confined space. The appropriate permit must be used depending on the evaluation of the space and possible work induced hazards.

4. Rescue procedures must be understood by all participants and practiced annually.
Appendix A
GLOSSARY

**Acute Hazard** - a hazard that can injure after short term exposure.

**Attendant (spotter)** - person stationed outside one or more permit spaces who monitors the authorized employees and performs attendant's duties assigned in this policy.

**Authorized Employee** - person who has received confined space entry training (permitted and non-permitted).

**Blanking or Blinding** - means the absolute closure of a pipe, line, or duct by the fastening of a solid plate (such as a spectacle blind or a skillet blind) that completely covers the bore and that is capable of withstanding the maximum pressure of the pipe, line or duct with no leakage beyond the plate.

**Ceiling Limit** - the maximum exposure of an employee permitted at any time.

**Chemical Asphyxiant** - a chemical that can asphyxiate a person by chemically reacting with the body to inhibit respiration.

**Chronic Hazard** - a hazard that can injure after long term exposure.

**Combustible Gas** - airborne concentration of gas or vapor which may present the risk of fire or explosion if an ignition source of sufficient energy is introduced. This term is synonymous with "flammable vapor" and "explosive gas".

**Confined Space** - a space that:
- Is large enough and so configured that an employee can bodily enter and perform assigned work.
- Has limited or restricted means for entry and exit (for example, tanks, tunnels, vessels, silos, storage bins, hoppers, vaults, and pits).
- Is not designed for continuous employee occupancy (for example, tanks, tunnels, vessels, silos, storage bins, hoppers, vaults, and pits).

**Decibel (dbA)** - a unit of measurement for sound or noise.

**Double Block and Bleed** - the closure of a line, duct, or pipe by closing and locking or tagging two in-line valves and by opening and locking or tagging a drain or vent valve in the line between the two closed valves.

**Engulfment** - the surrounding and effective capture of a person by a liquid or finely divided (flowable) solid substance that can cause asphyxiation, or can exert enough force on the body to cause death by strangulation, constriction or crushing.

**Entry Permit** - written authorization for entry into a permit required confined space.

**Entry Supervisor** - first line foreman or designated lead person, responsible for determining if acceptable entry conditions are present at a permit confined space.
where entry is planned; authorizing entry; overseeing entry operations; and terminating entry.

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

- Flammable gas, vapor, or mist in excess of 10 percent of its lower flammable limit.

- Airborne combustible dust that is at or approaching its lower flammable limit. This concentration may be approximated as a condition in which the dust obscures vision at a distance of 5 feet or less.

- Atmospheric oxygen concentration below 19.5% or above 23.5%.

- Any chemical or substance which may be at concentrations above the published federal or state permissible exposure limit.

**Hazardous Chemical** - any chemical which is a physical or health hazard.

**Hazardous Entry** - form of entry into a permit required entry space which presents the risk of engulfment or has an unknown or unacceptable air quality.

**Hazardous Substance** - a substance or mixture of substances, which may cause death, injury or illness.

**Hot Work** - cutting, welding, brazing, or torch soldering.

**Hot Work Permit** - specific written authorization to perform hot work operations in a confined space.

**Immediately Dangerous to Life or Health (IDLH)** - as applied to a work space or atmosphere, a condition in which death or serious injury will occur upon unprotected exposure.

**Lower Explosive Limit (LEL)** - the lowest concentration of a combustible substance in air that will explode due to the introduction of open spark or flame.

**Milligrams per cubic meter (mg/m³)** - a unit of concentration, roughly (though not exactly) equivalent to parts per million (ppm). Used to quantify the amount of a contaminant in air.

**Non-Permit Required Confined Space** - confined spaces that do not contain or, with respect to atmospheric hazards, have the potential to contain any hazard capable of causing death or serious physical harm (refer to list of Confined Spaces).

**OSHA** - The Occupational Safety and Health Administration. An agency within the US Dept. of Labor.

**Oxygen Deficient Atmosphere** - an atmosphere containing less than 19.5% oxygen by volume.
**Oxygen Enriched Atmosphere** - an atmosphere containing more than 23.5% oxygen by volume.

**Parts per million (ppm)** - a unit of concentration where the number of parts measured is compared to a million parts of air, water or other diluent. Equivalent to 1 sq.ft. in 23 acres.

**Permissible Exposure Limit** - the maximum exposure of an employee permitted, averaged over 8 hours.

**Permit Required Entry Briefing** - conference held between employees and the Entry Supervisor prior to allowing employees to enter a permit entry space.

**Permit Required Confined Space** - confined spaces that have one or more of the following characteristics:

- Contains or has the potential to contain a hazardous atmosphere.
- Contains a material that has the potential for engulfing an entrant.
- Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross-section.
- Contains any other recognized serious safety or health hazard such as exposed electrical wiring or devices, pipes, ducts, vents or other portals of entry of potentially hazardous substances.

