

CONFINED SPACE ENTRY PROGRAM

UFEH&S-SAFE-3/30/2001

Environmental Health and Safety

Finance and Administration

University of Florida

- OBJECTIVE: To establish minimum requirements for practices and procedures to protect employees from hazards of entry into and work in confined spaces.
- AUTHORITY: OSHA 29CFR 1910.146; Governors Executive Order 2000-292
- POLICY: All employees, students, volunteers, and contractors working under direct UF supervision shall comply with all elements of the UF confined space entry program (see Procedures Section).
- RESPONSIBILITIES: EHS - Develop, maintain, distribute, and provide oversight in accordance with all applicable federal and state regulations, and best industry practices. EH&S staff, supervisors and PIs have the responsibility and authority to halt any unsafe practices not in accordance with this policy.
- Departments - Comply with all policy and program elements.
- PROCEDURES: All entries into confined spaces shall be in accordance with this policy and the referenced confined space program.

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Introduction

A confined space is an area that is large enough to bodily enter and perform work, has limited access and is not intended for continuous employee occupancy. Confined spaces are characterized by poor ventilation and have a potential for hazardous atmospheres. Confined spaces also restrict rescue efforts and can often result in the death of poorly prepared or trained rescuers. Examples of confined spaces include boilers, fuel tanks, pipelines, pipe chases, pumping stations, process vessels, septic tanks, sewage digesters, silos, manholes, utility vaults, vats, pits or similar enclosures. The hazards encountered and associated with entering and working in these spaces are capable of causing physical injury, illness and death.

Confined space hazards can be divided into three major categories:

- 1) Chemical: oxygen deficiency, explosive atmospheres or toxic atmospheres.
- 2) Physical: temperature extremes, high noise levels, engulfment, radioactivity, electrocution, falling objects, and slick, wet surfaces.
- 3) Biological: infectious agents, stray animals, insects or certain plants.

Accidents occur in confined spaces for three basic reasons:

- 1) Failure to recognize the work area as a confined space,
- 2) Failure to monitor for the potential hazards, and
- 3) Failure to control those hazards identified.

Every case of confined space work must be considered hazardous and appropriate precautions and work practices must be adhered to religiously.

Responsibilities

When the work area meets the criteria for a confined space, all entry requirements shall be enforced. It shall be the responsibility of departmental supervisors and/or principal investigators to ensure implementation of this program when confined space activities are necessary. The specific responsibilities of each unit are:

EH&S is responsible for maintaining the program and making it available to all employees. Specific questions about the program and interpretations should be directed to EH&S.

Management:

- 1) Departmental supervisors and Principal Investigators should designate, in writing: confined space competent persons (CP), entrants, and attendants, rescue team members.
- 2) Department supervisors and Principal Investigators shall ensure that all persons involved with the confined space entry program are properly and thoroughly trained.
- 3) Management shall provide all necessary equipment (at no cost to employees) needed to implement the confined space entry program.
- 4) Management shall ensure that a trained rescue team is readily available to perform a rescue if needed.
- 5) Management should enforce disciplinary procedures as needed to ensure compliance with the established program.
- 6) Identify all work areas that meet the definition of confined space.

Employees:

- 1) Employees are responsible for following identified procedures when entering a confined space or standing by as an authorized observer, entrant, attendant, or rescue team member.
- 2) Employees are required to use specified protective equipment provided by management. If such equipment increases operational hazards, the hazards shall be conveyed to the entry supervisor for a determination on PPE use.

Confined Space Classification and Permits

Entry into a confined space shall be by permit only. Entry permit forms are included in Appendix B. The permit serves as written authorization and documentation specifying the location and type of work to be done and certifies that all existing hazards have been evaluated. The permit also documents that all necessary protective measures have been taken to ensure the safety of each employee. The CP shall be responsible for completing the permit and shall sign off on the permit only when all requirements have been fulfilled.

EH&S must approve Class A and B permits prior to entry. The completed permit for all confined space entries shall be kept and available by the CP or attendant close to the

entrance at each job site for the duration of the entry. The original entry permit shall be kept for a minimum of one year at the department office, with copies sent to EH&S.

There are three classes of confined spaces. The classifications are based upon the characteristics of the confined space: oxygen levels, flammability and toxicity. The classification shall be determined by the most hazardous condition of entering, working in and exiting the confined space. See Table 4-1.

The minimum requirements for each class of confined space entry are in Table 4-2.

**TABLE 4 - 1
UF CONFINED SPACE CLASSIFICATION**

Parameters	Class A	Class B	Class C
Characteristics	IDLH - rescue procedures require the entry of more than one individual equipped with life support equipment - maintenance of communication requires an additional standby person outside the confined space. No entry	Dangerous, but not IDLH - rescue procedures require the entry of no more than one individual fully equipped with life support equipment - indirect visual or direct auditory communication with employee.	Potential hazard requires no modification of work procedures - direct communication with workers from outside the confined space.
Oxygen	16% or less greater than 23%	16.1% - 19.4% or 21.5% - 23%	19.5% - 21.4%
	OR	OR	
Flammability Characteristics	20% or greater of LFL	19% - 1% LFL	1% LFL or less
	OR	OR	
Toxicity	IDLH values from American Conference of Governmental Industrial Hygienists (ACGIH)	Greater than PEL or TLV but less than IDLH	Less than PEL, TLV
Space Restrictions	No entry	No entry except by Express EH&S written authorization	Entry permitted in accordance with all program requirements.

**TABLE 4 - 2
CHECK LIST FOR ENTRY
WORKING IN AND EXITING CONFINED SPACES**

Requirement	Class A	Class B	Class C
1. Entry Permit	X ¹	X ¹	X ²
1a EH&S Approval	X	X	O
2. Pre-entry Air Test	X	X	X
3. Continuous Air Test	X	X	X
4. Annual Training	X	X	X
5. Labeling\Posting	X	X	X
6. Safety Equipment			
Confined space 4-gas meter	X	X	X
Body harness	X	X	X
Life line w/tripod and winch	X	X	X
Barricades	X	X	X
8. Preparations and Work Procedures:			
Purge\ventilate	X	X	O
Isolate\lockout\tag	X	X	X
Complete Permit	X	X	X
Standby Attendant	X	X	X
Communications	X	X	X
Rescue	X	X	X
11. Record keeping	X	X	X

X indicates requirement

O indicates determination to be made by CP

1 Class A and B permit

2 Class C pre-entry checklist

3 use permit or checklist as appropriate and determined by CP

Air Testing & Monitoring

Entry into a confined space is prohibited until all requirements of Table 4-2 Pre-entry section have been completed.

Many work practices in confined spaces have the potential to increase existing hazards or generate new ones. Therefore, it is necessary to continuously evaluate the space and determine any change in conditions.

Air Testing Procedures

- 1) EH&S must approve all monitoring instruments prior to purchase and can assist in selecting appropriate equipment. Individuals performing atmospheric testing must be trained and familiar with the equipment being used. Instruments shall be calibrated in accordance with the manufacturer's instructions before each use. Each calibration shall be recorded on the entry permit.
- 2) Measurement of values for each atmospheric parameter should be made for at least thirty seconds or until the meter reading is stable.
- 3) When monitoring for entries involving a descent into atmospheres that may be stratified, the atmosphere should be tested each 4 feet in direction of travel.
- 4) Atmosphere shall be monitored on a continuous basis while entrant is in the space either through entrant wearing the meter or by an attendant outside the space.
- 5) Air testing shall be performed using UF's standard 4-gas confined space meter or equivalent. The meter shall be configured with appropriate toxic gas sensors. Additional monitoring may be required if contaminants are generated by the work performed.
- 6) If using separate or manual gas instruments, a test for oxygen shall be performed first because most combustible gas meters are oxygen dependent and will not provide reliable readings in an oxygen deficient atmosphere.
- 7) If through monitoring any spaces are determined to be Class A or B, the entrances shall be posted. Signs shall state:

DANGER
HAZARDOUS CONFINED SPACE
DO NOT ENTER

Entry Procedures

General

The entry permit shall be compiled by the CP and be definitive for all possible hazards. Before entering a confined space, employees shall review the specific entry permit for safe entry and emergency exit.

An effective barrier shall be erected to prevent unauthorized access and to protect entrants from hazards such as pedestrian or vehicle traffic. The CP is responsible for maintenance of the barricade system.

When an employee is required to enter a confined space, a body harness, life line and means of extrication (e.g. tripod w/winch) shall be used at all times.

All hazardous energy sources associated with the confined space that may expose entrants to potential injury must be isolated, locked/tagged out prior to entry. Additionally, the space should be ventilated as necessary to ensure control of all atmospheric hazards.

Competent Persons

The CP is responsible for the overall permit space entry and must coordinate all entry procedures, tests, permits, equipment and other relevant activities. The duties of the CP include:

- 1) Evaluate all possible hazards that may be faced during entry and know the mode, signs, symptoms and consequences of exposure(s)
- 2) Verify that all tests specified by the permit have been conducted and that all procedures and equipment are in place before signing the permit and allowing entry to begin
- 3) Assign responsibilities and entry roles (e.g. attendant, entrant) to all personnel prior to entry
- 4) Terminate the entry and cancel the permit when the entry is complete or there is a need to terminate the permit
- 5) Verify that rescue services are available and that the means for summoning them are operable
- 6) Prevent unauthorized access

Entrants

All entrants must be authorized by the CP, have received the required training, use the proper equipment and observe the general entry procedures and those specific requirements of the entry permit. Additional duties of entrants include:

- 1) Know the hazards that may be faced during entry and the mode, signs, symptoms and consequences of exposure
- 2) Maintain communication and alert the attendant whenever any warning sign or symptom of a dangerous situation is recognized
- 3) Exit the space as quickly as possible whenever the attendant or CP gives an order to evacuate or the entrant recognizes any warning sign or symptom of exposure

Attendants

At least one attendant is required outside the confined space on all entries and on Class C and emergency entries at the direction of the CP. Specific duties of the attendant include:

- 1) Knowing the hazards that may be faced during entry and to be aware of the mode, signs, symptoms and behavioral effects of exposure in entrants

- 2) Be able to accurately identify authorized entrants and maintain a count of entrants in the space
- 3) NEVER enter the confined space during entry operations unless duties reassigned and directed by CP
- 4) Communicate with entrants as necessary to monitor entrant status and alert entrants of any changes or need to evacuate
- 5) Monitor activities both inside and outside the confined space and order evacuation if any problems are detected such as abnormal entrant behavior or a prohibited condition
- 6) Prevent unauthorized access
- 7) Initiate rescue and summon emergency services when needed