**Rescue Plan** - predetermined written set of actions that are to be taken when a rescue is necessary.

**Rescue Team** - one or more persons designated and trained to perform rescue work.

**Short Term Exposure Limit (STEL)** - the maximum exposure of an employee permitted, averaged over 15 minutes.

**Simple Asphyxiant** - a chemical that can asphyxiate a person by displacing oxygen.

**Work Induced Hazard** - hazard created due to nature of work such as welding (generates fumes) and painting (generates solvents in the atmosphere).

**Toxic** - that which could cause injury or death, when exposed to without protection. Usually concentration and duration dependent.

**Upper Explosive Limit (UEL)** - the highest concentration of a combustible substance in air that will explode due to the introduction of open spark or flame.
Appendix B
Appendix C
University of Michigan Contractor Confined Space Entry Notification

In compliance with 29 CFR Part 1910.146 and applicable state regulations, when the contractor's work may involve entry into permit required confined spaces, the University of Michigan must notify the contractor and inform them of the hazards associated with these spaces.

The work place contains confined spaces and entry is allowed only through compliance with a confined space entry program. Prior to entry, the contractor must submit a copy of their confined space entry program for review by the Department of Occupational Safety and Environmental Health (OSEH).

**Specific Location of the Permit Required Confined Space(s) (building, street, cardinal direction, type of space):**

____________________________________________________________________________________________
____________________________________________________________________________________________
____________________________________________________________________________________________

**Atmospheric Hazards (existing or potential):**

- Oxygen content less than 19.5% or greater than 23%
- LEL greater than 10%
- Hydrogen sulfide
- Carbon monoxide
- Other toxic gases or vapors
- Combustible dusts
- Work induced hazards (welding, hot work, painting, use of chemicals, etc.)

**Health and Safety Hazards:**

- Mechanical
- Electrical
- Engulfment
- Entrapment
- Slip, Trip, Fall
- Fire/Burn
- Heat Stress or Cold
- Other (specify)

Is coordination of contractor work with U of M personnel activities required? Yes/No

At the conclusion of the entry operations the contractor is required to discuss with the U of M representative the procedures followed and any hazards found or created during entry operations. Copies of permits used will be given to this representative and forwarded to OSEH.

__________________________________________________________________________  ___________________________________________________________________
U of M Representative (print and sign)  Contractor Representative (print and sign)

Contractor Company Name and Address: ____________________________________________________________________________
__________________________________________________________________________

Job or P.O. Number: __________________________  Date: __________________________
Appendix D
Appendix E
Air Monitoring Equipment Use

Two types of air monitors are available for use by personnel entering confined spaces: the Industrial Scientific CMX; and HMX meters. These monitors must be calibrated monthly and used according to the manufacturer’s instructions. The following table which illustrates the specific attributes of each meter, including alarm settings. Each monitor analyzes the air for only three of the four contaminants.

Always monitor for oxygen first, then flammables, and then toxics.

Table of Air Monitor Attributes:

<table>
<thead>
<tr>
<th>Type of Monitor</th>
<th>Monitors For</th>
<th>Alarm Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMX Meter</td>
<td>Oxygen ((O_2))</td>
<td>(\leq 19.5% \text{ and } \geq 23.0%)</td>
</tr>
<tr>
<td></td>
<td>Flammables (LEL)</td>
<td>(\geq 10%)</td>
</tr>
<tr>
<td></td>
<td>Carbon Monoxide (CO)</td>
<td>(\geq 35 \text{ ppm})</td>
</tr>
<tr>
<td>HMX Meter</td>
<td>Oxygen ((O_2))</td>
<td>(\leq 19.5% \text{ and } \geq 23.0%)</td>
</tr>
<tr>
<td></td>
<td>Flammables (LEL)</td>
<td>(\geq 10%)</td>
</tr>
<tr>
<td></td>
<td>Hydrogen Sulfide ((H_2S))</td>
<td>(\geq 10 \text{ ppm})</td>
</tr>
</tbody>
</table>
Appendix F
### University of Michigan Ann Arbor Campus Confined Space Identification Table

Note: These are examples based on the hazard descriptions given in column three.