Contractors

In some cases contractors and other non-employees may enter confined spaces to perform work. When contractors and others must enter confined spaces departmental supervisors, principle investigators or the CSEP coordinator, as appropriate, must ensure:

- 1) The contractors are informed that the workplace contains confined spaces and that they must follow a confined space entry program per OSHA standard 29 CFR 1910.146 and use an authorized permit for entry
- 2) The contractors are apprised of the hazards identified, any experience with the space and precautions or procedures necessary for employee protection
- 3) All contractors performing confined space entry inform the host employer of the confined space entry program that will be followed and any hazards confronted or created in the space(s)
- 4) The contractors coordinate entry operations with host employer units as necessary

Medical Examinations (Class A and B)

Medical requirements for employees who might enter a confined space should take into consideration the increased hazard potential of confined spaces. In this setting, employees must rely more heavily upon their physical, mental and sensory attributes, especially under emergency conditions. Employees should be evaluated by the University's Occupational Physician at the Student Health Care Center to ensure that they are physically and mentally able to wear respirators per the requirements of the UF Respiratory Protection Program. Because of the additional stress placed on the cardiopulmonary system, some pathologic conditions, such as heart disease or those associated with hypoxemia, should preclude the use of respiratory protective equipment.

Employees who work in Class A or B confined spaces or are required to perform emergency entries shall have a preplacement physical examination. The supervising department shall provide to the physician information such as the type of confined space the employee may be required to enter, the type of substances the employee may encounter and a description of any protective equipment the employee may be required to use. The physical examination shall include at a minimum:

- 1) Passing the UF respirator physical and clearance to work with respirators by the Occupational Physician
- 2) A demonstration of the employee's ability to see and hear warnings, such as flashing lights, buzzers or sirens
- 3) General evaluation emphasizing the detection of any diseases or abnormalities that may prohibit work in confined spaces and focusing on the employee's ability to carry out assigned duties

Following completion of the examination, the physician shall provide EH&S and the department with a written statement clearing the employee to work in confined spaces and specifying any restrictions that would limit the employee's confined space work. Employees required to work in Class A or B confined spaces shall have periodic medical examinations at the discretion of the Occupational Physician and at a frequency not less than that specified by the UF Respirator Program.

A post-employment examination shall also be conducted per the requirements of the UF Health Assessment Management System (HAMS). Records of exposure to known health hazards shall be included in that employee's medical record.

Training

Because of the potential hazards encountered in a confined space it is paramount to structure an effective training program that will provide for safe work practices and techniques. The training program shall be based on the specific hazard(s) to be encountered and given to all individuals who will perform the work or may be assigned as attendant or rescue personnel. Entrants, attendants, rescue personnel and qualified entry supervisors must receive training so they acquire the understanding, knowledge and skills necessary for the safe performance of duties assigned.

The training requirements of personnel entering and/or working in confined spaces shall be suited to the nature of the hazard(s) and the work to be performed and will therefore vary with the confined space classification. The CP shall be responsible for training all entrants, attendants and rescue personnel and for the safety of each confined space entry. Therefore, the CP shall receive a minimum of 24 hours of confined space entry training every two years. New employees must receive training prior to performing confined space entry duties. Refresher training shall be given before any change in duties, equipment, techniques or operations about which an employee has not previously been trained. Retraining should also be performed if a supervisor notices a weakness in employee performance or inadequacies in the employee's

knowledge or use of the CSE procedures. Rescue and training drills designed to maintain proficiency shall be conducted annually. EH&S can assist in developing and providing instruction and guidance.

Competent Person

It is essential that the person in charge of training know the relevant aspects of safety related to confined spaces. The CP must have a thorough working knowledge of the following:

- a) Types of confined spaces associated with work at the University of Florida.
- b) Hazards involved: chemical, physical and biological
- c) Work practices and techniques
- d) Testing requirements, exposure limits and action levels
- e) Safety equipment: respirators, clothing, harnesses, lifelines
- f) Rescue procedures
- g) Knowledge of applicable Federal, state and local regulations
- h) Evaluation of test methods

Entrants and Attendants

Personnel who are required to work in a confined space, or support those working in confined spaces shall have training in the following areas:

- a) Emergency entry and exit procedures
- b) Use of applicable respirators
- c) First-aid
- d) Lockout procedures
- e) Safety equipment use
- f) UF Confined Space Entry Permit system

The CP shall observe employees routinely to ensure safe work practices are being followed. Testing employees on knowledge of the operations and hazards shall be conducted after each training session. Appendix C provides additional guidance for training program content.

Rescue and Emergency Services

Emergency procedures, including phone numbers for emergency medical services, University Police Department, EH&S and Gainesville Fire and Rescue Department shall be posted conspicuously within the immediate area of the confined space, or at the telephone nearest the work area. Material Safety Data Sheets (MSDS) or similar written information shall be kept at the worksite when entrants are exposed to substances requiring such information so it can be made available to the medical facility treating exposed entrants.

Rescue procedures shall be specifically designed for each entry. Rescue and emergency services may be provided either by on-site (UF) or by off-site (GFD) personnel. If on-site personnel are used each member of the rescue service must be provided with, and trained to use properly, the personal protective and rescue equipment necessary for making rescues from confined spaces. Each rescue service member shall be trained in basic first aid and in cardiopulmonary resuscitation (CPR). Each rescue service member shall practice making confined space rescues at least once every 12 months, by means of simulated rescue operations in representative spaces.

If off-site rescue services are to be used they shall be contacted, approved and agree to provide rescue and emergency services for confined spaces. The service name (e.g. GFD), location, contact person and means of contact shall be attached to each CSE permit. The off-site rescue service shall be provided information concerning the hazard(s) they may face when called to perform rescues. In addition, they shall be given access to all confined spaces from which rescue may be necessary so they can develop appropriate rescue plans and practice rescue operations.

Record keeping

All impacted departments shall maintain written records of training including entry/rescue exercises and equipment inspections for at least one (1) year or until the date of the next training, inspection, test or maintenance. In addition, all entry permits and pre-entry checklists shall be retained for at least one year. Where medical monitoring is conducted for respiratory protection or over-exposure, records shall be maintained for the duration of employment plus thirty (30) years. Where atmospheric testing indicates the presence of a toxic substance, records shall be maintained in accordance with existing Federal and state regulations.

References and Resources

American Conference of Governmental Industrial Hygienists, [*Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices.*] 1994. Cincinnati, OH 45240.

American Industrial Hygiene Association. [*Confined Space Entry, An AIHA Protocol Guide.*] 1995. AIHA, Fairfax, VA.

American National Standards Institute. [*Safety Requirements for Confined Spaces.*] 1989. ANSI.

U.S. Department of Labor, Occupational Safety and Health Administration, 29 CFR 1910, 146.. [*Permit Required Confined Spaces, Final Rule.*] Federal Register Vo. 5, No. 9, January 1993.

U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health. [*Criteria for A Recommended Standard: Working in Confined Spaces.*] December 1979. NIOSH #80-106.

U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health. [*Worker Deaths in Confined Spaces. A summary of Surveillance Findings and Investigative Case Reports.*] January 1994. NIOSH #94-103.

APPENDIX A

DEFINITIONS

Atmosphere: Refers to the gases, vapors, mists, fumes and dusts within a confined space.

Attendant: A person trained in emergency rescue procedures and assigned to remain on the outside of the confined space in constant communication with those working inside the confined space. The attendant shall be approved and assigned by the qualified entry supervisor.

Ceiling Level: The maximum airborne concentration of a toxic agent to which an employee may be exposed for any period of time.

Combustible Dust: A dust capable of undergoing combustion or burning when subjected to a source of ignition.

Confined Space: Refers to a space which by design has limited access, unfavorable natural ventilation resulting in potential dangerous concentrations of air contaminants and which is not intended for continuous human occupancy.

Confined Space, Class "A": A confined space that presents a situation that is immediately dangerous to life and health (IDLH). These include but are not limited to oxygen deficiency, explosive or flammable atmospheres, and/or concentrations of toxic substances. Class "A" confined space requires prior EH&S approval of entry permit in Appendix B.

Confined Space, Class "B": A confined space that has the potential for causing injury or illness, if preventative measures are not used, but not immediately dangerous to life or health. Class "B" confined space requires completion of entry permit in Appendix B with a copy provided to EH&S.

Confined Space, Class "C": A confined space in which the potential hazard would not require any special modification of the work procedures. Class "C" confined space requires use of a Class "C" pre-entry checklist with a copy provided to EH&S.

Hot Work: Any work involving burning, welding, riveting, or similar high temperature producing operations as well as work which produces a source of ignition, such as drilling, abrasive blasting and space heating/drying.

Immediately Dangerous to Life and Health (IDLH): Those atmospheres containing sufficient concentrations of airborne materials to cause irreversible health effects upon exposures without respiratory protective equipment.

Inerting: Displacement of the atmosphere in a confined space by a non-reactive gas (such as nitrogen) to such an extent that the resulting atmosphere is noncombustible.

Isolation: A process whereby the confined space is removed from service and completely protected against the inadvertent release of material by the following means: blanking of supply lines, misaligning sections of all lines and pipes, a double block and bleed system, electrical lockout of all sources of power, and blocking or disconnecting all mechanical linkages.

Lower Flammable Limit (LFL): The minimum concentration of a combustible gas, vapor or dust in air (expressed in percent volume), which will ignite if an ignition source is present.

Oxygen Deficiency: Refers to an atmosphere with a partial pressure of Oxygen (PO₂) less than 132 mm mercury (Hg). Normal air at sea level contains approximately 21% Oxygen at a PO₂ of 132mm Hg. For the purposes of this program, an atmosphere containing less than 19.5% Oxygen by volume shall be considered oxygen deficient.

Oxygen Enriched Atmosphere: Any oxygen concentration greater than 23% at normal atmospheric pressure.

Permissible Exposure Limit (PEL): The maximum 8-hour time weighted average (TWA) concentration of an airborne contaminant to which an employee may be exposed by law as listed in the Occupational Safety and Health Act, 29 CFR 1910 Sub Part Z.

Purging: The method(s) by which gases, vapors or other airborne impurities are displaced from a confined space. The method usually involves injecting fresh air into the confined space using a compressor or blower, thereby forcing contaminated air out.

Qualified Entry Supervisor: A person designated by the department, as capable (by education, training, or both) of anticipating, recognizing, evaluating, and controlling employee exposures to hazardous substances or circumstances in a confined space. This person shall be capable of specifying necessary control or protective actions and equipment to ensure employee safety. This person shall certify the confined space entry permit and be approved by EH&S per the above criteria.