<table>
<thead>
<tr>
<th>Type of Space</th>
<th>Personnel Involved</th>
<th>Hazard</th>
<th>Type of Permit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Certain sections of Utility Tunnels (refer to specific POR listing) and section north of powerhouse (heat stress)</td>
<td>Steam fitters, sheet metal workers, plumbers, asbestos workers, welders, pipe coverers, painters</td>
<td>Heat stress, restrictive spaces, high pressure (60 lb. pressure) steam lines, chemical use, welding</td>
<td>General Permit Required Confined Spaces identified within tunnel system (note listing)</td>
</tr>
<tr>
<td>Electrical Manholes</td>
<td>High voltage electricians</td>
<td>High voltage electricity, possible contaminant build-up (gases) due to location</td>
<td>General Permit Required Confined Space</td>
</tr>
<tr>
<td>Sanitary sewer system and manholes</td>
<td>Plumbers, electricians, masons</td>
<td>Combustible gases, hydrogen sulfide (use appropriate meter), slippery surfaces, biological contamination, flooding</td>
<td>Hazardous Entry Permit Required Confined Space</td>
</tr>
<tr>
<td>Storm sewer</td>
<td>Plumbers, electricians, masons</td>
<td>Carbon monoxide, oxygen deficiency</td>
<td>General Permit Required Confined Space</td>
</tr>
<tr>
<td>Underground storage tanks</td>
<td>Sheet metal workers, welders</td>
<td>Lack of ventilation, residual or stored chemicals and their vapors, explosive or flammable chemicals</td>
<td>Hazardous Entry Permit Required Confined Space</td>
</tr>
<tr>
<td>Above ground storage tanks</td>
<td>see above</td>
<td>see above</td>
<td>see above</td>
</tr>
<tr>
<td>Crawlspaces</td>
<td>Electricians, welders, plumbers, painters</td>
<td>Restrictive work site</td>
<td>Non-Permit Required Confined Spaces. If lack of natural ventilation or safety hazard, then General Permit Required Confined Space</td>
</tr>
<tr>
<td>Boilers (steam sides and fire flu)</td>
<td>Welders</td>
<td>Heat, lack of ventilation</td>
<td>General Permit Required Confined Space</td>
</tr>
<tr>
<td>Sump stations</td>
<td>Plumbers, welders</td>
<td>Contaminants from sump system, hydrogen sulfide, biological contamination</td>
<td>General Permit Required Confined Space</td>
</tr>
<tr>
<td>Electrical Vaults</td>
<td>Electricians</td>
<td>Electrical, lack of ventilation, restrictive access</td>
<td>General Permit Required Confined Space</td>
</tr>
<tr>
<td>Telecommunications manholes</td>
<td>UM-Tel personnel</td>
<td>Vapors/gases can be carried by entrance ducts</td>
<td>General Permit Required Confined Space</td>
</tr>
<tr>
<td>Type of Space</td>
<td>Personnel Involved</td>
<td>Hazard</td>
<td>Type of Permit</td>
</tr>
<tr>
<td>----------------------------</td>
<td>-------------------------------------</td>
<td>------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Fume Hood Ductwork (interior)</td>
<td>Sheet metal, welders</td>
<td>Toxic or flammable gases or vapors, chemical residues, restrictive work site</td>
<td>General Permit Required Confined Space</td>
</tr>
<tr>
<td>Air Handling Units</td>
<td>HVAC personnel</td>
<td>Restrictive work site</td>
<td>Non-Permit Required Confined Space</td>
</tr>
<tr>
<td>Chimneys</td>
<td>Masons, powerhouse personnel</td>
<td>Depends on location</td>
<td>Non-Permit Required Confined Space. * Exception: if chemical, biological, or radioactive contaminants are burned within, then General or Hazardous Entry Permit Required Confined Space (contact OSEH)</td>
</tr>
<tr>
<td>Interstitial Spaces</td>
<td>Maintenance, HVAC, electrical personnel</td>
<td>Restrictive work site</td>
<td>Non-Permit Required Confined Space</td>
</tr>
</tbody>
</table>

Note: Hot Work Permit Required if performing welding, brazing or torch soldering tasks within any type of confined space.

If space characteristics/hazards change, the type of permit to be used may also change. This is determined by re-evaluating the confined space.

Confined spaces exist that are not identified within this chart and should be evaluated and handled accordingly.
Tunnel Confined Space Listing

The sections of the Campus Utility Tunnels listed below are confined spaces due to the lack of ventilation or high heat stress.

Point of Reference Number (POR)

- 100-110 (heat)
- 116-117 (ventilation)
- 121 to north (ventilation)
- 126 (ventilation)
- 325-326 (ventilation)
- 331-332 (ventilation)
- 411 to west of sidewalk door (ventilation)
- 414 under fountain (ventilation)
- 602 to west (ventilation)
- 603 to west (ventilation)
- 615 to President’s Residence (ventilation)*
- 835 to south of Angell Hall (ventilation)*
- 840-842 (ventilation)
- 911 (heat)

*crawl tunnels

A copy of this list should be kept for future reference.

In the event of an emergency, the Department of Public Safety should be contacted. If your radio does not work at the your location then leave the area and keep on transmitting until you have reached the Department of Public Safety. The nearest point of reference (POR) number and access point to the injured individual should be given. After this has been done you should go to the tunnel access point and wait for the arrival of help.