Respirator: A device designed to protect the wearer from inhalation of harmful atmospheres. The device shall meet the requirements of the UF Respiratory Protection Program, the Mine Safety and Health Administration (MSHA) and the National Institute for Occupational Safety and Health (NIOSH).

Threshold Limit Value (TLV): The maximum 8-hour time weighted average (TWA) concentration of an airborne contaminant to which an employee may be exposed. To be used in absence of PEL as recommended by the American Conference of Governmental Industrial Hygienists (ACGIH).

APPENDIX B
ENTRY PERMIT FORMS

University of Florida CLASS "A" AND "B" CONFINED SPACE ENTRY PERMIT

ENTRY

Time of Entry: Date _____ Time _____
 Purpose of entry: Inspection ___ Cleaning ___ Maintenance ___ Repair ___ Hot work ___ Other _____
 Brief description of purpose: _____ Location of entry _____

UF EMPLOYEE	UF EMPLOYEE	OTHERS	OTHERS	OTHERS
Name	Time In/Out	Name	Company	Time In/Out

EVALUATION

Does space contain a flammable or combustible gas or liquid? Yes _____ No _____
 Does space contain dry explosive dusts or ignitable residues? Yes _____ No _____
If "yes" is the answer to either of the previous two questions, clean, cover, or remove contaminants so tests show no possibility of flames or sparks igniting dry dusts, residues, or flammable gases or vapors.
 Is the level of flammable or combustible gases and vapors in the space and adjacent areas well below 10% of the LFL? Yes _____ No _____
 Type & S/N of sampling equipment-Model: _____ S/N: _____ Calibration date: _____

ATMOSPHERIC PARAMETERS	OPENING	MIDDLE	BOTTOM	OTHER	SAFE LIMIT
% Oxygen					>19.5% & <21%
% LFL					<10%
Toxic					< PEL or TLV

****Additional readings on back****

Have all energy sources been locked and tagged? Yes _____ No _____
 Is there any possibility of entrapment or engulfment by particulate matter? Yes _____ No _____
 If yes, have provisions been made to work safely in such an area? Yes _____ No _____

PREPARATION

Have all personnel been adequately trained to work safely? Yes _____ No _____
 Have all personnel gone through a pre-entry briefing? Yes _____ No _____
 Is the area secure with barricades, and attendant posted? Yes _____ No _____
 Do entry personnel have body harness and lifeline, if required? Yes _____ No _____
 Do all personnel have required protective equipment (PPE)? Yes _____ No _____
 Are there first-aid supplies and rescue provisions? Yes _____ No _____
 Is ventilation provided to adequately remove gases/vapors to a safe area? Yes _____ No _____
 Are all ventilators and electrical equipment intrinsically safe and approved for the space? Yes _____ No _____
 Communication devices to be used: _____ Equipment to be provided: _____

HOT WORK (if applicable)

Are hot work signs posted? Yes _____ No _____
 Has a fire watch been posted with portable fire extinguisher during, and 30 minutes after, work in all hot work areas? Yes _____ No _____
 Is space inerted? Yes ___ No ___ (If "Yes", with what gas? CO₂ ___ N₂ ___ Steam ___ Other _____)

If inerting is done to control the flammable gas or vapor, continuous monitoring shall be done to assure the O₂ level meets the specification of ANSI/NFPA 306-1992 (must be <5% by volume).

I certify that the above conditions are accurate and validate the entry only for the stated purpose, time, and identified employees, not to exceed work for one shift. If any question was answered "No" and a satisfactory answer was not given, do not issue permit.

Entry supervisor's name (print) _____ Signature _____

Title _____ Date _____

University of Florida
CLASS "C"
CONFINED SPACE PRE-ENTRY CHECKLIST

This certification form is to be completed for authority to allow entry into a confined space. It may only be issued under the conditions set forth in the written entry procedures specific to the space identified on this form. It shall be made available to each employee entering the space.

Specific location and space: _____

Date entry is authorized: _____

Time effective: From: _____ To: _____

Has each entrant received the prescribed training? Yes ___ No ___

Is area marked and secure? Yes ___ No ___

Atmosphere test readings must be taken before forced air supply is connected, if used, and PRIOR TO ENTRY. Readings recorded below must be within the prescribed safe limits.

ATMOSPHERIC PARAMETERS	INITIAL READING	FINAL READING	WITHIN PRESCRIBED LIMITS		SAFE LIMITS
			Yes	No	
Oxygen by volume			Yes	No	>19.5% & <21%
Percent LFL			Yes	No	<10% LFL
Carbon Monoxide ppm			Yes	No	<25 ppm
Hydrogen Sulfide ppm			Yes	No	<10 ppm
Other			Yes	No	

Is forced air equipment working properly? Yes ___ No ___

Is air supply from a clean source? Yes ___ No ___

Has forced air been supplied the amount of time prescribed before entry? Yes ___ No ___

Describe each step taken as prescribed by the written entry procedures as the basis for determining that all hazards have been eliminated (i.e. lockout/tagout of feed valves or power switches; removal of contaminants; etc.). _____

I certify that all recognized hazards have been eliminated in this permit-required confined space to allow for entry. Safeguards and work practices are in place to ensure safe entry operations.

Signature of person authorizing entry: _____

Title : _____ Date certification issued: _____

APPENDIX C

TRAINING PROGRAM CONTENT

The CP is responsible for ensuring that each employee is adequately trained and given refresher courses in assigned duties and that the employee understands and applies safe work practices. The following are areas that shall be covered in training:

- 1) The types of confined spaces that are found in the workplace. This should cover physical location, size and any pertinent information that would inform the worker of its function.
- 2) Physical and chemical hazards involved. The physical hazards would include structural members within a confined space, equipment that will be used such as scaffolding or ladders. Chemical hazards discussed should include the product that has been stored or cleaning agents used in the space that may contribute to the air contamination during work procedures.
- 3) Atmospheric testing of the confined space. This phase of the instruction should emphasize the contaminants that should be tested for, the permissible exposure limits and action levels for entry.
- 4) Ventilation of the space by mechanical methods to reduce or eliminate toxic airborne contaminants. This category should be covered sufficiently to alert employees of potential hazards and the need for warning devices to signal when there is a ventilation failure.
- 5) Isolation and lockout of the confined space. The employee should be able to recognize a hazard by visual observation of connecting lines in a confined space. The lockout of electrical circuits and mechanical disconnects to complete confined space isolation should be explained as should the employee's responsibilities in this area.
- 6) Safety equipment and clothing. The employee should be aware of the proper use and care of personal protective equipment. This should include the type of protective shoes, gloves, face protection, protective clothing, head protection, safety harnesses and hearing protection. Information should also include the rationale for their use. A major area of discussion will be the use of respirators: the types required, their use, fit testing, cleaning and proper storage. It should be emphasized that different types of respirators are required for different atmospheres and the dangers involved when the wrong type of unit is used. The mandatory wearing of safety harnesses should also be stressed. The use of safety belts and life lines should be demonstrated so that each employee understands the importance of having the rescue system available and operative and is constantly aware of the necessity of keeping life lines clear to the point of exit.
- 7) Buddy system and use of an attendant.
- 8) Communication systems and emergency signals.
- 9) Rescue procedures. All employees working in or around a confined space shall be fully trained in emergency exit procedures. Additional training should include first-aid and CPR. This should include on-site entry and rescue drills.
- 10) Permit system used by the University. Information covered on the permit shall include: purpose of the permit; location where the permit will be posted on site; responsible persons; emergency information and hazards to be expected. See Appendix B.
- 11) Documentation of training. Satisfactory completion of the safety training and refresher courses shall be entered into the employee's permanent record with copies provided to the EH&S CSEP coordinator.

APPENDIX D

CONFINED SPACE HAZARDS

1) Hazards of Confined Spaces

Hazards specific to a confined space are dictated by the material stored or used in the space, the activity to be carried out in the space and the external environment. These can be categorized as atmospheric, physical, and biological hazards.

Hazardous atmospheres encountered in confined spaces can be further divided into four distinct categories: flammable, toxic, irritant\corrosive and asphyxiating.

2) Flammable Atmospheres

A flammable atmosphere generally arises from enriched oxygen atmospheres, vaporization of flammable liquids, byproducts of work, chemical reactions, combustible dusts or desorption of chemicals from inner surfaces of the confined space.

An atmosphere becomes flammable when the ratio of oxygen to combustible material in the air is neither too rich nor too lean to burn. Combustible gases or vapors will accumulate when there is inadequate ventilation in areas such as a confined space. Flammable gases such as hydrogen sulfide, acetylene, butane, propane, hydrogen, methane, natural or manufactured gases or vapors from liquid hydrocarbons can be trapped in confined spaces. Since many of these gases are heavier than air, they will seek the lowest levels. In a closed top tank, it should also be noted that lighter than air gases may rise and develop a flammable level at the top of the confined space.

The byproducts of work procedures can generate flammable or explosive conditions within a confined space. Specific kinds of work such as spray painting can release explosive gases and vapors. Welding in a confined space will burn up oxygen and can release explosive gases thereby changing the conditions in the space to those conducive to explosion.

Chemical reactions forming flammable atmospheres occur when surfaces are initially exposed to the atmosphere, or when chemicals combine to form flammable gases. This condition can arise when dilute sulfuric acid reacts with iron to form hydrogen gas or when calcium carbide makes contact with water to form acetylene. Other examples include acetylene-metal compounds, peroxides and nitrates. In a dry state these compounds have the potential to explode upon percussion or exposure to increased temperature. Another class of chemical reactions that form flammable atmospheres arise from deposits of pyrophoric substances (carbon, ferrous oxide, ferrous sulfate, iron, etc.) that can be found in tanks used by the chemical and petroleum industry. These tanks containing flammable deposits, can spontaneously ignite upon exposure to air.

Combustible dust concentrations are usually found during the process of loading, unloading and conveying grain products, fertilizers, finely ground chemical products and other combustible materials. High charges of static electricity, accumulating during periods of low humidity (below 50%), can cause certain substances to accumulate sufficient energy to produce sparks and ignite a flammable atmosphere. These sparks may also cause explosions when the right air or oxygen to dust or gas mixture is present.

Desorption of chemicals from the inner surfaces of a confined space is another process that can produce a flammable atmosphere. This is often a natural phenomenon in which the partial pressure at the interface between the surfaces and the stored chemical is radically reduced. For example, after liquid propane is removed from a storage tank the walls of the vessel can desorb the remaining gas from the porous surface of the confined space.

3) Toxic Atmospheres

The substances to be regarded as toxic in a confined space can cover the entire spectrum of gases, vapors fumes, aerosols and finely divided airborne dust. The sources include manufacturing processes, product storage and operations performed in the space.

Toxic gases can be evolved when acids are used for cleaning. Hydrochloric acid can react with iron sulfide to produce hydrogen sulfide (H_2S). H_2S is also formed from the decay of organic matter such as leaves, silage, and sewage. During loading, unloading, formulating and production, toxic gases can be produced which are not part of the planned operation.

Toxic solvents such as trichloroethylene, methyl chloroform and dichloromethane are used for cleaning and degreasing. Acrylonitrile has been encountered as an ingredient in protective coatings applied to tank interiors. Trichloroethane and dichloroethane are widely used as cleaning agents because they are among the least toxic of the chlorinated aliphatic hydrocarbons. However, deaths have occurred from asphyxiation and explosions from failure to thoroughly purge and inert confined spaces.

The compatibility of materials must be considered when structural members and equipment are introduced into confined spaces. The previous history of the space must be carefully evaluated to avoid reactions with residual chemicals, wall scale and sludge, which can be highly reactive. Cases of incompatibility have occurred during the use of chemical cleaning agents. The initial step in chemical cleaning usually is the conversion of the scale or sludge into liquid state, which may cause poisonous gases to be liberated.

Another hazardous gas that may buildup in a confined space is carbon monoxide (CO). This odorless, colorless gas having the same density as air is formed from incomplete combustion of organic materials such as wood, coal, gas, oil and gasoline. It can also be formed from microbial decomposition of organic matter in sewers, silos and fermentation tanks. CO is an insidious gas because of its lack of warning properties mentioned above. Early stages of intoxication are nausea and headache. CO can be fatal at 1000 parts per million (ppm) in air and is considered dangerous at 200 ppm. It acts to bind with the hemoglobin of the blood in the place of oxygen resulting in death through asphyxiation.

CO is relatively abundant and any untested atmosphere must be suspect. It must also be noted that a safe reading on a combustible gas indicator (explosimeter) does not ensure that CO is not present. CO must be tested for specifically as formulation can result from chemical reactions or work activities and fatalities are not confined to any specific industry. There have been accidents in sewage treatment plants, paint and varnish industry, and welding operations.

4) Irritant (corrosive) Atmospheres

Irritant or corrosive atmospheres can be divided into primary and secondary groups. The primary irritants exert no systemic effects because the products formed by them on tissues of the respiratory tract are non-irritant and other effects are so violent as to obscure any systemic action. Examples of primary irritants are chlorine, ozone, hydrochloric acid, hydrofluoric acid, sulfuric acid, nitrogen dioxide, ammonia and sulfur dioxide. A secondary irritant is one that may produce systemic toxic effects in addition to surface irritation. Examples of secondary irritants include benzene, carbon tetrachloride, ethyl chloride, trichloroethane, trichloroethylene, and chloroprene.

Irritant gases are widely used throughout all areas of industrial activity. They can be found in plastics plants, chemical plants, the petroleum industry, tanneries, refrigeration industries, paint manufacturing and mining operations.

Prolonged exposure to irritant or corrosive concentrations in a confined space may produce little or no evidence of irritation. This has been interpreted to mean that the worker has become adapted to the harmful agent involved. In reality, it means there has been a general weakening of the defense reflexes from changes in sensitivity, due to damage of the impacted nerve system. The danger in this situation is that the worker is usually not aware of any increase in his exposure to toxic substances.

5) Asphyxiating Atmospheres

The normal atmosphere is composed approximately of 20.9% oxygen, 78.1% nitrogen and 1% argon with small amounts of various other gases. Reduction of oxygen in a confined space may be the result of either consumption or displacement.

The consumption of oxygen takes place during combustion of flammable substances, as in welding, heating, cutting, and brazing. A more subtle consumption of oxygen occurs during bacterial action, as in the fermentation process. Oxygen may also be consumed during chemical reactions as in the formation of rust on the exposed surface of the confined space. The number of employees in a confined space and the amount of work will also influence the oxygen consumption rate.

A second factor in oxygen deficiency is displacement by another gas. Examples of gases that are used to displace air, and therefore reduce the oxygen level are helium, argon and nitrogen. Carbon dioxide may also be used to displace air and can occur naturally in sewers, storage bins, wells, tunnels, wine vats and grain elevators. Aside from the natural development of these gases or their use in the chemical process, certain gases are also used as inerting agents to displace flammable substances and retard pyrophoric reactions. Gases such as nitrogen, argon, helium and carbon dioxide are frequently referred to as non-toxic inert gases but have claimed many lives by asphyxiation. The use of nitrogen to inert a confined space has claimed more lives than carbon dioxide. The total displacement of oxygen with nitrogen will cause immediate collapse and death. Carbon dioxide and argon are both heavier than air and can lie in a tank or manhole for hours or days after opening. Since these gases are colorless and odorless, they pose an immediate hazard to health unless appropriate oxygen measurements and ventilation are adequately carried out.

Oxygen deprivation is one form of asphyxiation. While it is desirable to maintain the atmospheric oxygen level at 21% by volume, the body can tolerate deviation from this ideal. When the oxygen level falls to 17%, the first sign of hypoxia is a deterioration of night vision which is not noticeable until a normal oxygen concentration is restored. Physiologic effects are increased breathing volume and accelerated heartbeat. Between 14-16% the physiologic effects are increased breathing volume, accelerated heart beat, very poor coordination, rapid fatigue and intermittent respiration. Between 6-10% the effects are nausea, vomiting, inability to perform and unconsciousness. Less than 6% results in spasmodic breathing, convulsive movements and death in minutes.

6) Mechanical Safety Hazards

If activation of electrical or mechanical equipment would cause injury, each piece of equipment should be manually isolated to prevent inadvertent activation before work in a confined space commences. The interplay of hazards associated with a confined space, such as the potential of flammable vapors or gases being present and the build-up of static charge due to mechanical cleaning, such as abrasive blasting, all influence the precautions that must be taken.

To prevent vapor leaks, flashbacks and other hazards, employees should completely isolate the space. To do so means closing all valves and disconnecting or blanking all pipes. Other special precautions must be taken in cases where flammable liquids or vapors may re-contaminate the confined space. The lines that are disconnected\blanked should be inspected and tested for leaks to check the effectiveness of the procedure. Other areas of concern are steam valves; pressure lines and chemical transfer pipes. A less apparent hazard is the space referred to as a void, such as double walled vessels, which must be given special consideration in blanking off and inerting.

7) Communication Problems

Communication between the employee inside the space and the standby person outside is of utmost importance. If the employee should suddenly feel distressed and not be able to summon help, an injury could become fatal. Frequently, the body positions that are assumed in a confined space make it difficult for the standby person to detect an unconscious employee. When visual monitoring of personnel is not possible because of the design of the space, a voice activated explosion proof communication system shall be instituted.

8) Entry and Exit

Entry and exit time is of major significance as a physical limitation and is directly related to the potential hazard of the space. The extent of the precautions taken and the standby equipment needed to maintain a safe work area will be determined by the means of access and rescue.

The following should be considered:

- a) Type of confined space to be entered,
- b) Access to the entrance,
- c) Number and size of openings or barriers within the space,
- d) The occupancy load,
- e) The time requirement for exiting in the event of fire or vapor incursion,
- f) The time required to rescue injured employees.

9) Physical Hazards

The hazards described in this section are non-chemical, physiologic stressors. These include thermal, noise, vibration and fatigue while working in a confined space.

10) Thermal Effects

Four factors effect the interchange of heat between man and the environment. These include air temperature, air velocity, moisture content of the air and radiant heat. Because of the nature and design of most confined spaces, moisture content and radiant heat are difficult to control. As the body temperature rises progressively, employees will continue to function until the body temperature reaches about 100.9°F to 102.9°F. When this body temperature is exceeded, employees are less efficient and are prone to heat exhaustion, heat cramps or heat stroke. In a cold environment, certain physiologic mechanisms come into play which tend to limit heat loss and increase heat production. The most severe strain in cold situations is chilling of the extremities so that activity is restricted. Special precautions must be taken in cold environments to prevent frostbite, trench foot and general hypothermia.

Protective insulated clothing for both hot and cold environments will add additional bulk to the employee and must be considered in allowing for movement in the confined space and exit time.

Therefore, air temperature of the space becomes an important consideration when evaluating working conditions.

11) Noise

Noise problems are usually intensified in confined spaces because the interior tends to cause sound to reverberate and thus expose the employee to higher sound levels than those found in an open environment. This intensified noise increases the risk of hearing damage, which could result in temporary or permanent loss of hearing. Noise in a confined space, which may not be intense enough to cause hearing damage, may still disrupt verbal communication with the emergency standby person on the exterior of the space. If the employees inside are not able to hear commands or danger signals due to excessive noise, the probability of severe accidents will increase.

12) Vibration

Whole-body vibration may be regarded as a generalized stressor and may affect multiple body parts and organs depending upon the vibration characteristics. Segmental vibration, unlike whole-body vibration, is more localized in creating injury to the fingers and hands of employees using tools like pneumatic hammers and rotary grinders.

13) General

Some physical hazards cannot be eliminated because of the nature of the space or the work to be performed. These hazards include such items as scaffolding, surface residues and structural hazards. The use of scaffolding in confined spaces has contributed to many accidents caused by employees or materials falling, improper use of guardrails and lack of maintenance to insure employee safety. The choice of material used for scaffolding depends upon the type of work to be performed, the calculated weight to be supported, the surface on which the scaffolding is placed and the substance previously stored in the confined space.

Surface residues in confined spaces can increase the already hazardous conditions of electrical shock, reaction of incompatible materials, liberation of toxic substances and bodily injury due to slips and falls. Without protective clothing, additional hazards to health may arise due to surface residues.

Structural hazards within a confined space such as baffles in horizontal tanks, trays in vertical towers, bends in tunnels, overhead structural members, or scaffolding installed for maintenance constitute physical hazards, which are exacerbated by the physical surroundings. In dealing with structural hazards, employees must review and enforce safety precautions to assure safety.

Rescue procedures may require withdrawal of an injured or unconscious person. Careful planning must be given to the relationship between the internal structure, the exit opening and the employee. If the employee is above the opening, the system must include a rescue arrangement operated from outside the confined space by which the employee can be lowered and removed without injury.

Confined spaces present many hazards that are inherent by design and exacerbated by definition. However, through proper training, evaluation and controls, duties can be conducted in a safe and efficient manner.